Essays on Competition and Innovations in the Automobile Markets

Inauguraldissertation
zur Erlangung des akademischen Grades
eines Doktors der Wirtschaftswissenschaften
der Universität Mannheim

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vorgelegt im Wintersemester 2007

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Tag der mündlichen Prüfung: Dezember 17, 2007

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April 14, 2008

Dissertation abstract

The central focus of my dissertation has been on the investigation of developments towards more competitive and innovative firm behaviour in the global automobile markets. The automobile companies meet each other in many product and geographical markets worldwide. A large proportion of their production is outside of their "home" country. In my work I focus on international most important car markets, namely US, European and German as the most important single European car market and a very innovative one. The increased competition in the automobile markets coexists with a trend towards more interfirm relationships (both equity and contractual, horizontal and vertical), which results in the complicated dynamic structure of the ownership and firm interactions in the automobile industry. The automotive manufacturers put also a lot of emphasis on innovation and new products introduction to preserve and/or increase their market shares (especially in the satiated triad traditional markets of Western Europe, United States and Japan). They try to win consumer loyalty already in the entry car market segments.

In addition to the automobile industry focus of my dissertation, this work has been also aimed to be a contribution to the growing literature on the new empirical approaches in the IO, namely the estimation of structural oligopoly models for differentiated products. I study market conduct, the extent of competition and the effects of new products introduction, which actually have not been investigated so much empirically, in general and for the automobile industry in particular. The major focus of the first two papers is on the investigation of the firms' strategic behaviour interdependence across the markets and testing of the mutual forbearance hypothesis for the automobile markets. I use both menu and conjectural variation approaches to determine the equilibrium patterns of the firm behaviour in the automobile markets. Under the menu approach the firm equilibrium behaviour is identified with the help of statistical tests, which also have not been applied extensively in the past for the structural oligopoly models for differentiated products. The reliability of the results of

such tests is addressed. Under the conjectural variation approach I construct the market conduct parameters and investigate the factors that may impact those firms' conjectures. In the third paper I focus on the investigation of the effects from the introduction of new car models in the automobile industry. The impact of new products and brand-name reputation on the market shares and the importance of such principle of differentiation as old versus new car models are investigated.

Demand side is derived from discrete choice models: depending on the data available, different specifications on the demand side are estimated. The product-level data on quantities, prices and product characteristics are used. Given the absence of individual-level data on consumer car purchases, some consumer heterogeneity is introduced into the models through using age sales data for the German car market and the information on the empirical income distribution in the US and in the European countries (Belgium, France, Germany, Italy and the UK) to derive reasonable substitution patterns. Both cross-sectional and panel data are used in the estimations.

The structure of my dissertation is as follows. The first essay of my dissertation investigates the mutual forbearance hypothesis and firm equilibrium interactions in the US automobile market. The second essay focuses on the impact of the degree of geographical and multiproduct market linkages on the firm behaviour in the European car market. The third paper looks at the innovation and competition patterns in the German automobile market.

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Chapter 1. Introduction

Introduction

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1 Structural models

Competition policy has exhibited growing interest in empirical oligopoly models to quantify the competitive effects of mergers, study market conduct, estimate the welfare effects of the introduction of new products, investigate deregulation effects, etc. In this part I would like to give a brief overview of structural oligopoly models for differentiated products, their general features and estimation challenges as well as I would like to discuss the use of such models to investigate market conduct and new products introduction in the differentiated products industries in my studies. The objective of this section is to make an introduction into the empirical methods that I am using in my dissertation, whereas their concrete application is discussed in more detail in my papers.

1.1 General features

Structural oligopoly models for differentiated products industries have some general features, which have to be paid attention to while estimating such models, in particular when aggregate-level data are used[1].

Both models of demand and supply are estimated in equilibrium. The model is derived from economic primitives such as utility and cost, unobserved factors are explicitly discussed, in this sense these models are considered to be "structural" models[2]. This allows conducting different simulations to derive policy implications. Cost and demand effects can be separated out because of the use of economic primitives. Estimation strategies depend on the properties of the "unobservables" in the model (Berry, Carnall, and Spiller, 1997).

[1] As compared to the aggregate-level data (i.e., market/product level data), the individual-level data are those data where the actual purchasing decisions of consumers, and, thus, their individual characteristics and characteristics of the products that they purchase are observed.

[2] The framework for structural econometric models has been in detail discussed by Reiss and Wolak (2005). These models incorporate economic structure and statistical assumptions. The models for differentiated products markets need more structure and assumptions as compared to the structural models for homogenous products.

Using discrete choice framework, demand is estimated using market-level data on prices, quantities and product characteristics. The seminal references are Berry (1994) and Berry, Levinsohn and Pakes (1995). Consumer preferences are projected onto a set of observed and unobserved product characteristics. The number of characteristics and not the number of products determine the parameter space in these models, thus, the dimensionality of estimating demand parameters is addressed[3].

Different assumptions on the consumer utility specification result in different demand models, the most widely used of which are simple logit, multinominal nested logit, and random coefficients/mixed logit models. These models imply different substitution patterns. The simple logit, although widely used because of its computational simplicity, yields the most unplausible substitution patterns (irrelevance of independent alternatives (IIA) property). The nested logit, also computationally easily tractable, as compared to the simple logit, solves the problem of the unreasonable substitution patterns to some extent through interacting product characteristics with an apriori grouping of product characteristics. The imposed groupings choice still restricts the correlation between the product attributes. The random coefficients model yields the most plausible substitution patterns through incorporating consumer heterogeneity, however, it is known for its computational complexity. The major challenge is that the product market share integral has no explicit form, so that the market share has to be simulated (the aggregation procedure has been suggested by Pakes (1986)). The second challenge is the inversion of the market share function to get the mean utility level of a product, which allows the use of standard instrumental variables techniques to estimate the demand parameters (the inversion routine for the mean utility has been suggested by Berry (1994)).

The choice of the relevant market equilibrium depends on the estimation of the demand systems. The sources for identification in the demand model may be differences in choice sets over time and markets, functional form, differences in the consumer characteristics (e.g., income) distribution across markets (Asker, 2004). Price equations are often used for the demand identification (e.g., Berry, Levinsohn and Pakes, 1995). An additional source of identification could be adding data, e.g., micro data on consumer characteristics to the aggregate product-level data (e.g., Petrin, 2002, Berry, Levinsohn and Pakes, 2004).

The price endogeneity (as well as market share endogeneity in nested logit models) needs to be solved in such models through finding an appropriate set of instruments, which will be discussed more in detail in the papers later.

Costs play an important role but are difficult to observe from the usual market-level data. Thus, some assumptions are needed to recover them. Usually static Bertrand-price competition is assumed as well as that the first-order conditions hold to recover the marginal costs. Constant marginal cost is usually assumed, first of all because of the data limitations as it is difficult to collect the data on the worldwide output across all models as in case of the automotive

[3] In a linear demand system with J products, J^2 parameters have to be estimated to capture the substitution patterns.

industry (Berry, Levinsohn and Pakes, 1999). In case of data availability the marginal costs equations can be estimated allowing for increasing/decreasing returns to scale. The price-setting assumption is in general consistent with automotive industry wisdom.

The retailers' pricing decisions are usually assumed away. Usually only the manufacturer side is taken into account, i.e., it is assumed that the manufacturers set prices and the retailers get some exogenous constant margins, or the retailers are assumed to be neutral pass-through intermediaries. There are some papers around that incorporate the distribution side into the profit-maximization task, or perform some policy simulations with it (e.g., Besanko et al., 2002, Bonnet et al., 2005, Villas-Boas et al., 2005, Brenkers and Verboven, 2006, Villas-Boas, 2006).

In general, on the technical (estimation) side, the structural oligopoly models for differentiated products are very sensitive to the choice of variables, functional forms, the choice of instruments, and different technical details (e.g., scaling of variables). The estimation of these models is very time-consuming, the use of the numerical methods is often accompanied by convergence problems.

1.2 Empirical analysis of market conduct

Structural oligopoly models for product differentiated markets have become more frequently used to evaluate market power, firm behaviour, merger effects, etc. Two major approaches towards identifying the firm behaviour are used in the empirical IO literature: the estimation and interpretation of conduct, or "conjectural variation" parameters and the use of the so-called 'menu' approach to identify the pattern of the firm behaviour. In my dissertation I use both these approaches. The idea behind them is discussed below whereas their concrete application is discussed in more detail in my essays.

The "conjectural variation" approach has been the first econometric application of firms' equilibrium interactions in oligopolistic markets (e.g., Iwata, 1974, Slade, 1987). The "conjectural variations" are defined as reactions of the competitors' to the firm's action. They are used to characterize the degree of competition in oligopoly markets[4]. Behaviour changes have been analyzed by Bresnahan (1981, 1987, 1989[5]), Porter (1983), etc. Nevo (1998) discusses the estimation of "conjectural variation" parameters in a differentiated products industry and argues that these parameters could be in principle identified but it is hard to satisfy the exclusion restrictions that are necessary for identification.

Later the menu approach has become used to study market conduct and different behavioural assumptions, following Gasmi, Laffont, and Vuong (1992). The problem of the interpretation of the values of the "conjectural variation"

[4]Nevo (1998) gives the following definition of the conjectural variation parameters: "By a conjectural variation I mean a continuous parameter that measures the degree of market power in an industry. This parameter can be interpreted as measuring, in some quantitative sense, how close the equilibrium outcome is to theoretical predictions, or as measuring the conjectures firms have regarding the competition".

[5]Bresnahan (1989) summarizes the early studies on market power.

parameters is solved within this approach. Gasmi, Laffont, and Vuong (1990) discuss a methodology to empirically analyze cooperative/non-cooperative behaviour of firms. A structural econometric approach foresees the simultaneous, or step-by-step estimation of demand and supply parameters and the specification of hypotheses about firms' strategic interactions (market conduct), after which the relative likelihood of each selected market structure (or relative performance) should be assessed.

The absence of real industry markups and marginal costs that could be used to assess the likelihood of different firm behaviours and, thus, could allow the precise identification of the firms' behaviour pattern has involved the need to develop statistical tests to evaluate the likelihood/relative performance of each firm behaviour scenario, and to find the market conduct, which is best supported by the data. Since the market structures are competing non-nested econometric models, the test for non-nested hypotheses should be used. Several approaches to selecting a model among non-nested hypotheses can be found in the literature. Below I describe the intuition and most important references for those tests that I use later in my papers: Vuong-type and Cox-type tests[6].

The model selection tests (e.g., Vuong, 1989, Rivers and Vuong, 2002) are often applied in the literature to choose among competing non-nested econometric models. The idea behind the Vuong-type tests is first of all to derive equilibrium conditions under different assumptions. Demand parameters and cost shifters (assuming a particular form for a cost function) determine the price-cost margins. The demand parameters are estimated in the first stage. In the second stage the pricing equation is estimated. Two competing models are compared: the null hypothesis is that the models are asymptotically equivalent, while the alternative hypothesis is that one model performs better than the other. The test is applied to different pairs of non-nested models, some of these models can be rejected, so that at the end of the day some preferred supply-side specification could be selected. Rivers and Vuong (2002) develop the generalization of the Vuong (1989) tests, which are applied in case of maximum likelihood estimation, to the broader class of estimations (in particular, GMM).

Another method to test among non-nested hypotheses follows the tradition of Cox (1961) and Mizon and Richard (1986). These are the so-called specification tests. The intuition behind the Cox-type tests (e.g., Davidson and MacKinnon, 1981) is that if the price-cost margin from a given model has a statistically significant impact on the price-cost margin from another model, that means that the latter model should be rejected. This test is very easy to implement in practice. Within this approach, the two non-nested models are embedded into a more general artificial model. MacKinnon, Davidson, and White (1983) extend the results of Davidson and MacKinnon (1981) paper, in particular to the cases when there are lagged dependent variables, or when the dependent variables in the non-nested models are different transformations of each other. As compared to the Vuong-type tests, under the Cox-type tests one of the tested

[6] There are also some 'omnibus' specifications tests (e.g., Hausman, 1978, White, 1982), under which that model is preferred, which is not rejected by any such tests (Gasmi et al., 1990). I do not apply these tests in my estimations.

models needs to be correctly specified, while the competing models might only approximate what happened in reality in the best case.

The major problem with the tests for non-nested hypotheses is that several hypotheses can be accepted or rejected. Other approaches to choose between non-nested models are fit measures, e.g., R-squared, adjusted R-squared, information criteria (Akaike information criterion, Schwartz criterion) (Greene, 2000).

Notwithstanding the variety of tests in the theoretical econometrics literature, the tests have not been so extensively used in the new empirical IO studies. Some examples include Bresnahan (1987, Cox (1961) test), Feenstra and Levinsohn (1995, Davidson and MacKinnon (1981) test), Jaumandreu and Lorences (2002, Rivers and Vuong (2002) test), etc. Many authors just consider and discuss the effects of alternative firm behavioural specifications (e.g., Berry, Levinsohn and Pakes, 1999, Jaumandreu and Moral, 2006).

1.3 Empirical analysis of new products introduction

Characteristics-based models have become an important tool in the empirical analysis of differentiated products. Utility functions are defined on product characteristics instead of products per se. The distribution of utility and cost functions, together with an equilibrium assumption, determine the relationship between prices and characteristics (Pakes, 2004).

The use of differentiated products models to study welfare implications from new goods introduction depends on the advances in the discrete choice literature (in particular, the use of aggregate market-level data). Demand estimation is a very crucial component in the studies about the introduction of new products in the differentiated products industries. Consumer preferences, which depend on consumers' characteristics and products' attributes, are explicitly aggregated in these models to get the demand function. On the supply side, it is assumed that firms set their prices to maximize single-period profits. Characteristics define preferences in these models, that is why, the change in utility due to the change in the product choice set can be evaluated. Discrete choice models, thus, accomodate entry and exit of products. Consequently, these models are attractive to use for studying the implications from new goods introduction (Pakes et al., 1993).

The actual choice of the characteristics of the models marketed is not endogenized. Even within existing models of dynamic industry equilibrium this is rather challenging to do (Berry, Levinsohn and Pakes, 1995).

There have been a few studies that study the impact of the introduction of new goods, and subsequent product placement decisions in the automotive industry (e.g., Petrin, 2002, Berry, Levinsohn, and Pakes, 2004). The differentiated products models allow approximating the likely returns to potential products (through performing counterfactuals, or simulations) and returns to the introduced new products through calculating their markups (and calculating producer variable profits). Producer and consumer surplus from the new products launching can be estimated. The producer profits from new products could be compared with product development costs to get the estimate of the returns on investment.

Besides, the products can be also nested into groups on the basis of certain principles of differentiation, in particular, into new and old products classes. Inter-group and intra-group competition could be then investigated, in particular to see whether the new products constitute a separate market niche, or they compete with the old products as well. This approach has been pioneered by Bresnahan et al. (1997) to study the impact of new products and brand-name reputation on the market shares in the PC market, however, it seems not to be applied afterwards in the empirical research of new products.

2 Overview of the three essays

2.1 Essay 1. Market power, multimarket contact and pricing: some evidence from the US automobile market

Multimarket contact is perceived to be one of those factors, which can facilitate and sustain implicit collusive (cooperative) arrangements. This paper attempts to develop new approaches to study the interdependence of firm behaviour across markets, especially in the context of differentiated products industries. I ask how to conduct a test of the mutual forbearance hypothesis in principle, and how to apply it using particular data. The multimarket contact effects are studied within a structural oligopoly model for differentiated products for the US automobile market on the basis of the aggregate product-level data for 2001-2003.

Some support has been found that multimarket contact may influence competition in the automobile market and increase the firms' strategic interdependence. This effect is, however, difficult to disentangle from the effect of the market concentration in the US automobile market (dominance of the market by the American Big Three) on the firm behaviour, which could also facilitate collusion. In other words, it is difficult to argue whether coordination is due to market concentration, or due to multimarket contact, or it can be attributed to both. Concentration is argued to foster the slack, which is transferred through the multimarket contact.

2.2 Essay 2. Geographical and multi-product linkages of markets: impact on firm equilibrium interactions (some evidence from the European car market)

This paper aims to study geographical and multi-product linkages of markets (multiple market presence) and firm behaviour interdependence as a result of such linkages existence. In particular, it attempts to answer whether the multimarket linkages lead to more cooperative behaviour among the firms, which results in higher prices and profits, and whether the degree of collusive/cooperative behaviour varies across markets. These issues are investigated within a structural oligopoly model for differentiated products for the European automobile market on the basis of the aggregate product-level data for 1970-1999. The results of the study reveal weak (quantitative) effect of multimarket contact on market conduct/pricing in the European car market as well as provide some evidence on the redistribution of the market power from the more collusive to the more competitive markets due to multimarket contact.

2.3 Essay 3. Private incentives to innovate: interplay of new products and brand-name reputation

This paper studies the introduction of new products (increase in product variety) in the automobile industry. The focus is on the two sources of market power that may allow the firms to get higher profits (and, thus, recoup investments): new products and brand-name reputation. The effects of new products on the private incentives to innovate are investigated on the basis of the dataset for the German car industry for 2003. The dataset is rather unique in the sense that it contains detailed information on the technical characteristics of cars, prices and sales as well as information on the introduction of new car models (including new variants and versions) into the German car market at a very disaggregate level. It has been found that both a new model and brand-name reputation may allow the innovative firms to get some market power and recoup their investments. Competition is, however, not localized within a market segment and the class of new, or old models, i.e., products from different market segments, new and old products compete with each other (coexisting and not eliminating each other) and do not constitute separate market niches. On the other hand, new (old) models are perceived to be closer substitutes than old (new) models. Consumer preferences towards brand and new products vary depending on their age.

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Chapter 2. Market Power, Multimarket Contact and Pricing: Some Evidence from the US Automobile Market

Market Power, Multimarket Contact and Pricing: Some Evidence from the US Automobile Market*

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Abstract

Multimarket contact is perceived to be one of those factors, which can facilitate and sustain implicit collusive (cooperative) arrangements. This paper attempts to develop new approaches to study the interdependence of firm behaviour across markets, especially in the context of differentiated products industries. I ask how to conduct a test of the mutual forbearance hypothesis in principle, and how to apply it using particular data. The multimarket contact effects are studied within a structural oligopoly model for differentiated products for the US automobile market on the basis of the aggregate product-level data for 2001-2003.

Some support has been found that multimarket contact may influence competition in the automobile market and increase the firms' strategic interdependence. This effect is, however, difficult to disentangle from the effect of the market concentration in the US automobile market (dominance of the market by the American Big Three) on the firm behaviour, which could also facilitate collusion. In other words, it is difficult to argue whether coordination is due to market concentration, or due to multimarket contact, or it can be attributed to both. Concentration is argued to foster the slack, which is transferred through the multimarket contact.

*I am thankful for the financial support from the German Research Foundation (Deutsche Forschungsgemeinschaft (DFG)) and the Center for European Economic Research (ZEW) during my doctoral studies at the Center for Doctoral Studies in Economics (CDSE), University of Mannheim. The comments of Dr. Georg Licht, Prof. Konrad Stahl, Prof. Jordi Jaumandreu, Prof. Dr. Ulrich Kaiser, Andrey Ivanov, Alia Gisatulina, the participants of the CDSE doctoral seminar (Mannheim), 2006 ENTER Jamboree (SSE, Stockholm), 2006 SFB Workshop (Würzburg), 2006 IIOC (Boston, MA), 2006 EARIE conference (Amsterdam), 2007 1st RNIC conference (Mannheim) and the Econometric Society Session during 2007 ESEM-EEA European Joint Meeting (Budapest) are very appreciated.

1 Introduction

Multiple competition, or multimarket contact rivalry, has become very important in the contemporary competitive strategy literature. Multimarket contact is perceived to be one of those factors, which can facilitate and sustain implicit collusion. This multimarket contact effect has got relatively little attention in the previous literature, although the theoretical and empirical discussion has somehow revived in the 1990s after the seminal paper by Bernheim and Whinston (1990).

The major objective of this paper has been to verify the existence and significance of the effect of the multimarket contact on the tacit collusion, through developing a new methodology, or approaches. The paper addresses two major issues: how to conduct the test of the mutual forbearance hypothesis in principle (to try to solve the problem of the previous inconclusive empirical evidence and address the weaknesses of the previous empirical studies), and how to implement a test using particular data (especially when some multimarket contact measure may not be readily available, or when the desirable situation for observing the multimarket contact effects on cooperative behaviour is not observable, however, the multimarket contact is present in an industry of interest).

Competition policy has exhibited growing interest in empirical oligopoly models to quantify the competitive effects of mergers, study market conduct, estimate the welfare effects of the introduction of new products, investigate deregulation effects, etc. In this paper, the multimarket contact effects on collusion are tested on the basis of the structural oligopoly model for differentiated products and estimated on the basis of the market-level data on prices, quantities, and product characteristics. The differentiated products demand is derived from the discrete choice framework. With a complete specification of the demand and cost conditions, the hypothesis of the mutual forbearance and of the traditional view of no interdependence of the firm behaviour across the markets can be tested directly. Different hypotheses on the firms' equilibrium interactions, including the hypothesis of collusive behaviour due to multimarket contact, are developed and tested in this paper through imposing specific assumptions on the firms' equilibrium interactions. Non-nested procedures and goodness-of-fit criteria are then applied to choose between different models of the firm behaviour.

Given the absence of the publicly available information on price-cost margins, it is important to look at the results of several tests or goodness-of-fit criteria (conduct robustness checks) to choose the most preferred specification for the supply side (i.e., the model that best fits the data). Non-nested procedures (MacKinnon, White, and Davidson, 1983, and Rivers and Vuong, 2002) are in particular applied in this paper to choose between different models of the firm behaviour.

The multimarket contact effects on oligopolistic coordination are tested for the automotive industry, on the basis of the product-level data for the US light vehicles market for 2001-2003. The automotive industry appears to be an interesting case for studying the above mentioned effects as it is characterized by extensive multimarket contact both across the product and geographical markets dimensions. The industry has undergone a significant consolidation process, which resulted in about 13 major independent OEMs, which are present in virtually all market segments and across different geographic regions. In this paper the multimarket contact is defined on a product segment level in the light vehicles market within one geographical market, namely the US car market.

The automotive industry has become a subject of empirical studies at the product level starting with Bresnahan (1981)[1], and later a number of studies appearing after Berry (1994) and Berry, Levinsohn and Pakes (1995) papers, relying on the advances in the discrete choice literature. Some automotive industry papers study the equilibrium firm interactions (e.g., Bresnahan, 1981, 1987, Feenstra and Levinsohn, 1995, Verboven, 1996, 1999, Berry, Levinsohn, and Pakes, 1999[2], Sudhir, 2001, Goldberg and Verboven, 2001, Brenkers and Verboven, 2006), but only a few of them study (directly, or indirectly) collusive behaviour (e.g., Bresnahan, 1981, 1987[3], Verboven, 1996, Sudhir, 2001, Goldberg and Verboven, 2001)[4]. In the automotive industry studies, which are based upon the estimation of the structural oligopoly models, Bertrand-Nash equilibrium is usually assumed, which may be not quite correct as the repeated interaction among the automotive firms may destroy the Bertrand outcome as well as the concentrated structure of the industry could foster cooperative behaviour. In some studies, Cournot equilibrium, or some "mixed" equilibrium is estimated (e.g., Feenstra and Levinsohn, 1995, Berry, Levinsohn and Pakes, 1999).

The literature on the firm behaviour pattern in different automotive market segments is scarce, the only exception is the paper by Sudhir (1991)[5]. The author studies the competitive pricing behaviour in the US automobile market in 1981-1990 and competitive interactions in each segment of the market using the conjectural variation approach (this is different to the other papers, which estimate the average competitive interactions across all automobile market segments). Cooperative, or aggressive behaviour is measured based on the degree of deviation from the Bertrand prices. The author finds the following firm behaviour patterns: aggressive behaviour in the minicompact and subcompact segments, cooperative behaviour in the compact and mid-size segments,

[1] There exists, however, some earlier studies that construct hedonic price indexes for the automobile industry (e.g., Court, 1939, Griliches, 1961, Ohta and Griliches, 1983).

[2] Berry, Levinsohn, and Pakes (1999) try to distinguish between three alternative equilibria for the American car market: Bertrand, Cournot, and some "mixed" equilibrium (i.e., price and quantity competition for different sets of firms).

[3] Bresnahan (1981) studies the firm behaviour in the American car market in 1977 and 1978 and estimates the price-cost margins during this period of time, as well as looks at the impact of import competition on the margins. Bresnahan (1987) investigates a supply-side shock in the American automobile market in 1995 and attributes this shock to the price war, while in the neighbouring years the firm behaviour could be characterized as collusive.

[4] Verboven (1996) and Goldberg and Verboven (2001) study the European car market.

[5] Brenkers and Verboven (2006) estimate correlation parameters (two-level nested logit) across the market segments for the European car market and make some inferences about the competition pattern in each market segment on the basis of those estimated correlation parameters.

which is consistent with prior expectations, and Bertrand pricing behaviour in the full-size segment. As it is mentioned by Bernheim and Whinston (1990), in case of heterogenous products, there may be different degrees of collusion in different markets due to the multimarket contact based on the demand and cost conditions.

In this paper I have found that multimarket contact may influence competition in the automobile market and increase the firms' strategic interdependence. This effect is, however, difficult to disentangle from the effect of the market concentration in the US automobile market (dominance of the market by the American Big Three) on the firm behaviour. In other words, it is difficult to argue whether coordination is due to market concentration, or due to multimarket contact, or it can be attributed to both. Concentration is argued to foster the slack, which is transferred through the multimarket contact.

The paper is organized in the following way. First I discuss theoretical and empirical literature related to multimarket contact effects on firm behaviour. After an overview of multimarket and multi-firm (multi-brand) linkages in the US automobile market, I move to the description of the empirical oligopoly model, multimarket contact test methodology, and estimation procedure. The paper concludes with the presentation and discussion of the results.

2 Multimarket contact theory and empirics

2.1 Theory

Multimarket contact (alternatively, multimarket/multiple competition, multipoint rivalry) can be observed in a number of situations: a firm can produce multiple products, or a single-product firm can operate in a number of geographical markets, a conglomerate may be represented along several business lines (Bernheim and Whinston, 1990). It is perceived to be one of those factors, which can facilitate and sustain implicit collusion, or facilitate oligopolistic consensus among firms engaged in noncooperative rivalry. From the theoretical point of view, there have been opposing opinions on the impact of the multimarket contact on collusion. On the one hand, there is a mutual forbearance hypothesis by Edwards (1955), defined as the situation when the multimarket contact leads to more cooperation in all the markets that are common to the rivals (i.e., strong interdependence across the markets). Besides, there is a view similar to the mutual forbearance hypothesis, "linked oligopoly theory", developed for the banking industry by Solomon (1970). According to this theory, the degree of linkage across the (adjacent) markets, or the presence of a firm in the multiple markets, is one of the important determinants of performance in the oligopolistic environment. Oligopolistic coordination can be strengthened as a result of the multimarket contact.

On the contrary to Edwards (1955) and Solomon (1970), according to the more traditional point of view, coordination is due to market concentration (internal factor, structure of the market/technology), and not due to multimarket contact (external factor, firm behaviour) (Scherer and Ross, 1990). The increased concentration in the market creates barriers to entry and expands the possibilities for the interfirm coordination, thus, lowering the rates of entry and exit from the market. According to the strongest form of this approach, the multimarket firms behave like independent firms in each market, where competition is determined only by those market factors.

In general, this aspect of multiple competition, namely the relationship between the multimarket contact and firm behaviour, in particular, reduction in the firm competition intensity/facilitation of the mutual forbearance[6], or increasing in general the firms' strategic interdependence (multiplicity of products and markets leading to strategic behaviour that otherwise would not be present) has got relatively little attention in the previous literature, although the theoretical and empirical discussion has somehow revived in the 1990s.

The more recent theoretical literature on the mutual forbearance hypothesis is represented by the contributions by Bernheim and Whinston (1990), Verboven (1998), Spagnolo (1999), and Matsushima (2001). Bernheim and Whinston (1990) state that the multimarket contact may lessen the degree of the competition between the rivals, as the multiple competitors are more likely to recognize their mutual dependence, and to sustain collusion across the range of markets, in which they meet. The firms can distribute their market power through pooling the incentive constraints across the markets (the so-called strategic effects): they can decrease prices and give up profits in the more collusive markets in order to facilitate collusion, raise prices and increase profits in the more competitive markets, as long as their total profits are maximized.

Bulow, Geanokoplos and Klemperer (1985) study the strategic interaction of firms due to cost- and demand-based linkages across markets. They just state that demand- and cost-related linkages lead to linkages in strategic interaction, however, they do not analyze whether multimarket contact may facilitate collusive outcomes. Bernheim and Whinston (1990) assume away these linkages to highlight the strategic linkages across markets. They point out several conditions that lead to multimarket contact fostering collusion: different firms, different markets, and scale economies. "Spheres of influence" could be developed when there are production costs differences across firms, or there are scale economies, which would allow the firms to have higher prices and profits. The maintenance of collusive prices may be facilitated in case of geographically-based reciprocal trade of output. There is an incentive towards multimarket diversification when the markets could be subjected to random shocks that are imperfectly correlated.

Verboven (1998) looks at the relationship between localized competition, multimarket operation and collusive behaviour. In case of localized competition, firms meet with different sets of rivals. As a result, there are problems of private information concerning the past actions of the firms. Strategies with sufficiently lenient punishments should be adopted by firms because of the resulting

[6] The terms "mutual forbearance hypothesis", "multimarket contact hypothesis", "linked oligopoly theory" are synonyms in this paper as they are used by different authors to explain essentially the same phenomenon.

communication problems. Spagnolo (1999) gives the more general conditions for the effect of the multimarket contact on collusion, and argues that multimarket contact always leads to collusion, independently from asymmetries between markets and firms, when a firm's static objective function is strictly concave, which makes the market supergames to be interdependent: a firm's payoff in each market is dependent upon how it is doing in the other markets. Matsushima (2001) investigates the issue of the multimarket contact under imperfect monitoring, and finds support for the existence of the multimarket contact effect on collusion as well[7].

2.2 Empirical evidence

There have been several experimental studies on the effects of the multimarket contact on collusion. For example, Phillips and Mason (1992) find the experimental support for the game-theoretic predictions by Bernheim and Whinston (1990). In another study, Phillips and Mason (1996) state that due to the multimarket contact, some regulatory action in one market will impact the other market. These studies are based upon the comparison of the firm behaviour under single-market and multi-market situations. In particular, Phillips and Mason (1992) first have a distinct duopoly setting without any multimarket contact, and then they observe the behaviour of the subject pairs in the two experimental markets.

The existing empirical studies (e.g., Heggestand and Rhoades, 1978, Scott, 1982, Evans and Kessides, 1994, Parker and Röller, 1997), which are mostly done for airlines and banking industry, have failed to give conclusive evidence about the existence, sign and significance of the multimarket contact effect on collusion. These are mainly the cross-sectional studies. They concentrate on testing the multimarket contact effect, based on the construction of some multimarket contact measure, on the firm's performance (i.e., the so-called reduced-form approach), while there have been virtually no studies done on the multimarket contact effect on collusion within a structural model of firm behaviour (the only exceptions are the papers by Jans and Rosenbaum (1996) and Parker and Röller (1997) for the homogenous products[8]). A few studies concentrate on the estimation of the "conjectures" as a way to study the mutual forbearance hypothesis, i.e., the reactions of the other firms to the actions of the given firm (e.g., Gelfand and Spiller, 1987[9]). The existing empirical studies have a major problem to distinguish between internal (e.g., concentration, demand conditions,

[7] Recently there has been some emerging theoretical literature stating that multimarket contact may not always facilitate collusion (e.g., Thomas and Willig, 2006). This may be attributed to the imperfect monitoring of adherence to cooperation, which is observed in the situation of asymmetric information about rivals' actions.

[8] These papers also involve the construction of the multimarket contact measures.

[9] Although the authors argue that they study the mutual forbearance hypothesis in such a way, it seems as if their methodology were more applicable to study the firms' strategic interdependence in the sense of Bulow et al. (1985), or to study generally the firms' oligopolistic interactions. Bresnahan (1989) also advises not to use the "mutual forbearance language" in case of the "conjectures" estimation.

barriers to entry) and external effects (e.g., multimarket contact) upon the firm performance (Bernheim and Whinston, 1990).

Longitudinal data surrounding deregulatory episodes are sometimes used to study the effect of multimarket contact on collusion (e.g., Gelfand and Spiller, 1987, Parker and Röller, 1997). Gelfand and Spiller (1987) study the impact of the relaxation of legal entry restrictions in the Uruguayan banking sector on the development of multiproduct oligopolistic practices. Parker and Röller (1997) use the deregulation in the US telecommunications industry to study the multimarket contact effects: they investigate the impact of the movement from monopoly to duopoly situation (e.g., movement to multimarket contact situation) on the market conduct.

3 Multi-market and multi-firm (multi-brand) linkages in the US automobile market

3.1 Market definition

Market definition is very important in the multimarket contact effects studies: markets should be strictly defined (it is also a crucial question in many antitrust investigations). In general, market boundaries could be outlined on the basis of several approaches. For example, the market boundaries could be delineated by the low cross-price elasticity of demand (on the basis of the econometric estimation of price elasticities). Another important empirical method of the market boundaries delineation is price correlation analysis. Other less frequently used methods are consumer interviews, shock analysis, Granger causality and cointegration tests, etc. (Bishop and Baldauf, 2006).

Given the industry wisdom about automotive market segmentation and that usually the cross-price elasticities of demand for cars in a given market segment with respect to the cars in a different market segment are found to be low in the empirical studies, the definition of market segments seems to be suitable for the definition of markets, across which the multimarket contact effects could be investigated for the automobile industry. Brenkers and Verboven (2006b) study the market definition in the European car market and find that the segments are the relevant markets for all car classes (subcompact, compact, intermediate, standard/luxury, and sports), except for minivans, for which the relevant market definition should be the aggregate country level, i.e., all new cars. They recommend the competition authorities to investigate the impact of their policies for each car market segment separately. Sudhir (2001) finds a different competition pattern across market segments in the US car market[10]. Consumers within each

[10] Sudhir (2001) argues that the greater concentration in the larger-car segments leads to more cooperation in these segments. The smaller-car segments are characterized by greater uncertainty in consumer demand. The customers are more loyal and less price-sensitive in the segments targeted to older or repeat customers, where the gains from the new customers could be more than offset by the profit margins losses from the existing customer base. The presence of the Bertrand price competition for the full-size segment is contrary to the prior

market segment are expected to be internally homogenous and externally heterogenous. They may be similar within a market segment on the basis of age, income, lifestyle, brand loyalty, readiness to buy, etc. To sum up, industry analysts and academic researchers support the view that the car market segments constitute distinct sub-markets, which differ in consumer demand, technology and competitors' type (Requena-Silvente and Walker, 2005).

With respect to demand linkages in the automobile market, the question is to what extent cars from different market segments substitutes are. As it has been mentioned above, the cross-price elasticities with respect to the cars from the other market segments are usually found to be low. Car customers are younger, with lower incomes, and, thus, more price-sensitive in the smaller car market segments and older, with higher incomes, and less price-sensitive in the premium car market segments. Thus, it is unlikely that consumers from a luxury car market segment will switch to a small car/mini car segment when there is a price increase in the luxury car segment, and vice versa. The product substitution between the adjacent markets (e.g., compact and subcompact cars) is more plausible. In addition, the diversity in the price dispersion for different market segments could be some support for the existence of distinct markets. On the supply side, there are likely to be economies of scale and scope across market segments for the automotive manufacturers, which rely a lot on the minimum efficiency scale (MES) to be profitable.

3.2 Multimarket presence in the US automobile market

As it has been mentioned above, the automobile market offers a nice possibility to study the multimarket contact effects on mutual forbearance across product lines and across geographical dimensions (i.e., the so-called geographic-product markets). The industry consolidation has resulted in a few major independent producers (see Table 1), which operate across a number of geographical markets (US, Western Europe, Japan, etc.)[11]. On the other hand, the development of the light trucks market has increased a number of product markets, across which the automotive firms interact.

Table 1. Interdependence of automotive manufacturers

expectations of cooperative behaviour. The author attributes this effect to the high volatility in this segment, which prevents from cooperation. This volatility is addressed to the declining market share of this segment, so that to preserve the market shares, the firms price aggressively, and the firm behaviour is close to the Bertrand short-run equilibrium. More empirical evidence on this issue and, in particular, more studies on the firm behaviour across different market segments could be necessary.

[11] In recent years there have been continuous changes in the corporate ownership of automobile companies. One of the recent most important changes has been the disengagement of Daimler from Chrysler: the private equity company Cerberus Capital Management L.P. has concluded the deal of purchasing 80.1% of the Chrysler Group from DaimlerChrysler in August 2007 for USD 7.4 bn. However, the picture of the ownership in Table 1 is relevant for the period of my estimations, i.e., 2001-2003, and I conduct my analysis on the basis of the ownership observed at that time.

Manufacturer group	Companies and share	Further ownerships
GM Group	Opel/Vauxhall (100%)	
	Saab (100%)	
	Isuzu (12%)	
	Suzuki (20%)	Maruti (54%)
	Fuji Heavy (20%)	
	Daewoo (42%)	
	Fiat (10%)	
Ford Group	Aston Martin (100%)	
	Jaguar (100%)	
	Mazda (33%)	
	Volvo (100%)	
	Land Rover (100%)	
DaimlerChrysler Group	Mercedes-Benz (100%)	
	Chrysler (100%)	
	Smart (100%)	
	Maybach (100%)	
	Mitsubishi (24.7%)	
Fiat Group	Fiat Auto (90%)	Alfa (100%)
		Lancia (100%)
	Ferrari (90%)	Maserati (100%)
Renault/Nissan Group	Dacia (100%)	
	Nissan (44%)	
	Samsung (70.1%)	
VW Group	Audi (100%)	Lamborghini (100%)
	Seat (100%)	
	Skoda (100%)	
	Bugatti (100%)	
	Bentley (100%)	
Toyota	Daihatsu (52%)	
BMW	Rolls Royce (100%)	
	Mini (100%)	
PSA	Peugeot (100%)	
	Citroen (100%)	
Hyundai	Kia (60%)	
	Asia (100%)	
Honda		
Porsche		
Rover	MG	
	Triumph, etc.	

Source: Deutsche Bank (2004)

The development of the light vehicles market is, in particular, a peculiar feature of the US automotive industry. At present, the light trucks sales make up about half of the total vehicles market sales in the US, increasing from about 32% in 1990. The most important market segments in the US are midrange

(24.7% in 2003), pickup (18.1%) and sports-utility vehicles (SUVs) (26.7%). The mid-size segment share decreased from 28.3% in 1999 to 24.7% in 2003 of the total market sales, which may be to a certain degree attributed to the increased competition from the SUVs. During 2000-2003 there has been an especially vivid trend in the growth of the SUVs market share, and the market segments developments have been rather volatile as reflected by the observed growth rates (see Table 2). The SUVs market was the only growing market during 2000-2003, with the total light trucks showing positive growth rates. The shares of the mid-range, traditional, pickup, and van segments declined, and the shares of the small, upscale, and sporty market segments remained stable during 1999-2003[12].

Table 2. US light vehicles market: shares of segment sales in total light vehicles sales, and % change to the previous year

[12] Some studies have considered the impact of multimarket contact on current market growth rates (e.g., Haveman and Nonnemaker, 2000). The authors argue that the firms' interdependence is strengthened by the growth in the current markets if the firms are present in multiple markets, so that the negative relationship between multimarket contact and the current markets growth rates will be then observed. Evans and Kessides (1994) argue that if the demand growth rates differ across markets, the firms may shift their punishment power from the rapidly to the slowly growing industries.

	1999	2000	2001	2002	2003
Small					
share	10.4	10.8	10.9	10.3	10.3
% change		7.3	-1.0	-7.3	-1.0
Mid-range					
share	28.3	27.6	27.1	27.0	24.7
% change		0.1	-3.2	-2.1	-9.4
Traditional					
share	3.6	3.5	3.1	2.6	2.3
% change		-0.6	-13.1	-17.3	-11.5
Upscale					
share	6.4	6.6	6.1	6.2	6.3
% change		5.8	-9.4	-0.8	1.7
Sporty					
share	2.9	3.1	3.2	3.2	3.0
% change		11.0	-0.3	-2.3	-5.1
Total cars					
share	51.6	51.7	50.4	49.4	46.8
% change		2.9	-3.9	-3.9	-6.1
Pickup					
share	19.3	18.7	18.6	17.6	18.1
% change		-0.7	-1.6	-7.5	1.7
Van					
share	10.4	10.2	8.9	8.7	8.4
% change		1.4	-14.0	-4.2	-4.9
SUV					
share	18.7	19.3	22.0	24.3	26.7
% change		6.1	12.6	8.3	8.7
Total light trucks					
share	48.4	48.3	49.6	50.6	53.2
% change		2.4	1.4	0.1	3.9
Total light vehicles					
% change		2.7	-1.3	-1.9	-1.0

Source: Automotive News Market Data Book, own calculations

The picture of the multimarket contact presence in the automobile market can be, to a certain degree, inferred from Table 3. As it can be seen, the car manufacturer groups are present in almost all market segments. The product lines of many automotive manufacturers have become rather similar and their product markets, therefore, overlap. The US traditional car market segment is especially concentrated and is characterized by the high presence of the domestic automotive producers, only Toyota having a 13.2% market share in 2003. C-4 concentration ratio for individual market segments ranges from 65.4% in the sporty market segment, where the largest number of producers is present, to 100% in the traditional market segment, with only four producers being present.

Table 3. US light vehicles market: shares in segments, %, 2003

Group	Small	Mid-range	Tradition	Up scale	Sporty	Pick up	Van	SUV
Honda		17.2		6.6	6.4		11.0	8.4
GM	26.9	32.5	36.3	18.4	6.1	35.2	24.3	32.0
Daimler/ Chrysler	7.2	9.2	7.4	16.1	9.6	18.6	28.4	14.3
Hyundai/ Kia	16.8	3.3			4.2		3.6	3.3
VW		8.0		2.7	1.7		0.3	0.4
Ford	19.4	10.8	43.0	21.3	36.7	35.5	23.2	22.2
Toyota	21.2	9.9	13.2	11.0	5.5	8.5	7.5	11.6
Renault/ Nissan	5.6	7.3		6.8	7.3	2.2	1.7	4.5
Mitsubishi	2.9	1.8			7.7			2.1
BMW				17.0	11.3			0.9
Fiat				0.1	0.3			
Porsche					3.1			0.3
No. firms	7	9	4	9	12	5	8	11
C-1	26.9	32.5	43.0	21.3	36.7	35.5	28.4	32.0
C-4	84.3	70.5	100	72.8	65.4	97.8	86.8	80.1
Domination of a market segment (C-1 ratio)	GM	GM	Ford	Ford	Ford	GM, Ford	Chrysler, GM	GM

Source: Automotive News Market Data Book, own calculations

The firms occupy different market shares/have different strengths in different market segments ("based on market share dominance"), which may be found due to the difference in the production costs between the firms, or due to the presence of the economies of scale, "home" brand loyalty, first-mover advantage, etc. American Big Three dominate different product markets. GM dominates (occupies the highest share of the market segment) small, midrange, pickup and SUVs market segments. Ford has the largest market shares in the traditional, upscale, sporty and pickup market segments, while Chrysler dominates the van market segment. Toyota, although, not dominating any market segment, has the highest market share in the small car market segment. Honda, Hyundai/Kia, VW, Renault/Nissan, Mitsubishi and BMW have a large market share in the mid-range market segment, in the small car market segment, in the midrange car market segment, in the midrange and sporty market segments, in the sporty market segment, and in the upscale market segment, respectively. Thus, it can be argued that producers occupy rather different positions of strengths in different markets, notwithstanding the obvious dominance of the automobile market by the American Big Three.

Table 4 gives an overview of the "most important" and "less important" markets for the automobile manufacturers as defined by the shares of the firm's market segment sales in the firm's total sales. The "importance" of the market, or "market share dependence" can be also measured by the percentage of the firm's total revenue/sales represented by the market. As for the American Big Three, Ford has the highest firm's shares in the pickup and SUVs market segments and has been known for its competitive advantage in the SUV market. For GM, the SUVs and midrange market segments are the most important market segments in the sales of a firm. Chrysler has high market shares in the pickup and SUVs market segments and is known to have a competitive advantage in the van segment, where it has the highest share among all the firms. For all American Big Three the SUVs is a very important market segment. As for the other car producers, for example, for Honda the midrange market segment is the most important market, while BMW gets most of its profits from selling cars in the upscale market, and for both firms the SUVs market is important.

Table 4. US light vehicles market: shares in a firm's total sales, %, 2003

	Small	Mid-range	Tradi tion	Up scale	Sporty	Pick up	Van	SUV	Share in total US sales
Honda		53.1		5.2	2.4		11.4	27.9	8.1
GM	9.4	28.2	2.9	4.0	0.6	22.1	7.1	29.6	30.0
Daimler/ Chrysler	5.1	16.4	1.2	7.2	2.1	23.9	16.9	27.2	14.1
Hyundai	44.2	21.4			3.3		7.9	23.2	3.8
VW		85.2		7.2	2.1		1.2	4.2	2.3
Ford	8.7	12.0	4.4	6.0	5.0	28.6	8.7	26.5	22.4
Toyota	19.3	22.4	2.8	6.3	1.5	13.9	5.7	28.0	11.1
Renault/ Nissan	11.9	38.0		9.1	4.6	8.5	2.9	25.0	4.8
Mitsubishi	18.8	28.9			15.1			37.1	1.5
BMW				64.8	20.5			14.7	1.7
Fiat				41.6	58.4				
Porsche					54.5			45.5	0.2
Share of segment sales in total sales	10.1	25.0	2.3	6.3	3.0	18.1	8.4	26.8	

Source: Automotive News Market Data Book, own calculations

To sum up, the US light vehicles market is a very concentrated market, with car manufacturers being present in almost all market segments. The market segments are, however, characterized by different competition intensity and are dominated by different car producers. These and other above described factors should be taken into account while performing a multimarket contact effects test.

3.3 Multi-firm (multi-brand) linkages in the US automobile market

Automobile firms do not only meet in multiple markets (both product and geographical). The global automobile market is characterized by the presence of a number of global automotive manufacturer groups owning several brands that dominate the market (see Table 1 above), several horizontal partial ownership arrangements (in particular, a number of European and American automobile companies have become share-holders in several Japanese automobile manufacturers) and different interfirm relationships[13]. This builds up a very complex picture of interrelationships and ownership structure in the global automotive industry, which certainly influences the firm behaviour. During the last few decades there has been an increasing number of mergers-acquisitions and alliances between the three automotive poles (Europe, US and Japan), as it has been reflected in the declining number of independent automotive manufacturers. The picture of firms' ownership and interactions is a very dynamic one, as it is reflected by the constant changes in the firm ownership and corporate structure. Some most recent examples from 2007 are DaimlerChrysler de-merger, although Daimler will retain about 20% share in Chrysler, or Ford's intention to sell financially troubled Jaguar and Land Rover brands.

Collusive behaviour may be facilitated and the independence of firm strategies across markets may be reduced the more firms behave on a corporate basis as opposed to a market-by-market basis[14]. Corporate groups (no brands) may develop products to compete with rival firms, or they may suffer from "cannibalization".

Table 5 gives an example of a product policy for VW Group, which includes VW, Skoda, Bentley, Bugatti, Audi, Seat, and Lamborghini. This illustrates the complex picture of multiple market presence and ownership structure in the

[13] Under interfirm relationships I mean both equity and contractual arrangements among the automotive manufacturers themselves and between the OEMs and their suppliers (e.g., strategic alliances, joint ventures).

[14] A number of empirical studies, which do not take into account the effects of partial ownership arrangements (POAs), find some evidence that the degree of collusion is very similar in both Japanese, where POAs are common, and American car markets (e.g., Odagiri and Yamawaki, 1986, Yamawaki, 1989). Some automobile market studies look at the impact of the POAs on market competition. In particular, Alley (1997) finds on the basis of a conjectural variation model, which takes into account POAs and foreign trade, that the degree of collusion due to the POAs in the American car market is even higher than that in the Japanese car market. The author studies the effect of cross-shareholdings between Japanese and US automobile manufacturers and between Japanese automobile manufacturers during 1979-1994. It has been generally found that cross-ownership leads to a more collusive outcome (e.g., Reynolds and Snapp, 1986, Farrell and Shapiro, 1990).

automotive industry. In particular, the VW Group comprises brands with different reputation, both premium and volume brands. The question arises whether the brands within a manufacturer group compete with each other (especially those only premium or volume brands), i.e., whether they suffer from "cannibalization", or the profits are jointly maximized for the whole manufacturer group.

Table 5. Product policy of an independent automotive producer: an example of Volkswagen

	Hatch	Notch	Station	MPV	Pickup/ del.van	SUV	Sport coupe	Limous. coupe	Conver tible	Road ster
Luxury		Bentley					Lambor ghini Bugatti			Lambor ghini
Upper		VW Audi					Bentley Lambor ghini	Bentley		
Upper middle		Audi	Audi	VW		VW				
Middle		VW Skoda Audi	VW Audi	VW Seat			Audi		Audi	Audi
Com pact	Audi VW Seat	Skoda Seat	VW Audi Skoda	VW Seat Audi	VW				VW	
Small	VW Skoda Seat	VW Seat Skoda	Skoda							
Mini	VW Seat									

Source: Volkswagen AG

As related to the presence of global automotive groups in the US automobile market and interbrand competition in those groups, Mercedes and Chrysler[15] do not compete with each other (relatively weak competition between premium and volume brands is usually expected). Saab's presence in the US automobile market is not that significant, so that one could seriously talk about competition between GM and Saab models[16]. Similar is true for Ford and Volvo, especially that Volvo is rather treated to be a premium brand in the US automobile market[17].

[15] Mercedes and Chrysler belong to DaimlerChrysler Group: they are present together in the upscale and sporty market segments.

[16] Saab belongs to the GM Group: it has insignificant shares in the midrange and upscale car market segments.

[17] Volvo belongs to Ford Group: it has insignificant market shares in the midrange and SUVs market segments, and 4.5% market share in the upscale car market segment. Land Rover and Aston Martin also belong to Ford Premier Automotive Group and have very low shares in the

The cases of cross-ownership arrangements, all of them between volume brands, as it can be inferred from Table 1 above are Ford (Mazda), GM (Subaru, Suzuki, Isuzu), RenaultNissan, Toyota (Daihatsu), Chrysler (Mitsubishi), GM (Fiat), Hyundai (Kia). Ford and Mazda compete directly in several market segments (small, midrange, sporty, pickup, van and SUVs). As for GM Group, Subaru is present in the midrange market segment, Suzuki is present in the small and SUVs market segments, and Isuzu is present in the SUVs market segment. The overlap of the markets between Chrysler and Mitsubishi are small, midrange, sporty and SUVs market segments. Hyundai and Kia overlap in the small, midrange, and SUVs market segments.

In this paper the multimarket contact effects are investigated at the level of manufacturer groups taking into account also cross-ownership arrangements in the other firms[18]. In addition, I distinguish between multiproduct (brand) and multiproduct (manufacturer group) assumptions.

4 Empirical structural framework for the US automobile market

4.1 Demand

4.1.1 Utility (McFadden's (1978) utility specification)

Assume that consumer i, $i = 1, ..., n$ has utility $u_{ij} = u\left(x_j, \xi_j, p_j; \theta\right)$ from consuming product j, $j = 1, ..., J$, where $j = 0$ is an outside good, x_j and ξ_j are observed (e.g., horsepower, engine size) and unobserved (e.g., style, image) product characteristics, p_j is the price of product j, and $\theta = (\alpha, \beta)$ are the parameters to be estimated.

The linear version of the random indirect utility is given by:

$$u_{ij} = \delta_j + \epsilon_{ij}, i = 1, ..., n, j = 0, ..., J \tag{1}$$

where ϵ_{ij} is assumed to be identically and independently distributed across consumers and products.

The mean valuation for product j common to all consumers is:

$$\delta_j \equiv x_j\beta - \alpha p_j + \xi_j \tag{2}$$

It is assumed that a consumer purchases one unit of good that brings him the highest utility. Therefore, consumer i purchases one unit of product j if and only if

$$u_{ij} > u_{ik}, 0 \leq k \leq J, k \neq j \tag{3}$$

SUVs and sporty market segments, respectively.

[18] Parker and Roller (1997) is the only paper that investigates the impact of cross-ownership and multimarket contact on the firm behaviour in the mobile phone industry. The more detailed investigation of the interfirm relationships in the automobile industry could be an interesting subject for future research.

Consequently, the probability s_{ij} that the consumer i purchases the product j is:

$$\begin{aligned} s_{ij} &= \Pr\left\{\delta_j + \epsilon_{ij} > \delta_k + \epsilon_{ik}, j \neq k\right\} = \\ &= \Pr\left\{\epsilon_{ik} < \epsilon_{ij} + \delta_j - \delta_k, j \neq k\right\} = \\ & \int_{-\infty}^{\infty} F_j\left(\epsilon_{ij} + \delta_j - \delta_0, ..., \epsilon_{ij}, ..., \epsilon_{ij} + \delta_j - \delta_J\right) \end{aligned} \tag{4}$$

where F_j are the partial derivatives of the joint cumulative distribution function F of $(\epsilon_{i0}, ..., \epsilon_{iJ})$ with respect to its jth argument.

In this paper I present the empirical framework and tests for the mutual forbearance hypothesis on the basis of the one-level nested multinominal logit[19].

4.1.2 Nested multinominal logit: one nest

Utility u_{ij} of household i for product j in group g is given by[20]:

$$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \zeta_{ig} + (1-\delta)\,\epsilon_{ij}, j = 1, ..., I_g$$

where $\zeta_{ig} + (1-\sigma)\,\epsilon_{ij}$ is an extreme value random variable.

The I brands (products) are partitioned into G groups: $g = 0, 1, ..., G$, the outside group is group 0[21]. Let the set (number) of products in a group g be $I_g : I_0, ..., I_G$.

The market share of product j in the group g is given by:

$$s_{j/g}\left(\delta, \sigma\right) = \left(\frac{e^{\delta_j/(1-\sigma)}}{D_g}\right) \tag{5}$$

where $D_g = \sum\limits_{j \in I_g} e^{\delta_j/(1-\sigma)}$, $0 \leq \sigma < 1$.

The probability of choosing group g among all groups is given by:

$$s_g\left(\delta, \sigma\right) = \frac{D_g^{1-\sigma}}{\left[\sum\limits_g D_g^{1-\sigma}\right]} \tag{6}$$

This gives a market share for product j that belongs to group g:

$$s_j\left(\delta, \sigma\right) = s_{j/g}\left(\delta, \sigma\right) s_g\left(\delta, \sigma\right) = \frac{e^{\delta_j/(1-\sigma)}}{D_g} \frac{D_g^{1-\sigma}}{\sum\limits_g D_g^{1-\sigma}} = \frac{e^{\delta_j/(1-\sigma)}}{D_g^{\sigma} \sum\limits_g D_g^{1-\sigma}} \tag{7}$$

[19] It should be noted that simple logit and nested logit models have been used extensively by economists for merger evaluation (e.g., Werden and Froeb, 1994, Werden, 1999, Jayaratne and Shapiro, 2000, Ivaldi and Verboven, 2005).

[20] In the exposition below, I follow Berry (1994).

[21] "Outside good" does not compete with other goods in the industry, its price or quantity is set exogenously. If there were not for the outside good, everyone would have been forced to purchase an "inside" good (Pakes lectures).

where $\sigma \in [0,1]$ is a measure of the degree of substitution, or the within-group correlation of the utility levels. The lower σ means the lower correlation of preferences. $\sigma = 0$ implies no correlation of preferences, and consumers, thus, may switch to the products in another group, which means the standard logit model. $\sigma = 1$ implies perfect correlation of preferences for products within the same group, i.e., perfect substitutes. E.g., if a new compact car is introduced, the demand for the other subcompact cars will go down rather than the demand for the cars in the other segments (Ivaldi and Verboven, 2002).

The group 0 has only one outside good, with $\delta_0 \equiv 0$ (i.e., the utility from consuming the outside good is normalized to zero) and $D_0 = 1$ and with the market share of:

$$s_0(\delta, \sigma) = \frac{1}{\left[\sum_g D_g^{1-\sigma}\right]} \tag{8}$$

The inversion procedure for the mean utility level has been suggested by Berry (1994).

Consequently, the following demand equation may be derived by inverting the market share equation:

$$\ln(s_j) = \ln(s_0) + x_j\beta - \alpha p_j + \sigma \ln\left(s_{j/g}\right) + \xi_j \tag{9}$$

where $s_{j/g}$ is the share of product j in group g (within-group share), s_j is the share of product j in the total market, and s_0 is the proportion of the consumers who choose the outside good.

The own price elasticity E_{s_j/p_j} of the market share s_j of product j is:

$$E_{s_j/p_j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} \tag{10}$$

with

$$\frac{\partial s_j}{\partial p_j} = \frac{\partial s_j}{\partial \delta_j}\frac{\partial \delta_j}{\partial p_j} \tag{11}$$

$$\frac{\partial s_j}{\partial \delta_j} = s_j \frac{1}{1-\sigma}\left[1 - \sigma s_{j/g} - (1-\sigma) s_j\right] \tag{12}$$

Thus, the own-price elasticity can be written down as:

$$E_{s_j/p_j} = -\alpha p_j \frac{1}{1-\sigma}\left[1 - \sigma s_{j/g} - (1-\sigma) s_j\right] \tag{13}$$

The cross-price elasticity E_{s_j/p_m} of the market share of product j with respect to the price of product m p_m is given by:

$$E_{s_j/p_m} = \frac{\partial s_j}{\partial p_m}\frac{p_m}{s_j} \tag{14}$$

with

$$\frac{\partial s_j}{\partial p_m} = \frac{\partial s_j}{\partial \delta_m} \frac{\partial \delta_m}{\partial p_m} \tag{15}$$

$$\frac{\partial s_j}{\partial \delta_m} = -s_j \left(\frac{\sigma}{1-\sigma} s_{m/g} + s_m \right) \tag{16}$$

Therefore, the cross-price elasticity is:

$$E_{s_j/p_m} = \alpha p_m \left(\frac{\sigma}{1-\sigma} s_{m/g} + s_m \right) \tag{17}$$

if j and m belong to the same market segment, and

$$E_{s_j/p_k} = \alpha p_k s_k \tag{18}$$

if j and k belong to different market segments.

4.2 Costs and firm behaviour

4.2.1 Price competition

The log-linear marginal cost function is assumed:

$$\ln(c_j) = w_j \gamma + \omega_j \tag{19}$$

where w_j and ω_j are observed and unobserved product characteristics, respectively, and γ are the parameters to be estimated[22].

Assume F sellers of a differentiated product[23].

Firm f produces J_f of F total differentiated products. The demand for product j is given by $Ms_j(p, X; \theta)$, where M is the market size.

Let P_{J_f} be the set of prices that the player f sets. Product characteristics for any year are assumed to be exogenous.

Assume that the outside good is competitively supplied.

The firm f chooses P_{J_f} to maximize its profits, for given J and p_j with $j \in J_f$:

$$\max_{p_{J_f}} \pi_f = \sum_{j \in J_f} (p_j - c_j) M s_j(p) - \sum_{j \in J_f} F_j \tag{20}$$

where c_j is the constant marginal cost of brand j, $s_j(p)$ is the market share of brand j, being a function of all brands' prices, and F_j is fixed cost for a product j.

[22] The quantity variable Q_j may be included to allow for increasing/decreasing returns to scale.

[23] In the exposition below, I follow Berry, Levinsohn and Pakes (1995).

The first-order conditions for the manufacturer f's profit maximization problem are (assuming that a pure-strategy Nash equilibrium in prices exists and that prices are strictly positive)[24]:

$$s_j(p) + \sum_{r \in J_f} (p_r - c_r) \frac{\partial s_r(p)}{\partial p_j} = 0 \tag{21}$$

Let firm f have $k(f)$ products, which are indexed by $j = J_1^f, ..., J_{k(f)}^f$, with $J_1^1 = 1$ and $J_{k(F)}^F = J$.

Define matrix Δ_f as:

$$\triangle_f = \begin{pmatrix} \frac{\partial s\left(J_1^f\right)}{\partial p\left(J_1^f\right)} & ... & \frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_1^f\right)} \\ ... & ... & ... \\ \frac{\partial s\left(J_1^f\right)}{\partial p\left(J_{k(f)}^f\right)} & ... & \frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_{k(f)}^f\right)} \end{pmatrix} \tag{22}$$

In vector notation, the first-order conditions for J total products simultaneously can be written down as:

$$\underbrace{\begin{pmatrix} s_1 \\ ... \\ s_J \end{pmatrix}}_{\mathbf{s}} + \underbrace{\begin{pmatrix} \triangle^1 & & 0 \\ & ... & \\ 0 & & \triangle^F \end{pmatrix}}_{\mathbf{\Omega}} \underbrace{\begin{pmatrix} p_1 - c_1 \\ ... \\ p_j - c_j \end{pmatrix}}_{\mathbf{p-c}} = 0 \tag{23}$$

Assume that $\mathbf{\Omega}$ is a non-singular matrix. Therefore, the first-order conditions can be expressed as:

$$p = c + \Omega^{-1} s \tag{24}$$

with the marginal cost equation taking up the following form:

$$\ln(p - \Omega^{-1} s) = w\gamma + \omega \tag{25}$$

Within the last equation, the following scenarios can be tested: Bertrand behaviour with single-product firms, Bertrand behaviour with multi-product firms[25], perfectly collusive (total industry) behaviour, market-segment collusive behaviour, and assumption concerning multimarket contact firm behav-

[24] Caplin and Nalebuff (1991) have shown that a pure strategy Nash equilibrium exists in case of single-product firms, using a rather general demand model. Anderson and de Palma (1992) have shown the existence of a pure strategy Nash equilibrium in case of multi-product firms using the nested logit demand model.

[25] If only products of a firm in the same market segment are considered by the firm in the profit maximization task, the explicit expression for the mark-up can be derived. If other products of the firm in the different market segments are considered as well, the whole matrix of market share derivatives with respect to the price has to be inverted to get the markups. The derivatives of products with respect to products in the other market segments are usually found to be low anyway, so that the markups may be not influenced significantly (Verboven, 1996). Verboven (1996) also tests for the presence of market segment-specific collusion. Sudhir (2001) finds a different competition pattern across market segments.

iour. This can be done within the menu, or conjectural variations parameters approaches that are discussed below.

Studying different price equilibrium assumptions can be done at the market segment level (i.e., case of myopic firms, each firm considers in its profit maximization task only the products of a particular market segment), in this case, the market segments are treated to be independent, or at the firm level (i.e., case of firms that behave strategically, the firm takes into account the cross-price elasticities of all its products), in this case the market segments are not independent and the substitution between them is possible. Both scenarios are tested in this paper to choose the pattern of the firm behaviour that best fits the data.

4.2.2 Menu approach

The menu approach is discussed in Bresnahan (1987), Gasmi et al. (1990, 1992) and advocated, in particular, by Nevo (1998). Under this approach, different models of competition may be tested through setting different elements of the ownership matrix to one. The choice among the different models of conduct, which constitute a finite set (defined by a researcher based on his understanding), is done on the basis of "fit" of different models, formally by performing a test of nonnested hypothesis (e.g., Vuong, 1979).

Consequently, the matrix Ω^{-1} may be written as $\theta * \triangle^{-1}$, where $\triangle^{-1}$ is the matrix of own- and cross-price elasticities, and θ is an ownership matrix, with $\theta_{ij} = 1$ if i and j are produced by the same firm, and 0 otherwise. This is an element-by-element multiplication of matrices of the same dimension.

4.2.3 Conjectural variations approach

The conjectural variations approach has been criticized for the problem of the interpretation of the conjectural variations parameters and the problem of identification, especially in case of differentiated products[26]. The detailed discussion of this approach can be found in Bresnahan (1989) and Nevo (1998). The conjectural variations approach may allow testing for the degree of collusiveness, or competitiveness of a particular market segment/industry, or distinguishing between the more collusive and more competitive markets, not necessarily finding perfect market segment collusion as based on the menu approach. In this paper I pursue the menu approach, while the paper dealing with the investigation of the mutual forbearance hypothesis in the European car market (Leheyda, 2007) uses a conjectural variation approach, in addition to the menu approach.

[26] Conjectural variations for the market segments in the automobile industry have been estimated by Sudhir (2001) and constructed for the market segments at the country level by Brenkers and Verboven (2006).

5 Methodological framework for testing the multimarket contact effects

5.1 Test for the mutual forbearance hypothesis: idea

The "ideal" test for identifying the multimarket contact effects on collusive behaviour would be to contrast the pricing behaviour in a single-market (e.g., two firms meet each other in one market M1) and a multi-market context (e.g., these two firms move together to another market M1+M2) to test for incremental effects on the firm behaviour. In addition, one could take some period of time and compare the break-down of collusive prices in M1 world and M1+M2 world, and if this period of break-downs under the latter scenario is shorter, then this could be a hard test for showing that the multimarket contact presence leads to more collusion.

The automobile industry, although characterized by extensive multimarket contact presence, offers no such "optimal" situations to test for the mutual forbearance hypothesis, and, thus, necessiates the search for other approaches to study the behaviour of the multimarket contact firms. I test for multimarket contact firm coalitions and perform simulations as a way to investigate the multimarket contact effects on the firm behaviour. The idea behind these approaches, which have not been applied before in the multimarket contact studies, is discussed in the next two sections 5.2 and 5.3.

5.2 Test for the mutual forbearance hypothesis (1): testing collusive assumption among the multimarket contact firms

As it has been mentioned above, Bernheim and Whinston (1990) state that the multimarket contact may lessen the degree of competition between the rivals as the multiple competitors are more likely to recognize their mutual dependence and to sustain collusion across the range of markets in which they meet. The advantage of fierce competition in one market is weighted against the costs of potential retaliations by the competitors in the other markets where they meet each other.

The idea behind the test for the mutual forbearance hypothesis (1) is to test different assumptions/hypotheses concerning the firm behaviour through adjusting in an appropriate way the ownership matrix θ (see Section 4.2.2) in order to derive the competition pattern in the industry and across market segments, including the possibility of the mutual forbearance hypothesis. The test under this approach can be conducted in two steps:

Step 1. Derive the pricing equation under the multimarket contact assumption using the menu approach, i.e., by specifying a particular ownership matrix.

Taking into account the above theoretical insights about the mutual forbearance hypothesis, the formal test for testing the multimarket effects on prices would be to see whether the multimarket contact firm takes into account the cross-price reactions of the other multimarket contact firms across the markets in its profit-maximization task:

$$\max_{p_{J_{MMC,f\in MMC}}} \pi_f = \sum_{j\in J_{MMC},f\in MMC} (p_j - c_j)\, M s_j(p) \tag{26}$$

where J_{MMC} are all products of multimarket contact firms, including the multimarket contact firm f. That is, the joint profit maximization over the products of the multimarket contact firms coalition is assumed (a firm f belongs to the set of the multimarket contact firms MMC).

The first-order conditions for a multimarket contact firm f that internalizes the cross-price effects with its competitors can be written down as follows:

$$s_j(p) + \sum_{r\in J_{MMC,f\in MMC}} (p_r - c_r)\frac{\partial s_r(p)}{\partial p_j} = 0 \tag{27}$$

This expression can be written down as market segment-specific (market segments are independent), or industry-specific (market segments are interrelated).

In addition to the multimarket contact specification, the Bertrand-Nash multi-product price specification can be written down not only for the car manufacturers (brand level, e.g., a Mercedes car) but also for the car manufacturer groups (i.e., corporate group, e.g., Mercedes and Chrysler cars of DaimlerChrysler Group) and those car manufacturers that hold shares in the other automotive firms (i.e., cross-ownership arrangements).

Step 2. Test different assumptions about the equilibrium interactions of firms (i.e., single-product, multi-product, collusion, collusion due to the multimarket contact), and choose the best supply model among the competing supply-side models on the basis of the goodness-of-fit of the model (most often R-squared, adjusted R-squared, some information, or prediction criterion), or the test of nonnested hypotheses (e.g., Vuong, 1989). In the absence of publicly available information on marginal costs and price-cost margins[27], this has been a way that has been pursued in a number of empirical studies as well.

The goodness-of-fit of the model as measured by the R-squared may be not the best criterion for selecting the best model, especially when the model specifications appear similarly good (in terms of the estimated coefficients and standard errors). The estimated coefficients in different models could be also investigated and assessed concerning which ones are the most plausible ones (e.g., Verboven, 2002, Bonnet et al., 2005).

As it has been mentioned, models are often selected on the basis of some information criterion (e.g., Akaike (1973, 1974) information criterion (AIC)[28],

[27] There exist only a few studies that select the best supply-side specification on the basis of some calculated marginal costs, or some publicly available information on the price-cost margins. For example, Nevo (2001) compares the estimated and observed markups to select the best model specification for the supply side.

[28] Akaike's information criterion (AIC), based on the minimization of the loss of information, is calculated on the basis of the mean squared prediction error (in case of the OLS estimation).

Schwarz (1978) Bayesian information criterion (BIC)[29], Hannan and Quinn (1979)). Under this approach, the model with the smallest information criterion is preferred. However, the selection procedures that these tests are based upon are not completely satisfactory (Rivers and Vuong, 1999). The actual values of the model selection criteria can be subject to statistical variations as they are determined by sample information. The models may not, thus, outperform each other significantly. In case of linear regression models, the criteria that are based on the calculation of the in-sample mean square error of prediction (MSEP) are widespread.

As there appears to be no single most reliable way to choose the best supply-side model, the results from the tests for non-nested hypotheses (MacKinnon, White, and Davidson, 1983, and Rivers and Vuong, 2002), the Akaike information criterion (AIC), the Bayesian information criterion (BIC) and the sum of squared residuals (SSR) are compared in this paper to reach some meaningful and hopefully reliable results at the end. The application of MacKinnon, White, and Davidson (1983), and Rivers and Vuong (2002) test procedures is described in detail in Appendix. The intuition behind these tests is given in the dissertation introduction (Chapter 1). These methods are the most frequently applied in the literature to choose a model specification that best fits the data. In addition, the concrete tests are chosen so that to fit my estimation methods for the supply side.

5.3 Test for the mutual forbearance hypothesis (2): testing shock effects

This test could be viewed as continuation of the previous test, or it can be conducted separately as well[30]. The test procedure involves two steps.

Step 1. Estimate the demand and marginal cost equations, and identify the competition behaviour in market segments through testing different assumptions about the firm behaviour (e.g., one market is collusive, the others are not, or all are collusive, etc.), and choose, as above, the best supply-side model, which best fits the data, on the basis of some goodness-of-fit criteria, or test.

Step 2. Simulate some shock[31] in a particular market segment, e.g., a price war in the (more) collusive segment, and see whether and to what extent it impacts the firm behaviour in the other market segments. The price war is approximated by the changes in the ownership matrix for that market (from

[29] Bayesian Information Criterion (BIC) is similar to the AIC criterion, it imposes only a heavier penalty for the degrees of freedom loss.

[30] For this test application it is not crucial that some support for a multimarket contact firms coalition is found in the first step, where I rather test for perfect collusion among multimarket contact firms, while there might be different degrees of collusion across markets.

[31] The examples of possible real shocks could be a significant change in the market share of a firm, or some abrupt change in the multimarket contact measure over time, or a price war in a particular market segment. The relatively short period of time for which I have the data does not allow me to observe such changes, that is why, I choose to simulate some hypothetical shocks.

the collusive to the competitive assumption)[32]. The question is whether the price war in this particular market segment will have some impact on the firm behaviour in the other market segments. The major idea behind is to look at the relative magnitude of the "own"-market reactions vs. cross-market reactions, and to see whether there is any correlation in the prices across the market segments. Another alternative is to move from the competitive to the collusive behaviour assumption in a particular market segment.

Consequently, the new equilibrium price under the new ownership matrix (Ω_{new}) is:

$$p^* = \bar{c} + \Omega_{new} (p^*)^{-1} s (p^*) \tag{28}$$

where p^* is a vector of the post-predicted equilibrium prices, $\bar{c}$ are the estimated marginal costs from the step-by-step estimation. The system of the non-linear equations has to be solved for an equilibrium price[33].

The simulation of shocks could probably help me to disentagle the effect of market concentration and multimarket contact on the firm behaviour. In addition, the simulation of shocks to separate markets allows to study the firms' (strategic and collusion) interdependence across the markets.

6 Data and estimation results

6.1 Data

The major source of the automotive data for this research is the Automotive News Market Data Book for 2001-2003[34]. The available data for the US automotive market include:

1. Car and light truck sales by market class for models. In the dataset those models with the yearly sales of less than 200 models have been excluded.

2. Prices of cars, pickups, minivans, vans and SUVs.

Prices for the given year are shown as of April/May of the corresponding year. The base prices include the retail price as suggested by the manufacturer and the destination charge. The prices of imported vehicles cover ocean freight and the U.S. import duty. State, or local taxes, or optional equipment are not

[32] Brenkers and Verboven (2006) apply the so-called SSNIP test to define markets. The test searches for the smallest set of products for which a small but significant and non-transitory increase in prices (SSNIP) (5-10%) could be jointly profitable. Ivaldi and Lörinz (2005) apply the full equilibrium market test to computer servers. It defines the relevant market as the set of products whose average price would be significantly raised at equilibrium if they were priced by a hypothetical monopoly, or jointly determined by a cartel.

[33] Nevo (1997) solves $\Omega_{post} (p^*) \left(p^* - \widehat{mc} \right) = s(p^*)$ using Matlab standard algorithm for solving non-linear equations (fsolve.m).

[34] I have tried to do some cross-sectional estimations, but it is difficult to fit the model. This result is similar to the one by Berry, Levinsohn and Pakes (1995), who have chosen to use the panel data, and Nevo (2001), who has used the quarterly data for several geographical markets.

included into the prices. The list prices are converted into real terms by using the US Consumer Price Index (CPI).

3. Vehicles characteristics: auto transmission, air conditioning, antilock brakes, sunroof/moonroof; information on dimensions, engines, capacities, safety, miscellaneous. The physical characteristics of the base specification have been used in the estimations.

4. Automotive advertising spending in the US (measured by the US ad spending per vehicle).

The data on miles per gallon, engine volume, cylinders are available from the Fuel Economy Guide by the US Environmental Protection Agency (EPA)). The log of the total sales volume, or global production by model, which is available from the Global Insight, can be used to account for the economies of scale. GDP data are taken from the Bureau of Economic Analysis (BEA)).

The number of potential customers is approximated by the total number of households in the economy, following Berry, Levinsonhn and Pakes (1995). That is, each household is treated to be a potential buyer of a new car. The information on the number of households is taken from the US Census Bureau.

The automotive market classification by the Automotive News, which I use in this study, is determined by vehicle size, price and market intent[35]. The cars are segmented into the following classes: small, midrange, traditional, upscale, sporty, alternative power[36]. The light trucks are segmented into the following classes: pickups, vans, and SUVs. Some general statistics for the market segments and the examples of car models for each market segment can be found in Table 6. SUVs, midrange, and pickups are the largest car market segments in the US. The SUVs market is characterized by the highest number of car models and may be viewed as the most competitive one. Japanese competitors play a large role in the smaller car market segments, while the European car producers are the major competitors of the US car producers in the upscale market segment.

Table 6. US light vehicles market: summary statistics across market segments

[35] For the sensitivity analysis (for my estimations, the definition of a relevant market is very important), alternative market segmentations could be tried, in particular, the one by Ward's (Ward's Automotive Yearbook). According to this classification, which is based upon price, body style and size, the light vehicles are segmented into the following classes: small, middle, large, luxury, cross-utility vehicles, SUVs, vans and pickups.

[36] The alternative power market is not analyzed because it is a thin market.

Market segment	Best-selling models, 2003	# obs. (min-max)	Share of segment in total market, % (2003)	Asian share, %, 2003	European share, %, 2003
Small	Toyota Corolla, Chevrolet Cavalier, Ford Focus	20-22	10.3	52.0	0.0
Midrange	Toyota Camry, Honda Accord, Ford Taurus	29-31	24.7	45.7	9.2
Traditional	Buick LeSabre, Mercury Grand Marquis, Ford Crown Victoria	6-7	2.3	13.2	0.0
Upscale	BMW 325, Merc. C class, Cadillac DeVille, Lexus ES 300	30-32	6.3	24.5	39.3
Sporty	Ford Mustang, Mitsubishi Eclipse, Nissan 350Z	20-25	3.0	35.8	22.1
Pickup	Ford F Series, Chevrolet Silverado, Dodge Ram	11	18.1	11.2	0.0
Van	Dodge Caravan, Honda Odyssey, Ford Econoline	20-21	8.4	26.0	0.0
SUV	Ford Explorer, Chevrolet TrailBlazer, Jeep Grand Cherokee	36-39	26.7	32.5	3.3

Source: Automotive News Market Data Book, own calculations

The summary statistics for selected variables across the market segments are presented in Table 7. The prices, size and horsepower increase as one moves from the smaller car segments to the larger ones, also to those with the higher presence of premium car brands.

Table 7. US light vehicles market: descriptive statistics across market seg-

ments

Variable	Mean	Std. dev. Overall	Between	Within
Small				
horsepower	122	14.9	14.1	5.3
price	12968	1608.5	1620.4	231.8
size	11795	622.7	595.4	166.0
Midrange				
horsepower	159	25.9	25.5	5.3
price	18949	2703.0	2673.3	402.1
size	13262	1038.6	1007.3	264.5
Traditional				
horsepower	215	15.4	18.1	1.1
price	25064	1810.0	2050.2	351.1
size	15366.7	980.2	1006.9	27.3
Upscale				
horsepower	227	38.1	37.8	6.1
price	38009	10951.9	11009.7	845.8
size	13917	1186.3	1165.6	251.7
Sporty				
horsepower	199	61.7	61.8	3.9
price	29822.1	15889.1	15591.9	390.0
size	11956	1245	1235.7	169.4
Pickup				
horsepower	164	35.8	35.0	11.6
price	15570	2368.2	2369.1	588.6
size	14527	1648.4	1686.2	227.2
Van				
horsepower	188	19.3	17.5	8.2
price	22668	2109.9	2015.7	544.3
size	15135	1180.0	1153.8	153.4
SUV				
horsepower	202	54.0	52.7	10.3
price	25386.9	7012.2	6910.2	1020.8
size	13543	1794.7	1808.4	24.9

Source: Automotive News Market Data Book, own calculations

In my estimations I do not include all the available technical characteristics in order to minimize the problem of multicollinearity. The variables have been chosen into the specification on the basis of the p-value correlation analysis. The summary of the variables used in the estimations is given in Table 8. The following variables have been selected in the specifications: horsepower (to measure car performance), width and length (vehicle dimensions), air conditioning and antilock brakes (safety), automatic transmission (convenience), miles per gallon (MPG) (fuel efficiency).

Table 8. US light vehicles market: variables description

Variable	Variable name	Notes
Horsepower	horse	Net horsepower
Width	width	Overall width (in.)
Length	length	Overall length (in.)
Air conditioning	air-cond	Dummy: 1 if air conditioning is standard equipment
Antilock brakes	brakes	Dummy: 1 if antilock brakes is standard equipment
Transmission	transm	Dummy: 1 if automatic transmission is standard equipment
Miles-per-gallon	mpgcity	City miles per gallon: for urban driving

Source: Automotive News Market Data Book, own calculations

6.2 Estimation strategies for the demand equation and full system

In general, the demand and pricing equations can be estimated either separately, or jointly. Under the separate, or step-by-step, estimation, the demand equation is estimated first. After that the matrix of own- and cross-price elasticities is constructed on the basis of the estimated demand parameters. In the next step the pricing equation is estimated after having substituted into it the matrix of the elasticities. The standard errors of the pricing equation parameters have to be corrected.

There are several advantages of this two-step procedure. For example, the computational burden may be reduced due to the separate estimation of the demand and pricing equations. Different supply-side specifications may be estimated without re-estimating the demand function each time. The possible misspecification of the supply side will have no impact on the demand side results (Goldberg and Verboven, 2001)[37]. The major drawback of this procedure is the loss in the efficiency of the estimated parameters.

[37] Step-by-step estimations are also used by Nevo (2001).

6.3 Instruments

Prices and market shares are endogenous, correlated with the error term ξ_j and ω_j, and, consequently, have to be instrumented. Prices will be collinear with product characteristics that are not observed. The introduction of product fixed effects to control for unobserved characteristics can lead to an identification problem due to the correlation between fixed effects and product characteristics. If there is some positive correlation between prices and omitted characteristics, the price coefficient will tend towards zero.

The detailed discussion of the choice of the efficient instruments for differentiated products models can be found in Berry, Levinsohn and Pakes (1995)[38]. In general several groups of instruments can be pointed out that have been used in the studies on the differentiated products demand and structural model estimation: cost shifters and quasi-cost shifters, product characteristics, prices in other markets (following Hausman et al. (1994) and Hausman (1996)), etc[39]. I use the product characteristics as instruments in my estimations, so I will discuss them in more detail now.

The best candidates for the instruments in the differentiated product markets are the model characteristics, which are usually treated to be exogenous, based on the assumption that in the short run they cannot be quickly adjusted by a firm. Thus, the matrix Z of instruments includes the product's own characteristics (which decreases the number of necessary additional instruments) and other exogenous variables used in the estimations. Product characteristics are used as instruments for a set of unobserved supply shifters in the pricing, or marginal cost equation. Furthermore, the functions of the exogenous characteristics of the competing products can be used as instruments.

The major difficulty with using nonprice characteristics as instruments is that these variables are usually used both in the demand and cost side. As a result, there may be an insufficient number of instruments for the parameters that have to be estimated. This problem has been discussed by Berry (1994) and Berry, Levinsohn and Pakes (1995), and it has been suggested to use the characteristics of competitors and their functions as additional instruments. The functions of the exogenous physical characteristics (own and competitors') can be used as instruments (sums and averages). The car's own price and demand will be correlated with the physical characteristics of the other products, and depend on the degree and closeness of competition that the firms face with other competitors. The distance from the nearest neighbouring product will determine the markup of each brand.

Bresnahan et al. (1997) suggest the following groups of instruments: principles of differentiation (defined on a group-specific basis), ownership (defined on a firm-specific basis, making use of the economics of the multiproduct pricing) and ownership with principles of differentiation (combination of a group-specific

[38] The authors follow the discussion on the set of the efficient instruments by Chamberlain (1986).

[39] Other authors use a lagged error term in the demand equation (Bonnet et al., 2005), brand dummies (Nevo, 2001), or lagged endogenous variables (Giacomo, 2004) as instruments.

and a firm-specific basis).

Therefore, the following instruments could be used for the estimation of the one-level nested logit: 1) number of other products in a group; 2) sum/average of characteristics of other products in a group (interacted with a group dummy variable); 3) number of other products the firm sells in the group; 4) sum/average of characteristics of other products the firm sells in the group (interacted with a group dummy variable); 5) number of products the other firms sell in the group; 6) sum/average of characteristics of products the other firms sell in the group (interacted with a group dummy variable).

6.4 Estimation results

6.4.1 Demand and supply

The results of the demand estimation for the one-level nested logit[40] can be found in Table 9. The demand equation can be estimated by the 2SLS, or GMM. The null hypothesis of homoscedasticity has been tested by performing the test of heterogeneity by Pagan and Hall (1983) for instrumental variables estimation. The tests results have not rejected the homoscedasticity hypothesis, thus, the IV estimation should be rather used (see the first two columns in Table 9). GMM estimation results are presented for sensitivity analysis and are quite similar in magnitudes to the 2SLS estimation results (see the last two columns in Table 9).

Table 9. US light vehicles market: demand estimation

[40] The estimations with different correlation parameters for different market segments (not reported here) produced rather implausible magnitudes (higher correlation for more luxury segments), and some coefficients turned out to be greater than 1, although the Wald test has not rejected the hypothesis that they could be equal to or less than one. The latter problem could be explained by the choice of instruments. It should be also mentioned that in some cases the coefficients greater than 1 could be consistent with the utility-maximizing behaviour.

Besides I have done estimations for the nested logit with two nests (market segment and country of origin, i.e., domestic vs. foreign producer) and the estimates of the correlation parameters were not consistent with utility-maximizing behaviour.

Variables	IV.A	IV. B	GMM.A	GMM. B
α	-0.00015***	-4.00***	-0.00017***	-4.47***
σ_g	0.87**	0.70**	0.80***	0.69**
horsepower	0.02***	0.01***	0.02***	0.02***
width	-0.06**	-0.03	-0.05**	-0.03*
length	-0.01	-0.002	-0.003	-0.005
air conditioning	0.08	0.49***	0.18*	0.55***
brakes	0.16	0.29**	0.21*	0.36***
transmission	0.39***	0.34***	0.38**	0.43***
mpgcity	-0.04*	-0.07***	-0.03*	-0.08***
const	0.63	35.19***	-0.39	40.16***
Adj. R2	0.36	0.56	0.26	0.51
Root MSE	1.06	0.88	1.14	0.93
Pagan&Hall (all,p-value)	1.00	0.99	-	-
Overidentification			4.95	3.14

Source: own estimations

Note: Specifications IV.A and GMM.A are with prices, while Specifications IV.B and GMM.B are with logarithmic prices. ***, **, * - indicate significance at 1%, 5% and 10% significance level, respectively. Time dummies have been included but are not reported. mpgcity stands for miles per gallon (city). Nest is market segment.

Horsepower has been found statistically significant in all specifications and has an expected positive sign. Width and length have got a negative sign. Length is, however, not significant anyway. Air conditioning, brakes and automatic transmission have got an expected positive sign. The miles per gallon variable has got a negative sign on the contrary to the a priori expectations: the higher miles per gallon value, the more efficient the vehicle is. The negative sign was also found in some other studies (e.g., Berry, Levinsohn and Pakes, 1995, Sudhir, 2001). The included but not reported in the table time fixed effects might capture macro-economic fluctuations that influence a person's decision to buy a car.

The most important for the calculation of own- and cross-price elasticities, the estimation of markups and the subsequent supply-side estimations are the estimates of price and segment correlation parameters. The price coefficient is negative as it has been expected and is quite low in magnitude. The estimated segment correlation parameters can be interpreted in terms of the correlation of consumer preferences within a particular market segment. When the correlation parameters are statistically different from zero, that may mean that consumers may be not so willing to substitute away from that market segment when there is a price increase in that segment. The results show that consumer preferences are strongly correlated within a market segment. This may be interpreted as some evidence for strong competition within market segments in the US light vehicles market.

I have also estimated the demand equation jointly with the hedonic pricing equation. These results can be found in Table 10 (first column, 'joint estimation'). In this case width, length, and miles per gallon have got a statistically significant positive sign, however, the air conditioning has got a negative sign. One may argue that adding the supply side contributes to a better model identification. The segment correlation parameter is significantly lower as under the separate estimation of the demand equation.

I also present some results of the random coefficients model estimation for the US light vehicles market[41] (the last four columns, 'random'). The first two columns give the parameter estimates and their standard errors for the means (β's), while the last two columns give the parameter estimates and their standard errors of standard deviations (σ_k's). However, the results of many coefficients have turned out to be negative[42]. Thus, it could be better to rely on the estimates from the one-level nested logit to proceed with the test for the multimarket contact effects.

Table 10. US light vehicles market: demand estimation (continuation)

Variables	Joint estimation	Random			
		Means ($\beta's$)		Std. deviations ($\sigma_k's$)	
		Esti mate	Std. Err.	Esti mate	Std. Err.
price-income	-0.0001***	-4.30	0.00		
ln (segmentshare)	0.43***				
horsepower	0.01***	0.60	0.01	0.06	0.04
width	0.11***	-1.14	0.03	0.13	0.26
length	0.01***	2.37	0.02	0.08	0.11
air conditioning	-0.23***	-0.18	0.00	0.12	0.05
brakes	1.17***	-0.15	0.01	0.03	0.05
transmission	0.97***	-0.05	0.04	0.08	0.10
mpgcity	0.13***	-3.49	0.07	0.16	0.00
year01		0.28	0.00		
year02		0.39	0.01		
const	-17.38***	-9.83	0.12	0.24	0.05

Source: own estimations

Note: ***, **, * indicate significance at 1%, 5% and 10% levels of significance, respectively. Time dummies have been included but are not reported in case of joint estimation.

The supply-side equation under different assumptions on the firms' equilibrium interactions is estimated using OLS with robust standard errors (Hu-

[41] I have tried to estimate the demand equation, which is derived from the following utility specification following Berry, Levinsohn and Pakes (1999):

$u_{ij} = x_j\beta + \xi_j - \alpha_i p_j + \sum_k \sigma_k x_{jk} v_{ik} + \varepsilon_{ij}$ for $j = 1, ...J$, where $\alpha_i = \frac{\alpha}{y_i}$, β is a vector of mean parameters to be estimated, and σ_k is a vector of standard deviations parameters to be estimated.

The price coefficient is interacted with income. Income draws are made from the US Consumer Population Survey (CPS). I introduce consumer heterogeneity on the products characteristics: the random draws have been made from multinominal normal distribution (ν_{ik}). This together should have allowed me to get more flexible substitution patterns.

[42] One of the possible explanations could be the short time period of the data that I have. A longer time span, and, thus, a larger number of markets could contribute to the better model identification.

ber/White sandwich estimator of the variance) (see Table 11[43]). In the Table I present the results for some selected specifications: 'Single': single-product Bertrand pricing equilibrium; 'Multi': multi-product (brand-level) Bertrand pricing equilibrium; 'Market': market-segment collusive assumption for each market segment; 'Hedonic': the pricing equation under a competitive assumption; MMC1: collusive assumption for GM, Ford, DaimlerChrysler, Toyota and Renault-Nissan and competitive assumption for the others; MMC2: collusive assumption for GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai and BMW and competitive assumption for the others; MMC3: collusive assumption for GM, Ford, DaimlerChrysler and Toyota and competitive assumption for the others; MMC4: collusive assumption for GM, Ford, DaimlerChrysler and competitive assumption for the others.

Horsepower is found to be positive in all specifications. The signs and magnitudes of some coefficients have been changing across different specifications[44]. At the first sight, Toyota appears to be not the most efficient producer. These results may be in line with some of the results of the previous studies. In particular, Petrin (2002) finds the marginal costs to be slightly higher for Japanese producers as compared to those of American producers. Higher marginal costs for Japanese producers have been also found by Sudhir (2001).

Table 11. US light vehicles market: supply-side estimation results under selected assumptions

[43] I present the estimation results under selected assumptions, as the results are rather similar under all specifications, just to illustrate the problem that I have faced while choosing the best supply-side specification: on the basis of the estimated coefficients and R-squared comparison the supply-side models do not appear to outperform each other significantly.

[44] Bonnet et al. (2005), for example, obtain different magnitudes and signs of coefficients in the cost equations. They were made, therefore, perform a non-nested test to differentiate between different patterns of competition.

Variables	Single	Multi	Market	Hedonic	MMC1	MMC2	MMC3	MMC4
horsepower	1.00***	1.01***	1.26***	0.95***	1.18***	1.20***	1.13***	1.07***
width	-0.05	-0.05	0.16	-0.05	0.14	0.01	0.02	-0.13
length	-0.50***	-0.50***	-0.74***	-0.48***	-0.94***	-0.64***	-0.79***	-0.52***
air conditioning	0.16***	0.16***	0.28***	0.14***	0.24***	0.24***	0.22***	0.17***
brakes	0.07***	0.07***	0.08***	0.06***	0.05*	0.06***	0.05**	0.04**
transmission	0.14***	0.14***	0.16***	0.13***	0.20***	0.15***	0.18***	0.19***
mpgcity	0.00	0.01	-0.09	0.02	0.19***	0.12*	0.16**	0.10*
year01	0.03**	0.03**	0.04**	0.03**	0.03*	0.04**	0.03*	0.03*
year02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02
hyundai	-0.37***	-0.38***	-0.60***	-0.34***	-0.22***	-0.50***	0.21***	-0.23***
kia	-0.36***	-0.37***	-0.60***	-0.33***	-0.16***	-0.52***	-0.17***	-0.20***
toyota	-0.21***	-0.22***	-0.33***	-0.19***	-0.33***	-0.31***	-0.30***	-0.10***
gm	-0.32***	-0.34***	-0.47***	-0.30***	-0.41***	-0.41***	-0.38***	-0.34***
ford	-0.27***	-0.29***	-0.40***	-0.25***	-0.36***	-0.36***	-0.33***	-0.29***
chrysler	-0.30***	-0.31***	-0.43***	-0.28***	-0.40***	-0.39***	-0.38***	-0.34***
nissan	-0.40***	-0.41***	-0.57***	-0.38***	-0.52***	-0.22***	-0.27***	-0.28***
mazda	-0.17***	-0.17***	-0.26***	-0.15***	-0.25***	-0.24***	-0.22***	-0.19***
mitsubishi	-0.21***	-0.22***	-0.33***	-0.19***	-0.08	0.02	-0.07	-0.09*
suzuki	-0.40***	-0.41***	-0.59***	-0.37***	-0.55***	-0.57***	-0.51***	-0.44***
honda	-0.24***	-0.26***	-0.35***	-0.23***	-0.17***	-0.31***	-0.15***	-0.14***
vw	-0.12***	-0.13***	-0.21***	-0.11***	0.02	0.09*	0.02	0.02
subaru	-0.27***	-0.28***	-0.40***	-0.25***	-0.14***	-0.10**	-0.14***	-0.14***
audi	-0.05	-0.06	-0.12**	-0.04	-0.00	0.07	0.02	0.05
bmw	0.04	0.02	-0.03	0.04	0.10	0.00	0.21**	0.13***
mercedes	0.22***	0.21***	0.17***	0.22***	0.18***	0.20***	0.21***	0.24***
volvo	0.07*	0.06	0.03	0.07*	0.05	0.02	0.07	0.09**
jaguar	0.08*	0.07	0.00	0.09**	0.04	0.03	0.07	0.11**
saab	0.20***	0.19***	0.20***	0.19***	0.20***	0.16***	0.21***	0.22***
const	7.58***	7.49***	6.58***	7.61***	7.42***	6.47***	7.57***	7.30***
R-sqr.	0.89	0.89	0.90	0.89	0.87	0.88	0.87	0.89
Root MSE	0.14	0.14	0.18	0.13	0.18	0.17	0.17	0.15

Source: own estimations

Note: ***, **, * - indicate significance at 1%, 5% and 10% significance level, respectively. The estimates are done based on GMM.A specification. Isuzu is used as a reference group. Horsepower, width, length and mpgcity (miles per gallon, city) are in logarithmic form.

6.4.2 Results of the test for the mutual forbearance hypothesis

Testing collusive assumption among multimarket contact firms The application of the test for the mutual forbearance hypothesis for the automotive industry as described above is complicated by the high concentration ratios and the fact that the automotive manufacturers are present in almost every market segment. Thus, one needs to find some variation in the multimarket contact among the automotive firms in the US car market to reduce the number of potential candidates for the multimarket contact firms, which could form the "multimarket contact firms coalition" and for which the assumption of implicit collusive behaviour could be then tested. There could be different criteria for that, e.g., how long the firm has been present in the market, difference due to the geographical market presence, technology difference (e.g., diesel technology), number of markets, in which a firm is present, etc.

In the US, the firms that are present in all automotive product markets are Toyota, GM, Ford and DaimlerChrysler. Renault-Nissan group is present in all the markets, except for the traditional market segment.

The criteria that I use for the differentiation of the multimarket contact to point out the coalitions of multimarket contact firms are: 1) the presence of the firm in all or almost all market segments, 2) multimarket firms with shares with more than 10% in each market segment (i.e., considering "influential" rivals, with "spheres of influence"), and 3) the combination of the above two criteria. Under the first criterion the collusion possibility between GM, Ford, DaimlerChrysler, Toyota and Renault-Nissan groups is tested. Under the second criterion, there is a collusion possibility between GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai and BMW. Under the third criterion, the collusion is tested between GM, Ford, DaimlerChrysler and Toyota. The collusive/cooperative assumption between GM, Ford, DaimlerChrysler and Toyota should be also tested on the basis of the fact that they are present in all market segments and have the highest number of multiple contacts. In addition, the collusive behaviour between GM, Ford, and DaimlerChrysler is tested as these firms have tended to dominate the US automotive market in general and across separate market segments. In addition, Toyota has been argued to be the "heatest" competitor for the US car producers, so the cooperative behaviour between them could be rather doubtful. For the other firms, I have tested different assumptions: competitive, single-product, and multi-product.

The choice of the above criteria for the multimarket contact differentiation has been based on the following arguments. Not only the diversification aspect matters (to support collusion due to multimarket contact it is not enough to be present in several markets) but also the ability of the firms to use it in the creation of the transferrable slack should be taken into account. It is unlikely that the firms with a small market share will be able to generate the necessary slack (which is usually fostered by the market concentration), which could be transferred to the other markets through the multimarket contact.

As I have mentioned above, in my estimations I distinguish between multi-product (brand) and multi-product (manufacturer group, taking into account the cross-shares in other firms) assumptions. Under the latter assumption, a joint profit maximization for Hyundai/Kia, GM/Suzuki/Saab/Isuzu, Ford/Mazda/Volvo/Jaguar, Chrysler/Mitsubishi/Mercedes, and VW/Audi is assumed, but this led to only slight changes in the markups as compared to those under the multi-product (brand) assumption. This is attributed to the low market shares of the car brands that are added to the main (parent) brand and the low cross-price elasticities of demand.

In accordance with the above assumptions, the ownership matrix θ is adjusted, and the markups could be calculated on the basis of the demand estimates from the first step. Given the markups, the marginal costs under different assumptions could be calculated (see Section 4.2.1 for more detail).

The results of the estimated marginal costs equations under selected multimarket contact assumptions can be found in Table 11 above. For the best supply-side model selection, the best way would be, of course, to get the real estimates of the marginal costs of the automotive firms at the model level, and to compare the obtained estimates with those ones, but this is difficult to realize in practice. Not surprisingly, there is not so much publicly available information about the margins of the OEMs in the US car market.

That is why, I am moving now to the discussion of the results from statistical procedures to choose the supply-side specification that best fits the data. Relying on the "goodness-of-fit" of the model may be not the best criterion for selecting the best model under these circumstances. As it can be already seen from the estimation results (see Table 11), the R-squared is rather similar for all model specifications. Below I apply the information criteria (Akaike (AIC), and Bayesian (BIC)), sum of squared residuals (SSR), the test for non-nested hypotheses by MacKinnon, White and Davidson (1983), and the test for model selection by Rivers and Vuong (2002) to try to choose the model that best fits the data.

The results of the comparison of the information criteria and the sum of squared residuals (SSR) as a way to differentiate between the supply side models can be found in Table 12. In addition to the single-product, multi-product (brand), multi-product (group) and market segment collusion assumptions, the information criteria for the following multimarket contact firms coalitions have been estimated: MMC1: collusive assumption for GM, Ford, DaimlerChrysler, Toyota and Renault-Nissan and competitive assumption for the others; MMC2: collusive assumption for GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai and BMW and competitive assumption for the others; MMC3: collusive assumption for GM, Ford, DaimlerChrysler and Toyota and competitive assumption for the others; MMC4: collusive assumption for GM, Ford, DaimlerChrysler and competitive assumption for the others; MMC5: collusive assumption for GM, Ford, DaimlerChrysler, Toyota and Renault-Nissan and single-product assumption for the others; MMC6: collusive assumption for GM, Ford, DaimlerChrysler, Toyota and Renault-Nissan and multi-product assumption for the others; MMC7: collusive assumption for GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai and BMW and single-product assumption for the others; MMC8: collusive assumption for GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai and BMW and multi-product assumption for the others; MMC9: collusive assumption for GM, Ford, DaimlerChrysler and Toyota and single-product assumption for the others; MMC10: collusive assumption for GM, Ford, DaimlerChrysler and Toyota and multi-product assumption for the others; MMC11: collusive assumption for GM, Ford, DaimlerChrysler and single-product assumption for the others; MMC12: collusive assumption for GM, Ford, Daimler-

Chrysler and multi-product assumption for the others.

The model specification that gets the lowest information criteria and SSR should be chosen as the supply-side specification that best fits the data. The specifications of the single-product, multi-product (brand) and multi-product (manufacturer group) price competition have got the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values. However, these values are not so much different from the values for the supply-side specification under the three multimarket contact assumptions, namely collusive behaviour for Ford, GM and DaimlerChrysler and competitive (MMC4), or single-product (MMC11), or multiproduct (MMC12) price competition for the other automotive players. That is why, one should be rather careful in making conclusions on the basis of these information criteria results. The comparison of the SSR values shows a similar picture. It should be noted that the SSR in any case could not be treated as a sufficient condition for rejecting all the other null hypotheses.

Table 12. US light vehicles market: information criteria and sum of squared residuals (SSR) for different supply side specifications

Specifications	AIC	BIC	SSR
Single-product	-539.63	-415.83	9.97
Multi-product (brand)	-535.29	-411.49	10.05
Multi-product (group)	-534.40	-410.59	10.07
Market segment collusion	-306.90	-183.10	15.49
MMC1	-306.30	-182.50	15.51
MMC2	-324.57	-200.76	14.98
MMC3	-345.43	-221.63	14.40
MMC4	-497.40	-373.60	10.80
MMC5	-306.56	-182.76	15.50
MMC6	-306.77	-182.96	15.49
MMC7	-331.26	-207.45	14.79
MMC8	-331.34	-207.54	14.79
MMC9	-347.72	-223.91	14.34
MMC10	-347.81	-224.00	14.33
MMC11	-480.08	-356.28	11.16
MMC12	-478.98	-355.18	11.18

Source: own estimations

Note: 'AIC' means Akaike Information Criterion, 'BIC' stands for Bayesian Information Criterion, and 'SSR' denotes sum of squared residuals.

The results of the test for nonnested hypotheses by MacKinnon, White and Davidson (1983) can be found in Table 13 (a,b). The detailed description of the test procedure that I have applied can be found in Appendix. At the top of each row there are several modes of market conduct (null hypothesis). Each of the columns represents one of the alternative market conduct scenarios (alternative hypothesis). The results of the test can be best seen by evaluating the columns. It could be seen that when the alternative is MMC4 assumption (specification A8), i.e., collusive assumption for the American Big Three GM, Ford and DaimlerChrysler and competitive assumption for all other automotive players, all other null hypotheses are rejected. That is, this supply-side specification could be argued to be the most preferred supply-side specification on the basis of this test.

Table 13a. US light vehicles market: results of the test for the non-nested hypotheses (MacKinnon, White and Davidson, 1983)

H0/H1	A1	A2	A3	A4	A5	A6	A7	A8
A1		-0.0	0.6	1.7	-6.0	-0.5	-5.3	-2.6
A2	0.7		1.4	1.8	-6.4	-0.5	-5.6	-3.0
A3	0.1	-1.1		1.4	-6.4	-0.6	-5.6	-3.0
A4	-1.0	-1.3	-1.0		-6.0	-0.7	-4.8	-2.6
A5	14.8	14.9	15.0	14.7		11.2	6.2	14.4
A6	5.8	5.7	5.8	6.0	-5.2		-4.9	2.0
A7	13.0	13.0	13.1	12.8	-2.3	9.5		12.2
A8	7.2	7.3	7.4	7.3	-8.0	2.0	-7.5	
A9	14.9	15.0	15.0	14.7	1.3	11.3	6.2	14.4
A10	14.8	14.9	15.0	14.7	-0.2	11.3	6.1	14.3
A11	5.9	5.8	5.8	6.1	-5.2	0.1	-4.9	2.0
A12	5.9	5.8	5.8	6.1	-5.2	0.1	-4.9	2.1
A13	13.0	13.1	13.1	12.8	-2.3	9.7	1.5	12.2
A14	12.9	13.0	13.1	12.8	-2.3	9.7	0.0	12.2
A15	7.4	7.4	7.5	7.4	-7.9	2.2	-7.4	4.1
A16	7.3	7.3	7.4	7.3	-7.9	2.1	-7.4	1.8

Source: own estimations

Note: t-statistics are given in the cells. A1: Single-product. A2: Multi-product (brand). A3: Multi-product (group). A4: Market segment collusion. A5: MMC1. A6: MMC2. A7: MMC3. A8: MMC4. A9: MMC5. A10: MMC6. A11: MMC7. A12: MMC8. A13: MMC9. A14: MMC10. A15: MMC11. A16: MMC12. These assumptions are explained in more detail in the text above.

Table 13b. US light vehicles market: results of the test for the non-nested hypotheses (MacKinnon, White and Davidson, 1983) (continuation)

H0/H1	A9	A10	A11	A12	A13	A14	A15	A16
A1	-6.1	-6.1	-0.5	-0.5	-5.4	-5.3	-2.8	-2.7
A2	-6.4	-6.4	-0.5	-0.5	-5.7	-5.6	-3.2	-3.1
A3	-6.4	-6.4	-0.6	-0.6	-5.7	-5.6	-3.2	-3.1
A4	-6.0	-6.0	-0.7	-0.7	-4.9	-4.9	-2.8	-2.7
A5	-0.9	0.8	11.1	11.1	1.8	1.8	8.9	8.9
A6	-5.3	-5.3	0.0	-0.0	-5.0	-5.0	1.8	1.9
A7	-2.3	-2.2	9.5	9.5	-1.1	0.5	12.1	12.1
A8	-8.0	-8.0	2.0	2.0	-7.6	-7.5	-3.7	-1.3
A9		1.5	11.3	11.3	6.1	6.2	14.2	14.3
A10	-1.3		11.3	11.3	6.0	6.1	14.1	14.2
A11	-5.3	-5.3		-0.1	-4.9	-4.9	1.9	1.9
A12	-5.3	-5.3	0.1		-4.9	-4.9	1.9	1.9
A13	-2.4	-2.3	9.7	9.7		1.3	12.1	12.1
A14	-2.4	-2.4	9.7	9.7	-1.2		12.0	12.1
A15	-8.0	-8.0	2.2	2.2	-7.5	-7.4		1.6
A16	-8.0	-8.0	2.1	2.1	-7.5	-7.4	-1.4	

Source: own estimations

Note: t-statistics are given in the cells. A1: Single-product. A2: Multi-product (brand). A3: Multi-product (group). A4: Market segment collusion. A5: MMC1. A6: MMC2. A7: MMC3. A8: MMC4. A9: MMC5. A10: MMC6. A11: MMC7. A12: MMC8. A13: MMC9. A14: MMC10. A15: MMC11. A16: MMC12. These assumptions are explained in more detail in the text above.

The interpretation of the above finding is not so straightforward. Ford, GM and DaimlerChrysler have got extensive multimarket contacts with each other, at the same time they individually dominate all market segments, so that the found on the basis of the above test collusive behaviour could be attributed to the highly concentrated nature of the US light vehicles market, which could also foster collusive behaviour. Another interpretation of the result could be that the collusive behaviour can be facilitated in case of both multimarket contact presence and high market concentration, and it could be even higher than in case of only multimarket contact presence, or only high market concentration. Concentration in a particular market may foster a slack, which is transferred through the multimarket contact to the other markets.

The above test for non-nested hypotheses is based upon the assumption that one of the nested models is correctly specified. It might be, however, not the case. That is why, for robustness checks, I have also tried to perform the model selection test by Rivers and Vuong (2002). However, I have failed to get any conclusive results.

The results from testing procedures are, thus, not quite satisfactory. The test for non-nested hypothesis by MacKinnon, White and Davidson (1983) could give some support for collusive behaviour in the US car market. Whether this is a plausible result, that is another question, which is difficult to answer given the absence of the publicly available cost data.

It could be argued that the US automobile market has become quite competitive recently. As a result, it is difficult to expect healthy profits in the industry. Although this argument is quite a natural argument given the current financial situation of the US automobile producers, several arguments could be named to support the results of this paper. First, 2001-2003 period, although quite competitive, is still less competitive than the subsequent and current period, when all Big Three American car producers face severe financial problems. Furthermore, the markups estimated on the basis of structural models and the markups calculated on the basis of the accounting data that appear sometimes in public could be quite different[45]. In addition, several studies find collusive behaviour in the automobile industry notwithstanding the increased competition (e.g., Jaumandreu and Moral, 2006). It would be good to conduct a similar analysis for the earlier period of time if the data are available, say before 2000, to try to get more support for the findings of this paper.

It should be noted that the multi-product (group) specification, which captures the effect of the cross-ownership and the impact of owing several brands by the manufacturer group on the firm behaviour has not been found to be the most preferred supply-side specification on the basis of the test for the non-nested hypotheses. It seems as if the relevant for the US car market manufacturer groups include minor brands that may be not of great importance in determining the firms' equilibrium behaviour.

Testing shock effects Testing shock effects to make some inferences about the mutual forbearance hypothesis largely depends on the results of the choice of the supply-side specification that best describes the data[46]. The plausible estimates of own- and cross-price elasticities, mark-ups and, consequently, marginal costs are likely to determine the simulation results. It should be noted that simple logit and nested logit models have been frequently used for policy simulations.

Testing shock effects could probably help me disentangle the effects from concentration and multimarket contact on pricing. Two types of shocks can be distinguished: specific-market shocks (to study multimarket contact effects, to study the impact on other markets) and industry-level shocks (to study concentration effects, to see whether there is an impact on all markets in the industry). This analysis could be done to study the mutual forbearance hypothesis on the basis of the multimarket contact assumption that gets most support in the first step. If some other pricing equilibrium turns out to be supported by the data, strategic interactions of firms could be still investigated (there could be also different degrees of collusion in the markets due to the multimarket contact).

As I have mentioned before, the price war can be approximated by the

[45] Verboven (1997) also in particular argues that the price-cost margins calculated on the basis of the accounting data should be treated with caution while evaluating market power in an industry. The estimation of an oligopoly model gives an indirect way to determine market power.

[46] The results from these simulations may be to some extent equivalent to those from the estimation of the "conjectures", i.e., own- and cross-market reactions in the homogenous goods case.

changes in the ownership matrix for a particular market segment. Thus, even if I test, e.g., multimarket contact assumption at the firm level (i.e., I assume collusion for a coalition of firms in each market segment), I can simulate what happens when the firm behaviour in one market segment becomes more competitive, whether this will influence the firm(s)' behaviour in the other market segments, and where these changes will be most pronounced.

On the basis of the above described simulations, I have failed to derive some conclusive evidence. I could get perhaps much more reasonable simulation results on the basis of the random coefficients framework.

7 Concluding remarks

To the best of my knowledge, this is the first study on the automotive industry, which concentrates on studying various sources of the market power in an extensive way: fewness (a few competitors and large concentration), differentiation (products have unique features), market-specific collusion, and collusion due to the multimarket contact presence, and which exclusively concentrates on studying the firms' equilibrium interactions in the US car market. The mutual forbearance hypothesis is tested in the industry characterized by extensive multimarket contact, however, in which it is not so easy to test for the multimarket contact effects on collusive behaviour. In this study I have tried to analyze how to conduct a test for the mutual forbearance hypothesis in principle, and how to implement it using a particular data for the US automobile market.

It has been found that multimarket contact may influence competition in the automobile markets and increase the firms' strategic interdependence. This effect is, however, difficult to disentangle from the effect of the market concentration in the US automobile market on the firm behaviour. It should be noted that in general the empirical studies find a problem to distinguish between internal (e.g., concentration) and external (e.g., multimarket contact) effects on the firm behaviour. The model specifications of single-product and multiproduct firm behaviour for the car producers have been found among the most preferred supply-side model specifications on the basis of the information criteria and sum of squared residuals, but not on the basis of the test for non-nested hypotheses. The test by MacKinnon, White and Davidson (1983) showed some support for the specification where GM, Ford and DaimlerChrysler behave in a cooperative way, and all other automotive players behave competitively. On the basis of the model selection test by Rivers and Vuong (2002) it was difficult to choose the best supply-side specification. Therefore, one should be careful in applying a particular statistical test and interpreting its results. It seems worthwile to compare the results from several testing procedures as robustness checks for the chosen "best" supply-side specification.

The major novelty of this paper as compared to the other empirical studies on the mutual forbearance hypotheses has been the specification of coalitions of multimarket contact firms and testing collusive assumption among them. The test has been applied in a non-traditional set-up as compared to the "traditional" for such studies industries and markets (e.g., banking, or airlines). This paper has rather concentrated on testing the existence of the significant and positive impact of multimarket contact on the firm behaviour. Namely, it has been tested that the firms behave perfectly collusively because of multiple market presence. The degree of collusive behaviour is assumed to be the same in all the markets where the rivals meet each other. The precise quantification of the multimarket contact effect on the firm behaviour is difficult on the basis of this approach.

The results of this paper may be improved in the future by estimating more flexible substitution patterns (e.g., on the basis of random coefficients model estimation for a longer time period), which may lead to the more plausible mark-ups and more reliable marginal costs estimates. A less competitive time period could be considered using the same approach. It would be also worthwile to have the data for a longer time period, where there may be periods of collusive and more competitive behaviour among the multimarket contact firms.

While estimating the nested multinominal logit, I have had to rely on the market segmentation criteria often used in other empirical and analytical automotive industry studies. The changes in the market segmentation may lead to the changes in the demand estimates. The question is how distinctive, or relevant, the market segments are. Whether they are perceived in the same way by the automotive manufacturers poses another important issue. The market definition is particularly critical in the context of the mutual forbearance hypothesis. On the demand side, this problem can be solved by estimating the random coefficients model. However, the problem still remains when the interdependence of the firm behaviour across the market segments is being tested. Sensitivity analysis due to the changes in the market segmentation could be helpful to shed some light on this problem. However, since the market segmentation classification is very well-established, I have relied upon it in my estimations. The definition of a market in the US light vehicles market could be an interesting topic for future research, with policy implications for antitrust authorities.

List prices of light vehicles may be not the best alternative in my estimations due to the numerous price incentives in the US automotive market, and, thus, this could be a point of potential critique. Transaction prices should be rather used, which are difficult to get. A possible way out is to collect information on the customer incentives for the cars offered, which are often cited in the automotive news media, and then calculate the "transaction" prices. On the other hand, the problem of the list prices may be not so severe as the use of list prices instead of transaction prices can be treated as a measurement error in the explanatory variable, and the prices are instrumented in any way.

Some policy implications may be derived for conducting competition policy. The possible anticompetitive effects of the multimarket contact will have to be taken into account while setting up the antitrust policy (e.g., there may be implications for the entry of new firms), and assessing the effects of the conglomerate mergers. If the markets are strategically linked, then policy makers should take into account both direct effects of their regulatory actions in one particular market, and indirect effects in the other markets. The sole market assumption by the regulators may, thus, be irrelevant. The measurement of the competitive pressure in an industry can be more complicated than it could be inferred from the concentration ratio, or Herfindahl index, if accounting for the multimarket contact effects.

To sum up, the results of the study allow verifying to a certain extent the theoretical predictions about the mutual forbearance hypothesis, give empirical evidence on the intermarket relationships of the multiproduct firms, contribute to the literature on the market power, and, furthermore, help explore the competitive interactions in the automotive industry, thus, gaining a deeper understanding of the pricing behaviour in the automobile market, which constantly receives a lot of public interest.

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9 Appendix. Tests for non-nested hypotheses

9.1 MacKinnon, White and Davidson (1983) test for non-nested hypotheses

These tests fall under the category of "artificial testing"[47]. Two non-nested models are embedded into a more general artificial model. MacKinnon, White and Davidson (1983) derive the test for the linear case (J-test), the non-linear

[47] This test has been in particular applied by Feenstra and Levinsohn (1995) and Verboven (2002).

case (P-test), with transformed dependent variables and in case of the IV estimation.

I can re-write the below pricing equation, which is derived from the first-order conditions and can be decomposed into marginal cost and markup:

$$p = c + \Omega^{-1}s \tag{29}$$

in the following way:

$$p = w\gamma + D\lambda + \omega + \Omega^{-1}s \tag{30}$$

where w are product characteristics, D are firm dummies, ω are unobserved product characteristics. The quality-adjusted prices will then be:

$$\pi = p - w\gamma - \omega = D\lambda + \Omega^{-1}s \tag{31}$$

The null hypothesis will be as follows:

$$H_0 : p = w\gamma_0 + \pi_0 + \varepsilon_0 \tag{32}$$

The alternative hypothesis can be written down as:

$$H_1 : p = w\gamma_1 + \pi_1 + \varepsilon_1 \tag{33}$$

If the model under H_0 is a true model, then there should be no correlation between its residuals and the difference between the fitted values of H_0 and H_1. w, i.e., product characteristics, will be the same in case of both models, thus, the quality-adjusted prices π_0 and π_1 will be the fitted values of interest.

The idea of the P-test is to evaluate whether $p - \widehat{\pi}_0$ is orthogonal to $\widehat{\pi}_1 - \widehat{\pi}_0$. For that purpose, the artificial regression should be run:

$$(p - \widehat{\pi}_0) = wa + (\widehat{\pi}_1 - \widehat{\pi}_0)b + u$$

a and b are the parameters to be estimated. Pairs of models are compared on the basis of the t-statistic, which is normally distributed.

9.2 Rivers and Vuong (2002) model selection test

Assume the following cost specification[48]:

$$c_j^h = \exp(\omega_j\gamma + w_j^h) \tag{34}$$

Taking the logarithms on both sides I get:

$$\ln c_j^h = \omega_j\gamma + w_j^h \tag{35}$$

or

[48] Vuong-type tests have been in particular applied by Jaumandreu and Lorences (2002), Bonnet et al. (2006), and Jaumandreu and Moral (2006).

$$\ln(p_j - \Omega^{-1}s) = \omega_j\gamma + w_j \tag{36}$$

It is assumed that two models h and h' are tested against each other:

$$p_j = c_j^h + (\Omega^{-1}s)^h \tag{37}$$

and

$$p_j = c_j^{h'} + (\Omega^{-1}s)^{h\prime} \tag{38}$$

The lack-of-fit criteria are defined for both models as:

$$\min Q_n^h = \min \frac{1}{n}\sum(\varpi_j^h)^2 = \min \frac{1}{n}\sum(\ln(p_j - \Omega^{-1}s) - \omega_j\gamma)^2 \tag{39}$$

The null hypothesis is defined as the two models are asymptotically equivalent when

$$H_0 : \lim_{n\to\infty}(\bar{Q}_n^h - \bar{Q}_n^{h'}) = 0 \tag{40}$$

The two alternative hypotheses are that model h performs asymptotically better than model $h^{'}$, or that model h' performs asymptotically better than model h.

The test statistic is then calculated in the following way:

$$T_n = \frac{\sqrt{n}}{\widehat{\sigma}^2}\left\{\bar{Q}_n^h - \bar{Q}_n^{h'}\right\} \tag{41}$$

where $\bar{Q}_n^h, \bar{Q}_n^{h'}$ are the sample-of-lack criteria that are estimated for the models h and h' at the estimated parameters values of the model, and $\widehat{\sigma}^2$ is the estimated value of the variance of the difference in the lack-of-fit. The test statistic has an asymptotic standard normal distribution.

If the standardized difference is statistically negative that implies that the model h is better than model h'. If the test statistic is large and positive that means that the model h' is better than model h.

Chapter 3. Geographical and Multi-product Linkages of Markets: Impact on Firm Equilibrium Interactions (Some Evidence from the European Car Market)

Geographical and Multi-Product Linkages of Markets: Impact on Firm Equilibrium Interactions (Some Evidence from the European Car Market)*

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April 14, 2008

Abstract

This paper aims to study geographical and multi-product linkages of markets (multiple market presence) and firm behaviour interdependence as a result of such linkages existence. In particular, it attempts to answer whether the multimarket linkages lead to more cooperative behaviour among the firms, which results in higher prices and profits, and whether the degree of collusive/cooperative behaviour varies across markets. These issues are investigated within a structural oligopoly model for differentiated products for the European automobile market on the basis of the aggregate product-level data for 1970-1999. The results of the study reveal weak (quantitative) effect of multimarket contact on market conduct/pricing in the European car market as well as provide some evidence on the redistribution of the market power from the more collusive to the more competitive markets due to multimarket contact.

*I am thankful for the financial support to the German Research Foundation (Deutsche Forschungsgemeinschaft (DFG)) and the Center for European Economic Research (ZEW) during my PhD studies at the Center for Doctoral Studies in Economics (CDSE), University of Mannheim. I am very grateful for the comments to Prof. Konrad Stahl and for the discussion to Prof. Frank Verboven at the early stage of the paper. Enormous thanks to my sister Tetyana Romanchenko for data assistance. The comments of the participants of 2007 CDSE Doctoral Seminar (Mannheim) and 2007 9th INFER annual conference at Loughborough University (UK) are appreciated.

1 Introduction

Most of the existing on the European car market[1] studies have been devoted to the investigation of significant price dispersion in the European car market (e.g., Verboven, 1996, Degryse and Verboven, 2000, Goldberg and Verboven, 2001)[2]. Empirical studies find the following reasons for the price dispersion in the European car market: differences in demand elasticities, concentration, import quota constraints, lack of uniform taxation, incomplete pass-through of exchange rates, differences in local costs[3], etc. Verboven (1996) mentions considerable cross-border arbitrage costs, which result in geographical car market fragmentation[4]. The volume of parallel imports is very low. Ginsburgh (1996) and Lutz (2000) point out the "block exemption" to be the most important factor that has hindered competition in the European car market. Additional obstacles to purchase a car abroad are national type approval rules (harmonized only in 1995) and national registration systems (Goldberg and Verboven, 2001). This leads to significant artificial trade barriers.

The European car market is characterized by extensive multimarket contact (i.e., the firms are present in many geographic and product markets), a high degree of interfirm linkages, and presence of several global automotive manufacturer groups[5]. The impact of these factors on the firm behaviour has not been considered in the previous studies, which could explain more precisely the firm conduct in the European car market and shed more light on the pricing behaviour differences across markets, thus, possibly contributing to understanding better the price dispersion pattern in the European car market.

Multiple market presence is generally argued to foster collusive firm behaviour (e.g., Bernheim and Whinston, 1990, Spagnolo, 1999). The major objective of this paper has been to test the game-theoretic predictions about the impact of multimarket contact on the firm behaviour by Bernheim and Whinston (1990) for the European car market. First of all, I have aimed to test for the general effect of the multimarket contact presence, i.e., the extent of the markets overlap, on the firms' equilibrium behaviour pattern. Furthermore, the firms should

[1] In Introduction I refer to European car market as a whole Western European car market. In my estimations later, however, under the European car market the new car sales in the following five countries are meant: Belgium, France, Germany, Italy and the UK.

[2] A detailed survey and major findings of these studies can be in particular found in Degryse and Verboven (2000). A number of studies on the price differentials in the European car market has been published by the European Commission. Questions being addressed in the other European car market studies have been in particular the effects of the reform of the car distribution system in Europe (Brenkers and Verboven, 2006a), and defining a relevant car market (e.g., Brenkers and Verboven, 2006b).

[3] Manufacturing cost differences across countries in the European car market have been found to be important (e.g., Kirman and Schueller, 1990). The highest-cost producer is the UK, followed by Italy and Germany, with Belgium and France being the least-cost producers.

[4] The possibility of arbitrage trade between markets and the degree of market segmentation have been addressed in Lutz (2004).

[5] At present there are about 13 global independent automotive manufacturer groups. These manufacturer groups own several car brands (e.g.,VW Group). The notion of interfirm linkages comprises equity and contractual as well as horizontal and vertical relationships among the firms. This issue will be discussed in more detail later in the paper.

"forbear" from retaliating more, the larger shares they have in those markets. For them there is more to lose in the concentrated markets if they choose to deviate from collusive prices, and there will be lower coordination costs in those markets. That is why, I have attempted to investigate whether the multimarket contact effect on collusion is stronger in the more concentrated markets. In empirical studies it is usually difficult to measure the effect of multimarket contact on competition and to differentiate between the impact of multimarket contact and concentration on pricing, which I have intended to address in this paper. I have also aimed to test directly for the presence of the "spheres of influence" that would foster collusive behaviour (this term has been introduced by Edwards (1955) and has been discussed by Bernheim and Whinston (1990)). That is, I have tested for collusion among "influential rivals", which could respect each others' "spheres of influence" (e.g., these could be the markets where they have cost advantages). Finally, I have intended to test for the presence of the strategic effects of the multimarket contact as specified by Bernheim and Whinston (1990), namely, the redistribution of the market power from the more collusive to the more competitive markets in case of differentiated products due to the multimarket contact in the European car market.

The previous empirical evidence on multimarket contact effects has been rather inconclusive concerning the existence, sign and significance of the effect on the tacit collusion (e.g., Heggestand and Rhoades, 1978, Scott, 1982, Evans and Kessides, 1994, Parker and Röller, 1997). In Leheyda (2007a) I could find some evidence about the possible existence of the multimarket contact effects on the firm behaviour in the US light vehicles market. However, some addiditional evidence could have been worthwile to get to argue firmly about the relevance of these effects for the automobile markets. In particular, it was difficult to differentiate that effect from the possible concentration effect on collusive pricing. As compared to that study, in this paper the longer period of time and a greater number of markets allow me to study a richer number of the research objectives (including the existence of the strategic effects of the multimarket contact) and apply other approaches to study the multimarket contact (as well as concentration) effects on the firm behaviour. Geographical aspect of the multimarket contact is added to the multi-product context of the automotive industry, which increases the number of markets, across which the automotive firms interact.

Evidence for collusive behaviour found in the other studies, or facts observed in reality[6] could serve as an additional motivation to investigate the multimarket contact hypothesis. The empirical evidence on the multimarket contact effects existence, if found, might be another potential explanation/motive for cooperative/collusive behaviour among the firms. Verboven (1996) could not reject the hypothesis of the presence of collusive behaviour in Germany and United Kingdom in 1990. Goldberg and Verboven (2001) attribute the higher prices in Italy to the presence of the strong bias towards domestic brands, higher prices

[6] The UK has been, e.g., mentioned as the only European country where a legal investigation for collusive behaviour has been initiated by Monopolies and Merger Commission (Goldberg and Verboven, 2001).

in the UK to "the better equipped cars and/or differences in the dealer discount practices". Brenkers and Verboven (2006a) find that the firm behaviour in the UK is slightly more collusive than the Bertrand-type behaviour, and that the behaviour in France, Germany and Italy is slightly less competitive than the multiproduct behaviour as compared to Belgium. As compared to the above three studies[7], I am using other approaches to identify the collusive firm behaviour[8]. In addition, I try to link it to the presence of the extensive multimarket contact and high concentration in the European car market. That is, I attempt not only to report the existence of the collusive behaviour in the European car market, but point out some factors behind its existence if found. Jaumandreu and Moral (2006) find support for the price coalition by domestic and European firms in the Spanish car market during 1990-1996, notwithstanding the increased competition starting 1993 (connected with tariffs dismantling for foreign firms, demand downturn, and high entry of new models).

Absence of the consistent and considerable evidence and no targeted study on the firm behaviour in the European car market has served as an additional motivation for doing this study. For example, Verboven (1996) argues that there could be differences in the degree of collusive behaviour across countries and calls for a more detailed analysis of the differences in the firm behaviour across the countries. My study has been meant to be a contribution to the market conduct literature using new empirical approaches in the IO. In this paper the emphasis is on different demand and cost conditions in geographical markets and also product markets, which could lead to different degrees of collusion/cooperative behaviour in these markets due to multimarket contact, which has been pointed out by Bernheim and Whinston (1990). The idea of this paper is to extend the empirical approach of structural oligopoly model with product differentiation by Verboven (1996), Goldberg and Verboven (2001) and Brenkers and Verboven (2006a, b) for geographical markets to study the impact of the degree of geographical and multiproduct market linkages on the firm behaviour in the European car market. To sum up, this study attempts to systematize the previous evidence on the firm behaviour in the European car market and draw some new inferences by going further into the methodology on the firm equilibrium interactions.

The major contribution of this paper in terms of the methodology to study the impact of multiple market presence on the firm behaviour is to estimate conjectural variation parameters (in case of differentiated products) and test the impact of concentration and multimarket contact within this market conduct equation. These effects are tested directly within the hedonic pricing equation as well. To measure the degree of multimarket linkages, I construct several mul-

[7] These are the only studies that estimate structural oligopoly models with product differentiation for the total European car market. The other studies apply mostly the reduced-form approach to study the price dispersion in the European car market, or they concentrate on specific country markets developments.

[8] For the demand side, I take the similar demand specification. I am not interested in the demand specification as such in this paper. The most important for me has been to get the reliable estimates of price and correlation parameters that could have been used to estimate substituion patterns, markups and market conduct parameters.

timarket contact measures at the firm and market level. I also discuss different "spheres of influence" for the car producers at geographic, market segment and geographic-product market levels. In addition, the likelihood of a number of multimarket contact firms coalitions as candidates for a potential equilibrium outcome in the European car market is being tested on the basis of the menu approach. In particular, the test for non-nested hypotheses by MacKinnon, White, and Davidson (1983) and the model selection test by Rivers and Vuong (2002) are applied to test for different modes of market conduct.

The results of the study reveal the existence of the effect of multimarket contact on the firm behaviour in the European car market as well as provide some evidence on the redistribution of the market power from the more collusive to the more competitive markets. The impact of multimarket contact on the firm behaviour is economically (quantitatively), however, rather insignificant. The impact of concentration on prices is found to be more considerable. The multimarket contact effect on the market conduct and prices may be also stronger in the more concentrated markets. It has been challenging to choose the best model specification for the supply side on the basis of the menu approach that has been aimed to test directly for the "spheres of influence" version of the mutual forbearance hypothesis.

The paper proceeds in the following way. First, the literature review is presented. In the next section I describe the structural characteristics of the European car market as well as observed in the market multimarket contact and inter-firm linkages. After that empirical framework for testing the mutual forbearance hypothesis is discussed. Then data, estimation procedure and results are described. The paper ends with some conclusions.

2 Literature review

The literature on multimarket contact theory has been more extensively discussed in the paper on the multimarket contact effects in the US light vehicles market (Leheyda, 2007a). In this section I would like to highlight some empirical studies that are more relevant for this study and have not been discussed in detail in the paper earlier.

As I have already mentioned, the existing empirical studies (e.g., Heggestand and Rhoades, 1978, Scott, 1982, Evans and Kessides, 1994, Parker and Röller, 1997), which are mostly done for airlines and banking industry, have failed to give conclusive evidence about the existence, sign and significance of the multimarket contact effect on facilitating and maintaining collusion. These are mainly the cross-sectional studies. They may rather identify correlations between multimarket contact and competition, while prices, concentration and multimarket contact are rather endogenously determined. One of the sources of endogeneity is the unobserved heterogeneity across markets, which can be captured by introducing market fixed effects in panel-data models.

Most existing empirical studies concentrate on testing the multimarket contact effect, based on the construction of some multimarket contact measure, on the firm's performance (i.e., the so-called reduced-form approach), while there have been virtually no studies done about the multimarket contact effect on collusion within a structural model of firm behaviour. The only exceptions are the papers by Jans and Rosenbaum (1996) and Parker and Röller (1997) for homogenous products. The existing empirical studies have a major problem to distinguish between internal (e.g., concentration, demand conditions, barriers to entry) and external effects (e.g., multimarket contact) upon the firm performance (Bernheim and Whinston, 1990).

Most of the existing empirical studies on the multimarket contact effects focus on geographical markets (for banking, airlines, mobile telephony markets, etc.). The only exception there seems to be a paper by Scott (1982), where the study is done for the lines of businesses.

Some studies find that the effect of multimarket contact on prices is stronger in the more concentrated markets (e.g., Scott (1982), Jans and Rosenbaum (1996)). Scott (1982) and Jans and Rosenbaum (1996) find a more pronounced effect of multimarket contact on collusion in the more concentrated markets, and higher impact of concentration on collusion in the markets characterized by the more extensive multimarket contact. Fernandez and Marin (1998) find lower prices in the markets where it is easier to collude, and higher prices in the markets where it is more difficult to reach collusive agreements. They attribute this effect to the presence of the so-called strategic effects of the multimarket contact, i.e., the redistribution of the market power from the more collusive to the more competitive markets.

The focus of many empirical studies are the general conditions of the existence of the multimarket contact effects (i.e., studying the impact of the overlap of the markets in which the firms are present), while not so many studies focus explicitly on the different effectiveness of multimarket contact when the firms differ in their territorial interests (in other words, "spheres of influence"). This idea of the "spheres of influence" version of the mutual forbearance hypothesis has been discussed in detail by Gimeno (1999). He argues that firms under multimarket contact competition tend to recognize different "territorial interests" that the firms may have in different markets. They may use their market shares in the markets that are important for their rivals to reduce the competition in those markets that are important for them and sustain their dominant positions. The benefit for the firms from multimarket retaliation threats is not equal across all their markets. These threats of multimarket retaliation are rather used by the firm to defend its position in those markets, where the firm has "spheres of influence". The empirical literature on this aspect of the multimarket competition is not extensive, which may serve as an additional argument to investigate this issue more profoundly in this study.

In addition to the construction of multimarket contact measures and testing their impact on the firm performance, the estimation of the so-called conjectures has been another approach used in the literature to study the firm strategic interdependence as a result of multiple market presence. Feinberg (1985) argues that the theory of the mutual forbearance could be treated as an extension of traditional oligopoly theory, which foresees the possible existence of cross-market conjectural variations. When firms meet each other in several markets, a firm can conjecture a possible reaction of another firm in all the markets where they meet each other to an action by anyone of them. The estimation of own- and cross-market effects is in tradition of the empirical industries with market power (survey by Bresnahan (1989)). Feinberg (1985) and Gelfand and Spiller (1987) estimate "conjectures", i.e., own- and cross-market reactions, and interpret them in terms of the mutual forbearance hypothesis[9]. But what is actually rather being tested in these papers, that is the notion of strategic interdependence (introduced by Areeda and Turner, 1979), or the presence of multiproduct oligopolistic strategies, which may be not actually the evidence for the cooperative behaviour of firms. When firms recognize this mutual interdependence, the mutual forbearance behaviour can evolve, which led to the hypothesis formulated by Edwards (1955) and formalized by Bernheim and Whinston (1990) (i.e., collusive behaviour as strong interdependence across markets).

The number of studies that estimate the conjectural variation parameters for differentiated products industries is rather limited (as compared, e.g., to those that estimate homogenous goods demand and marginal cost). Thus, any contribution in this field could be welcome, despite some critisisms of this approach (e.g., identification problem, conjectures interpretation). Both menu[10] and conjectural variation approaches to identify the market conduct have their weaknesses, so it is worthwile to apply both of them in order to come up with the reliable results at the end. This has been the strategy pursued in this paper.

3 European car market

3.1 Structural characteristics

The European car market, although less concentrated than the US car market, is characterized by significant cross-country differences in concentration ratios. The markets are especially concentrated in France and Italy, followed by Germany and the UK, with the lowest concentration ratio for Belgium (see Graph B1, Appendix B). The most concentrated market based on the one-firm (C1)-concentration ratio is Italy, while the most concentrated market on the basis of the four-firm (C4)- and seven-firm (C7)-concentration ratios is France in 1999. During the considered period of time, i.e., during 1970-1999, the concentration ratios have declined in Italy. The concentration ratios for the total European car market have stayed on average at the same level, while the multimarket contact, which will be discussed in more detail below, has increased.

The number of producers in geographic markets has increased in 1999 as compared to 1970. In particular, several foreign producers have entered the European car market (e.g., Mazda (1972), Mitsubishi (1976), Daihatsu (1979),

[9] Their analysis is based upon the investigation of the "conjectures" values and their change as a result of some regulatory actions.

[10] The menu approach to identifying the firm behaviour has been in particular described by Gasmi et al. (1990).

Hyundai (1980), Suzuki (1981), Seat (1983), Skoda (1993)). The share of the non-European firms is the highest in Belgium, where there are no domestic producers.

The European car market is also characterized by different tax levels (see Table B2, Appendix B) and import quotas (3.0% in France, 15.0% in Germany, 1.0% in Italy, and 11.0% in the UK (Goldberg and Verboven, 2001)).

The above mentioned differences in concentration ratios as well as in the number of car producers across geographic-product markets imply that the markets that I consider could be quite different. As Bernheim and Whinston (1990) state (among other possible conditions), the effect of the multimarket contact on cooperative behaviour can be facilitated in case of different markets, or in case of a different number of firms in those markets.

A few words should be mentioned about the international price dispersion in the European car market. International price differences are the lowest for the luxury car market segments, while the highest international price differentials are observed in segments C and D (Degryse and Verboven, 2000). In general in the smaller car market segments the price differentials are found to be higher. The highest price differentials are observed by Japanese and Italian brands (that have most models in the smaller car market segments). As for international price differentials across brands, Degryse and Verboven (2000) find the highest price differentials by Fiat, Alfa Romeo, Nissan, Honda, Toyota, Subaru, Mazda and Ford, and the lowest by Mercedes, BMW, Lancia, Peugeot, Citroen and Renault. Lutz (2000) finds that among European car producers Peugeot/Citroen, Fiat and Ford Groups price-discriminate more than GM Opel, VW, and Renault. The lowest absolute price differentials have been found for BMW, Mercedes, Audi and Volvo. Japanese producers are not found to price-discriminate more than other producers but Nissan, Daihatsu, Suzuki and Subaru price-discriminate more than Honda, Toyota, Mitsubishi and Mazda. At the country level the most expensive models are found in the UK, followed by Germany, France, Austria, Finland and Greece.

3.2 Multimarket and multi-firm linkages

This sub-section is built in the following way. I start with a definition of a geographic-product market in the European car market, while the exact definition of a market is important for identifying the effect of the multimarket contact on the firm behaviour. After that I present a general picture of multimarket contact across markets, namely describe the overlap of the markets, in which the automobile companies are present, and describe the "territorial interests", the presence of which could make the automotive companies respect each other's "spheres of influence" and, thus, behave cooperatively. This discussion is presented at the geographic, market segment, and geographic-product market for the European car market. Next the descriptive statistics for the constructed multimarket contact measures and concentration ratios is presented. The sub-section ends with some discussion of interfirm relationships between the automobile companies.

3.2.1 Definition of a geographic-product market

The European car market is characterized by considerable multimarket contact both within geographic and product-level dimensions. Geographic-product market, i.e., the overlap of geographic and product markets (e.g., Belgium subcompact, Germany luxury, etc.), is a main unit upon which the multimarket contact effects are investigated in this paper.

Geographic-product market is used as a market to define the number of multiple contacts among the firms and to construct the multimarket contact and concentration measures. The major question is how distinct these markets are so that one could discuss them separately and investigate the multimarket contact effects. The major criteria used in the literature to delineate the market boundaries[11] is to consider the cross-price elasticities of demand (econometric tests for the delineation of market boundaries have been developed by Sheffman and Spiller (1996)), or to investigate the co-movements in prices across markets[12] (e.g., Kay, 1990).

Brenkers and Verboven (2006b)[13] find the existence of distinct product markets in the European car market: the segments are the relevant markets for all classes (subcompact, compact, intermediate, standard/luxury, and sports), except for minivan, for which the relevant market definition should be the aggregate country level, i.e., all new cars. They recommend the competition authorities to investigate the impact of their policies for each car market segment separately. The cross-price elasticities of demand are usually found to be low with respect to the cars in the other market segments (e.g., Berry, Levinsohn and Pakes, 1995, Brenkers and Verboven, 2006a). Demand linkages if any are likely to be stronger across adjacent than across more remote market segments. Different price dispersion across market segments is also observed in the European car market (e.g., Degryse and Verboven, 2000). To sum up, industry analysts and academic researchers support the view that the car market segments constitute distinct sub-markets, which differ in consumer demand, technology, and competitors' type (e.g., Requena-Silvente and Walker, 2005).

Geographical European car market fragmentation is taken as a standardized fact: there is very little, or no cross-price elasticity of demand across country markets. There is no single European car market: the European car market consists of many national markets with quite distinct characteristics.

Automotive firms are multinational firms that are present in a lot of geographic-product markets. The mutual forbearance foresees that there is a company-level decision-making process coordinated across geographic-product markets[14]. It

[11] Candidates for markets are different products or services within an industry, geographical demand for a product or service, different industries (Gimeno and Woo, 1999). Market definition is partially determined by the level of aggregation as there could be multiple products in any industry, or a country market can be divided into regional, or local markets.

[12] If there is a high positive correlation between the prices of two potentially competing products, that would mean that the products are likely to be substitutes, and, thus, they could be in the same relevant market.

[13] Brenkers and Verboven (2006b) apply the SSNIP (a small but significant and non-transitory increase in prices) test to delineate relevant markets.

[14] Gimeno and Woo (1999) argue that the decisions should be coordinated at the organization

has been argued that the European car market fragmentation prevents from exploiting the economies of scale ("plant-scale") (European Commission, 2004).

At the product market level the economies of scale ("product-scale", large numbers of more or less the same product) and scope (ability to make many different and new products; not one car for different markets, but different cars for different markets and types of customers; the number of market segments and niches has been continuously increasing) have been important for the automotive firms. The VW Group is an example of the company that relies a lot on scale and scope economies.

3.2.2 General picture of multimarket contact across markets

In addition to a just simple market overlap between multipoint competitors (i.e., presence of the same competitors in several markets), the "spheres of influence" of firms could play an even more important role in sustaining collusive outcomes between multimarket firms as the firms may tend to respect each other's "spheres of influence" and behave less competitively.

The "spheres of influence" of firms could be defined on the basis of the "market share dominance" and "market dependence"[15]. "Market share dominance" is measured by the largest shares the firms hold in different markets. It is defined for every firm, that is why, the share of a firm may not be the largest one if it is not a large car producer, especially this can hold for premium producers, or foreign producers. "Market dependence" ("importance" of the market) is measured by the percentage of the firm's total sales (revenue) represented by that market[16]. Domestic car markets could be considered as "spheres of influence" of the automobile producers at the geographical level. In addition, there are "spheres of influence" for producers at the product level.

Below I concentrate on the descriptive analysis of the multimarket presence of the automotive manufacturers at geographical, product and geographic-product market level as well as discuss the presence of the "spheres of influence" for the automotive manufacturers in the European car market. This is used later to define the possible coalitions of the multimarket contact firms. I start with the description of the multimarket presence of the automotive firms and their "spheres of influence" at the geographical level.

Table B3 (Appendix B) gives an idea of the most important country markets for the car producers (comparison of 1999 to 1970). The simple market overlap can be inferred from this Table: many of the OEMs, especially large

level if the managers want to exploit the scope economies.

[15] This has been first suggested by Gimeno (1999). He actually uses three criteria to define asymmetric territorial interests of firms: market share dominance, market dependence, and resource centrality. Under "resource centrality" the firms have different territorial interests because of different competitive advantage, which is linked to "underlying resources and capabilities of the firm".

[16] As compared to the "market share dominance" criterion, the "market dependence" criterion takes into account the size of the market and the size of the firm. For example, a large firm may have a dominant share in a small market, but this may be strategically unimportant for this large firm.

volume ones like VW, are present in almost all countries. In 1999 France is the most important country market for Peugeot and Renault. Germany is the most important country market for BMW, Daihatsu, Kia, Mazda, Mercedes, Mitsubishi, GM, Suzuki, Toyota, VW and Smart. Italy is the most important country market for Fiat, Hyundai and Daewoo. The UK is the most important country market for Ford, Honda and Nissan. As for the largest European volume car producers that could be seen as the primary candidates to recognize and respect each other's "spheres of influence", to sum up, it can be seen that Italy is the most important market for Fiat, Germany is the most important market for VW and GM, France is the most important market for Peugeot and Renault, and the UK is the most important market for Ford. The large players are likely to be uninterested in forming implicit collusive arrangements with small players like Daihatsu. Mercedes and BMW are premium producers that will rather compete with each other. Audi is also a premium brand, but it is considered as a part of the volume car producer VW Group.

Table B4 (Appendix B) shows the share of a firm in the total country market sales in 1999 as compared to 1970 and gives some picture of "market share dominance". The "spheres of influence" defined on the basis of this criterion are France for Peugeot and Renault, Germany for BMW, Mercedes and VW, Italy for Fiat, the UK for GM and Ford, which actually reflect the "domestic origin" of a producer, except for the UK[17]. The largest share in Belgium belongs to VW, in France - to Peugeot, in Germany - to VW, in Italy - to Fiat, in the UK - to Ford. The largest shares in the total European car market (Belgium, France, Germany, Italy and the UK) belong to VW (20.1%), Peugeot (13.1%) and GM (12.2%).

Now I move to the discussion of the multimarket contact presence of the automotive producers and the determination of the "spheres of influence" at the market segment level for the European car market.

Table B5 (Appendix B) gives the largest car manufacturers in each market segment and for the whole European car market in 1999 as compared to 1970 ("market share dominance"). In general, the structure of the European car market in 1999 is as follows: subcompact (37.8%), compact (30.2%), intermediate (19.7%), standard (6.7%) and luxury (5.6%). As for the simple overlap of markets, a fewer number of firms are present in almost all markets, which are defined here to be the market segments, as compared to the overlap of geographical markets. There are some firms like Mercedes and BMW that are present in one or two market segments, here standard and/or luxury market segments, or e.g., Kia is present only in the smaller car market segments. Subcompact market segment is a "sphere of influence" for Daihatsu, Fiat, Hyundai, Renault, Daewoo and Smart. Compact market segment is a "sphere of influence" for Ford, Mitsubishi, GM and VW. Intermediate market segment is a "sphere of influence" for Kia, Mazda, Nissan, Peugeot, Suzuki, Toyota and VW. Standard market segment

[17] As for the non-European firms, the so-called "spheres of influence" in 1999 are Belgium for Suzuki, FujiHI, Mitsubishi and Toyota, the UK for Honda, and Nissan, and Germany for Daihatsu, Kia, and Mazda. The shares of these firms in these countries are, however, very small.

is a "sphere of influence" for BMW and Honda. Luxury market segment is a "sphere of influence" for Mercedes. Except for Fiat, Renault, Peugeot, VW, GM, Ford, BMW, Mercedes, the other firms have small shares. The collusive arrangements of the influential players with small automotive players are highly unlikely. The most important markets ("market dependence") are subcompact for Daihatsu, Fiat, Hyundai, Nissan, Peugeot, Renault, Suzuki, Toyota, Daewoo, and Smart, compact for Ford, Honda, Mazda, GM, and VW, intermediate for Kia and Mitsubishi, standard for BMW, and luxury for Mercedes. This can be inferred from Table B6 (Appendix B).

The combination of geographic and product market presence leads to geographic-product market linkages, which is actually the level of my analysis. The below discussion is important to define the "spheres of influence" and "influential rivals" at the geographic-product market level, among whom later the assumption of collusive behaviour could be tested. Geographic-product market linkages are described in Table B7 (Appendix B). The firms that are present in all 25 geographic-product markets in the European car market in 1999 (5 countries and 5 market segments) are Fiat, Ford, GM, and VW. Peugeot and Renault are present in almost all market segments[18]. BMW has also increased its presence across markets as compared to 1970. For Fiat, Ford and Renault the three most important "spheres of influence" (based on "market share dominance") are the respective domestic markets, while for GM and VW the "spheres of influence" may lie outside of the domestic country market. For Fiat these are subcompact, standard and luxury market segments in Italy. For Ford these are subcompact, compact and intermediate market segments in the UK. For Renault these are subcompact, compact, and standard market segments in France. GM has the largest market shares in the subcompact market segment in Germany, and in the intermediate and standard market segments in the UK. As for VW, it has the largest market shares in the compact and intermediate market segments in Germany and in the intermediate market segment in Italy.

Table B8 (Appendix B) presents the picture of the most important geographic-product markets for firms ("market dependence"). As for the largest car volume producers, the most important market for Fiat is Italy's subcompact market segment, for Ford - the compact market in Germany, subcompact and compact markets in the UK, for GM - the compact market in Germany, for Peugeot - the subcompact market in France and intermediate market segment in France, for Renault - the subcompact market in France, for VW - the compact market segment in Germany. These firms might behave rather collusively if they would like that their competitors respect their "spheres of influence" in return for that they themselves respect the "spheres of influence" of their competitors.

The biggest geographic-product markets in Europe are subcompact market segment in France (the most important for Peugeot and Renault), compact market segment in Germany (the most important market for GM and VW) and subcompact market segment in Italy (the most important for Fiat). For

[18] As for non-European firms, Toyota and Nissan are the firms that are most frequently present in the geographic-product units of the European car market.

Ford the subcompact market segment in the UK is the most important. These firms could be interested in respecting each other's "spheres of influence", as the stakes in the markets are rather high.

3.2.3 Multimarket contact and concentration measures for the European car market

To measure the impact of multimarket contact on the firm behaviour in the European car market, I consider the construction of several multimarket contact measures. These measures can be constructed at the firm and market level. Quite a large number of geographic-product markets in which the automobile firms are present in the European car market allows me to construct these measures, which have not been considered for the automobile markets before (also a long period of time allows me to get variation in these measures (cross-sectional and within-group variation)). I consider four measures of the multimarket contact: number of geographic-product markets, in which a firm is present, number of multiple contacts of a particular firm with other firms, simple and market-share weighted multimarket contact measures[19].

Two simple count measures of the multimarket contact presence have been constructed at the firm level: the number of geographic-product markets in which a firm is present and the number of multiple contacts (see Table C1, Appendix C).

The number of geographic-product markets in which a firm is present is a simple count measure. Its interpretation can be twofold: multiple market presence (the larger the number of markets in which a firm is present, the greater is the probability that the firm will meet the same competitors in those markets, the more cooperatively the firm should then behave) and economies of scope (large producers are more likely to be present in several markets).

The number of multiple contacts is constructed as the sum of pairwise contacts in a year: e.g., for Ford: the number of contacts between Ford and GM in all geographic-product markets where they are both present, plus the number of contacts between Ford and Mercedes, etc., i.e., the number of pairwise contacts in all contact markets for the particular firm with its competitors. The larger the number of these multiple contacts, the more cooperatively the firm should behave with its multiple competitors and the more collusively it will tend to set its prices (for the mutual forbearance hypothesis to hold).

As compared to 1970, in 1999 the automotive firms are characterized by even greater multiple market presence and higher number of multiple contacts (in particular, due to the expansion of their product line, movement to new geographic and product markets, the entry of Asian competitors into the European car market). The average number of geographic-product markets in which

[19] These measures have been previously used in the literature, which may allow me to compare the results of this paper with the results of the other studies as well as derive some implications in terms of the use of such measures for the automobile industry. In Leheyda (2007a) these measures have not been constructed as there would have been little variation in these measures to identify their impact on prices due to a short period of time as well as a small number of markets has been observed.

a firm is present increased from 14.02 in 1970 to 19.37 in 1999. The average number of multiple contacts for a firm went up from 93.49 in 1970 to 228.43 in 1999. The number of multiple contacts is also constantly being influenced by changes in the corporate ownership, which contributes to the variation in the multimarket contact measures.

Simple and market-share weighted multimarket contact measures at geographic-product market level have been constructed (see Appendix A for details on the methodology of these measures construction, see Table C2, Appendix C for the descriptive statistics of these measures).

The intuition behind the simple multimarket contact measure construction is as follows: to proxy the degree of multimarket contact in a particular geographic-product market $k = 1, ..., K$, I take every automotive manufacturer $n = 1, ..., N$ in a market k (which is defined to be a focal market, or market under consideration) and aggregate all the contacts this firm has in K markets (which are defined to be contact markets) with its N_k competitors (i.e., the number of competitors in the market under consideration). The number of contacts is aggregated for all firms that are present in the market under consideration and then divided by the number of firm pairs in the focal market. Thus, the firm's average multimarket contact with its rivals in the given market is calculated. As compared to the above considered number of multiple contacts with other firms calculated at the firm level, this measure is calculated as a market average for a pair of firms.

In addition, the contact markets may have different importance for the firm, thus, the contacts need to be weighted taking into account different characteristics of the contact markets. I weight each contact by the market shares of the firms. This reflects that the higher the market shares (and, thus, the firms' stakes in those markets) are, the more likely the firms will try to compete less aggressively (to avoid punishments, which are likely to be more severely felt by the firm, when it has a large market share in that market), and the higher the profits the firms may expect to get. Then all the contacts are aggregated and divided by the number of firm pairs in the market under the consideration to get the average share-weighted multimarket contact measure at the market level. As compared to the simple multimarket contact measure, the share-weighted measure may show more variation (as there is large variation in the market shares over time).

The higher the simple and market-share weighted multimarket contact measures for a market, the more cooperatively the firms should behave (for the mutual forbearance to hold) and the higher prices should be observed.

The average simple multimarket contact measure increased from 8.07 in 1970 to 14.41 in 1999, while the average market-share weighted multimarket contact measure somewhat decreased from 1258.53 in 1970 to 1021.11 in 1999. The highest simple count multimarket contact measure is found for the intermediate market segment, while the lowest value is found in the luxury market segment. In case of the share-weighted multimarket contact measure, the highest value is found for the luxury car market segment, which is related to the high market shares of luxury car producers and a small number of such producers in this market segment (BMW, Mercedes, and Fiat in Italy).

Concentration measures (C1, C4, and C8) have been constructed at the country (see Graph B1) and geographic-product market level. Some descriptive statistics for these concentration measures at the geographic-product market level can be found in Table C3 (Appendix C). The average concentration ratios have decreased: C1 ratio from 47.38 in 1970 to 34.40 in 1999, C4 ratio from 89.68 to 77.15, C8 ratio from 99.53 to 94.45. On the basis of the C1 ratio, the most concentrated markets are the luxury car market segment of Belgium, France and Germany and the subcompact market segment of Italy. Except for the luxury car market segments, the most concentrated markets on the basis of C4 ratios are intermediate, standard and subcompact market segments in France, standard market segment in Germany, and standard and subcompact market segments in Italy. Higher concentration is generaly expected to result in higher prices.

3.2.4 Some picture of interfirm linkages

The discussion in this Section is important as I aim to test for the mutual forbearance hypothesis among the multimarket firms, and it should be decided whether these effects should be evaluated at brand (e.g., Mercedes), or manufacturer group (e.g., DaimlerChrysler) level.

As it has been already mentioned, the automobile industry is characterized by a lot of interfirm linkages. By interfirm linkages I mean both contractual and equity arrangements of firms. By contractual arrangements first of all non-traditional contracts are implied (e.g., joint R&D, joint product development, long-term sourcing agreements, joint manufacturing, joint marketing, shared distribution service). Equity agreements may generally take up different forms, in particular with or without new equity creation. The picture of international linkages between automotive manufacturers (in particular, contractual arrangements) can be found in Automobile Production (Automobil Produktion) (2005) that has been originally prepared by WardsAuto.

The automobile industry has gone through a period of tremendous consolidation. This consolidation has influenced the degree of external multimarket contact and decreased the number of the independent automotive manufacturers. At present there are about 13 global independent automotive manufacturer groups. Table B9 (Appendix B) gives the picture of the presence of global manufacturer groups that own several car brands. These brands within a group may directly compete with each other especially if they are very similar and belong to the same market segment. For example, Opel and Saab are both present in the standard market segment. Or Rover and Volvo compete in the standard market segment, Ford and Rover both have car models in the compact market segment.

Table B10 (Appendix B) gives the picture of the cross-ownership in the automobile industry[20]. Cross-ownership arrangements between manufacturers

[20] Partial ownership arrangements as it has been mentioned have been in particular discussed by Davis and Alley (2004) and Alley (1997). It has been found that even small partial

and suppliers (i.e., vertical interfirm linkages) are not considered in this paper. As for the overlap of the market shares, for example, Ford and Mazda are present together in the three market segments: subcompact, compact and intermediate, Mazda has, however, much lower market segment shares than Ford. As for GM (Subaru, Suzuki, Isuzu) and Fiat constellation, Suzuki has very small market shares, Opel's shares are higher than Fiat's in the UK, Germany and Belgium, while Fiat's shares are higher in Italy and somewhat more comparable in France.

The multimarket contact effects in this paper are discussed at the level of automotive manufacturers, which may own several brands. The possible cross-ownerships are not taken into account. It could be worthwile to find out about the interbrand competition within an automotive manufacturer group (e.g., VW Group). It is interesting to analyze whether groups (no brands) develop products to compete with rival firms, or they suffer more from "cannibalization". The analysis could be more of relevance for only volume brands, or only premium brands. This could be a subject of future research.

4 Structural oligopoly model for the European car market

In this section of the paper an empirical oligopoly model for the European car market is presented. This is a model with multiproduct firms that sell differentiated products in geographically segmented markets.

4.1 Demand side

The demand equation is derived from a two-level nested logit where the price coefficient is interacted with income, and, thus, enters the demand equation in a non-linear way[21].

The general utility function can be written down in the following way:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

V_{ij} is the deterministic part of the utility function and can be expressed by $V_{ij} = \delta_j + \alpha \ln(y_i - p_j)$. The error term ε_{ij} follows the assumptions of a two-level nested logit distribution. The common part to all consumers in the utility function is $\delta_j = x_j\beta + \xi_j$. The individual-specific part is $-\alpha_i p_j + \varepsilon_{ij}$, where $\alpha_i = 1/y_i$. α_i is the consumers' distaste for price increases. It is assumed that the distribution of α_i varies with income. Price sensitivity is modelled as

ownership arrangements may lead to collusive behaviour.

[21] In the exposition below, I follow Berry (1994), Verboven (1996) and Brenkers and Verboven (2006a), after McFadden (1978) and Ben-Akiva and Lehrman (1985). The demand-side derivation on the basis of restricted two-level nested logit (i.e., without consumer heterogeneity) can be also found in Leheyda (2007b). The interaction of consumers' individual characteristics with products' characteristics is generally expected to allow getting more reasonable substitution patterns.

inversely proportional to income. Income effects are one of the most important sources of consumer heterogeneity in the automobile markets.

It is assumed that there are $G+1$ exhaustive and mutually exclusive groups, $g = 0, ..., G$, where 0 is an outside good. In each group there are further subgroups H_g, $h = 1, ..., H_g$. Utility u_{ij} of household i for product j in subgroup h of group g is given by:

$$u_{ij} = x_j\beta - \alpha_i p_j + \xi_j + \varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}, j \in h_g \subset g, \forall i, \forall j \quad (2)$$

where $\epsilon_{ij} = \varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}$ and $\alpha_i = \frac{1}{y_i}$. Variation in consumer tastes enters through α_i and ε_{ij}.

The error term ϵ_{ij} is decomposed into an iid shock, a group-specific component and a sub-group specific component. $\varepsilon_{ig}, \varepsilon_{ih}, \varepsilon_{ij}$ are standard for the nested logit distributions, ε_{ig}, $\varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg}$ and $\varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}$ are assumed to have an extreme value distribution. It is assumed that ε_{ij} are uncorrelated across customers; for a particular customer, ε's, which belong to the same group, will be more correlated with each other than with the ε's that belong to any other group (ε_{ig}[22]); and for a particular customer, ε's, which belong to the same subgroup, will be more correlated with each other than with the ε's that belong to any other subgroup (ε_{ihg}). That is, the products of the same sub-group or group share common features, and consumers' preferences for these features may be correlated. Nesting parameters σ_{hg} and σ_g can be interpreted as random coefficients on discrete dummies for subgroups and groups rather than on variables that are continuously measured (e.g., performance or size). It should be noted that correlation parameters σ_{hg} and σ_g here are allowed to be different across groups and subgroups. In such a way additional consumer heterogeneity is introduced into the model.

σ_{hg} measures the degree of substitutability of products in a subgroup, and σ_g is the degree of substitutability of products in a group. The following $0 \leq \sigma_g < \sigma_{hg} < 1$ should hold to be consistent with random utility maximization. That is, consumer preferences will be more correlated across all products of the same subgroup than across products of the same group but a different subgroup. Consequently, more plausible substitution patterns can be obtained, and localized competition among the products from the same group or subgroup can be allowed.

The above mentioned assumptions upon the aggregation of choices across all consumers result in the well-known formulas of the nested logit model for the conditional choice probabilities. The mean utility for the outside good is normalized to zero, $\delta_0 = 0$.

The choice probability of a consumer i for a car j in a subgroup h, group g can be written down as:

$$s_{ij}(p) = \frac{e^{(\delta_j - \alpha_i p_j)/(1-\sigma_{hg})}}{e^{I_{ihg}/(1-\sigma_{hg})}} \frac{e^{I_{ihg}/(1-\sigma_g)}}{e^{I_{ig}/(1-\sigma_g)}} \frac{e^{I_{ihg}}}{e^{I_i}} \quad (3)$$

[22] For consumer i, the variable ε is common to all products in a group g and has a distribution function that depends on σ_g. Similar interpretation is for a subgroup.

where I_{ihg} , I_{ig} and I_i are called "inclusive values" for consumer i, which are defined in the following way:

$$I_{ihg} = (1-\sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} e^{(\delta_l - \alpha_i p_j)/(1-\sigma_{hg})}, I_{ig} = (1-\sigma_g) \ln \sum_{h=1}^{H_g} e^{I_{ihg}/(1-\sigma_g)}, I_i = \ln \sum_{g=1}^{G} e^{I_{ig}} \tag{4}$$

The individual probabilities over the number of individuals are averaged into the predicted aggregate market share for product j below:

$$s_j(p) = \sum_{i=1}^{N} s_{ij}(p)/N \tag{5}$$

where N is the number of individuals drawn from an empirical income distribution.

4.2 Cost side and multimarket contact equilibrium interactions

The firm f maximizes its profits over all markets in period t π_{ft}:

$$\pi_{ft} = \sum_{m=1}^{M} \sum_{j \in F_{fmt}} (e_{fmt} p^w_{jmt} - e_{fst} c_{jmt}) L_{mt} s_{jmt}(p_{mt}) + \sum_{m=1}^{M} \sum_{j \notin F_{fmt}} \varphi_{jmt} (e_{fmt} p^w_{jmt} - e_{fst} c_{jmt}) L_{mt} s_{jmt}(p_{mt}) \tag{6}$$

where M is the number of markets, F_{fmt} is the set of products of firm f in market m in period t, p^w_{jmt} are wholesale prices for product j in market m in period t, p_{mt} are list prices (includes prices of products that are in market m in period t), c_{jmt} is the constant marginal cost of producing product j in market m in period t, e_{fmt} is an exchange rate between the registration country of firm f and the destination market, e_{fst} is an exchange rate between the registration country of firm f and the production location of model j, L_{mt} is market size in market m in period t, and s_{jmt} is the share of product j in market m in period t.

φ_{jmt} is the weight on competitors' products for product j in market m in period t: a positive value means cooperative behaviour relative to Bertrand, while a negative value can be interpreted as aggressively competitive behaviour relative to the Bertrand behaviour. The value of zero implies just multi-product Bertrand pricing assumption. The value of one is the case of perfect collusion. But generally these parameters are allowed to take on any values in a broad range. If the product is sold in all five geographic markets, there will be five values of the market conduct parameter for this product.

Demand linkages across geographical markets are assumed away: the sales of each car model in market m depend on the prices only in that market and not on the prices for that model in the other markets (prohibitive arbitrage costs to the consumers are assumed, this also follows from considerable artificial trade barriers).

The relationship between consumer (list) p_{jmt} and wholesale p^w_{jmt} prices is modelled as exogenous and takes up the following functional form:

$$p^w_{jmt} = \frac{p_{jmt}}{[(1+t_{jmt})(1+\tau_{jmt})]} \tag{7}$$

where t_{jmt} is a value added tax in market m, period t for product j, and τ_{jmt} is a dealer markup in market m, period t for product j[23].

The first-order conditions can be written down in the following way[24]:

$$\sum_{k\in F_{fmt}} (e_{fmt}p^w_{kmt} - e_{fst}c_{kmt})\frac{\partial s_{kmt}}{\partial p^w_{jmt}} + \sum_{j\notin F_{fmt}} \varphi_{jmt}(e_{fmt}p^w_{kmt} - e_{fst}c_{kmt})\frac{\partial s_{kmt}}{\partial p^w_{jmt}} + e_{fmt}s_{jmt} = 0 \tag{8}$$

The J_{mt} pricing equations can be further expressed in matrix form for all models that are sold in period t in market m as:

$$p_{mt} = c_{mt} + [\Delta. * (\Xi^{own} + \Theta^{comp})]^{-1} s_{mt} \tag{9}$$

where Ξ^{own}, Θ^{comp} are ownership matrices: $\Xi^{own}_{i,j} = 1$, if i and j are produced by the same firm, and zero otherwise, and $\Theta^{comp}_{ij} = \varphi_j$ if the products i and j are produced by different firms. This value will be an average value for product j with respect to the products of its competitors in market m in period t. The vector φ for J products is obtained[25]. Ξ^{own}, Θ^{comp} are the matrices of the same dimension J_{mt} (i.e., the number of products in market m in period t). Δ is a matrix of own- and cross-price elasticities, also of dimension J_{mt}. Thus, I have got an element-by-element multiplication of two matrices of the same dimension.

The marginal cost for product j in market m in period t takes up the following form:

$$c_{jmt} = \exp(\omega_{jmt}\phi + w_s + w_f + w_m + w_t + w_{jmt}) \tag{10}$$

where ω_{jmt} are the product characteristics other than price, ϕ is the vector of parameters to be estimated, w_s, w_f, w_m, w_t are the fixed effects for production locations, firms, markets and time, respectively, and w_{jmt} is an iid error term.

[23] Some information on the dealer discounts in the European car market can be found in Verboven (1996). In particular, in 1990 the maximum dealer markups were 11% in Belgium, 8% in France, 10% in Germany, 10% in Italy, and 15% in the UK.

[24] Here I follow Goldberg and Verboven (2001) in the derivation of the first-order conditions and, subsequently, price expressions. The authors derive the first-order conditions accounting for absolute and relative import quotas. I do not take into account import quotas in my estimations, following Brenkers and Verboven (2006a) but allow to have conjectural variations parameters in the pricing equation.

[25] For homogenous products in case of market power the following equation is written down: $MR = P + \lambda\left(\frac{1}{\alpha}\right)Q$, where α is the price sensitivity parameter, and λ is the market conduct parameter.

In addition, to examine the roots for why a firm takes into account the behaviour of other firms while setting prices in a particular market, I allow φ to depend upon firm, geographic and product market characteristics z_{jmt} that may help explain the deviation in prices across the same products across different markets, including concentration and multimarket contact:

$$\varphi_{jmt} = \lambda z_{jmt} + \eta_s + \eta_f + \eta_m + \eta_t + \eta_{jmt} \tag{11}$$

where λ is the vector of parameters to be estimated, η_{jmt} is an iid disturbance term, and $\eta_s, \eta_f, \eta_m, \eta_t$ are the fixed effects for production locations, firms, markets, and time, respectively. The fixed effects are important to include into the model to control for systematic differences in the market conduct parameter.

Higher positive values of the conjectures imply more cooperative firm behaviour relative to multi-product Bertrand pricing behaviour. Larger negative values of the conjectures imply more competitive firm behaviour relative to multi-product Bertrand pricing behaviour. In the market conduct equation (11), one would expect a positive relationship between concentration and market conduct and a positive relationship between multimarket contact and market conduct (for the mutual forbearance hypothesis to hold). In addition to the multimarket contact and concentration variables, I include the interaction term between the two and attempt to measure the so-called strategic effects of the multimarket contact, e.g., the distribution of the market power from the more collusive to the more competitive markets. In this case this term should be negative. Concentration and the number of competitors in a geographic-product market are used to distinguish between more and less competitive/collusive markets in the European car market.

4.3 Testing multimarket contact firms coalitions

In addition to testing the direct impact of the multimarket contact measure on the market conduct parameter as above (where the so-called "conjectural variation" approach is applied), the collusive assumptions could be tested for multimarket contact coalitions in the supply-side specification (that is, the so-called "menu" approach is rather applied here). The best supply-side model specification can be then selected with the help of a statistical test (e.g., MacKinnon, White and Davidson (1983), Rivers and Vuong (2002)).

The idea behind this approach is that the multimarket contact firms will jointly maximize their profits. The first-order conditions for a multimarket contact firm that internalizes the cross-price effects with its competitors can be written down as follows (as compared to equation (8) above):

$$\sum_{k \in F_{MMCmt}, f \in F_{MMCmt}} (e_{fmt} p^w_{kmt} - e_{fst} c_{kmt}) \frac{\partial s_{kmt}}{\partial p^w_{jmt}} + e_{fmt} s_{jmt} = 0 \tag{12}$$

where MMC_{mt} is the coalition of firms in market m in period t, $F_{MMC_{mt}}$ are all products of multimarket contact firms, including firm f, in market m in period t.

The J_{mt} pricing equations can be further expressed as (as compared to equation (9) above):

$$p_{mt} = c_{mt} + [\Delta. * (\Xi^{MMC})]^{-1} s_{mt} \tag{13}$$

where $\Xi_{i,j}^{MMC} = 1$ if i and j are produced by multimarket contact firms that behave collusively and 0 otherwise (the same is true for the own products of the firm). That is, as compared to the approach that I have just discussed in the section above, where I estimate conjectural variation parameters, I test for the assumption that the conjectural variation parameters are equal to 1, i.e., I test for the case of perfect collusion among multimarket contact firms in market m in period t.

5 Data description and estimation procedure

5.1 Data description

The dataset on the European car market is maintained by Penny Goldberg and Frank Verboven[26]. The dataset includes the information on list prices, sales, and technical characteristics of cars during 1970-1999 for five European countries: Belgium, France, Germany, Italy, and the UK. The data are rather aggregate, at the level of a model (e.g., VW Polo). The average number of models per year is about 100 models. The technical characteristics include horsepower, displacement, weight, length, width, height, fuel consumption, acceleration time and maximum speed. In addition, there is some data on such macroeconomic variables as GDP, exchange rates, population, price indexes, and tax rates. Furthermore, there is information on the production location of each model, brand ownership, and market segment. The detailed description of the data sources can be found in particular in Goldberg and Verboven (2001). Some descriptive statistics for the car dataset (in general and across countries) can be found in Table D1 (Appendix D).

5.2 Estimations steps

5.2.1 Demand side

Demand, pricing and market conduct equations are estimated separately[27]. On the demand side, the two-way error components model is estimated to account for the panel nature of the data similar to Brenkers and Verboven (2006a).

[26] The dataset is available at the website of Prof. Frank Verboven.

[27] I pursue this approach notwithstanding the possible loss in the efficiency, first of all because of computational tractability. Step-by-step estimation has been pursued in a number of papers. In particular, separate estimation approach for demand, pricing and excess margins equation has been pursued by Slade (2004), only the standard errors in the second step have to be adjusted. The estimation steps for the demand side are described in Nevo (2000). The Matlab algorithm for random coefficients demand model is available from Ariel Nevo's website. I am also very grateful to Prof. Frank Verboven for the opportunity to get acquainted with his Gauss code on the demand equation estimation.

The structure of the error term is as follows: $\xi_{jmt} = \xi_j + \xi_{mt} + u_{jmt}$, where ξ_j does not vary across time (e.g., style), ξ_{mt} can account for macroeconomic fluctuations in market m in period t (captured by market/time fixed effects dummies), u_{jmt} captures the remaining unobserved characteristics. The fixed effects model is estimated. A within-transformation of the data is used to control for the product-fixed effects.

The instruments that I have used in the demand estimation for prices and market shares are standard in the literature (for a more detailed discussion of the instruments see Leheyda (2007a)). Formally, $E\left[u_{jmt}|z\right] = 0$. The instruments have been constructed at group and sub-group levels: these are the own characteristics of the firm and the sum of characteristics of own and competing products in the market segments and in the subgroups of domestic and foreign producers as well as the number of own and competing products in the market segments and the subgroups of domestic and foreign cars.

The market share for product j can be written down as:

$$s_j = \int_y \frac{e^{(\delta_j - \alpha_i p_j)/(1-\sigma_{hg})}}{e^{I_{ihg}/(1-\sigma_{hg})}} \frac{e^{I_{ihg}/(1-\sigma_g)}}{e^{I_{ig}/(1-\sigma_g)}} \frac{e^{I_{ihg}}}{e^{I_i}} d\hat{P}^* (y) \tag{14}$$

where $d\hat{P}^* (y)$ is the distribution of income. It is approximated by the empirical income distribution in each country. The market shares of different types of consumers are added based on how common that type is.

The above integral has no closed form, therefore, its computation requires aggregation via simulation. This procedure has been suggested by Pakes (1986). The market share is computed for an average consumer in each income class (10 deciles are distinguished), and then the average market share is calculated:

$$s_j = \frac{1}{NS} \sum_{ns=1}^{NS} \frac{e^{(\delta_j - \alpha_i p_j)/(1-\sigma_{hg})}}{e^{I_{ihg}/(1-\sigma_{hg})}} \frac{e^{I_{ihg}/(1-\sigma_g)}}{e^{I_{ig}/(1-\sigma_g)}} \frac{e^{I_{ihg}}}{e^{I_i}} \tag{15}$$

The following contraction mapping is used to recover the mean utility level δ_{jt} by minimizing the distance between the observed and predicted sales:

$$\delta^{t+1} = \delta^t + (1 - \max(\sigma_1, ..., \sigma_G))(\ln(s) - \ln(s\left(\delta^t\right))) \tag{16}$$

The demand side unobservables are afterwards computed conditional on the linear parameters $\widehat{\beta}$:

$$\xi_{jt} = \delta_{jt}(\widehat{\alpha}, \widehat{\sigma}) - x_j \widehat{\beta} \tag{17}$$

These unobservables are then interacted with a set of instruments to get a GMM estimator.

One searches for the parameter vector that minimizes the objective function

$$\min \widehat{\xi}' Z \Phi^{-1} Z' \widehat{\xi} \tag{18}$$

where Φ is a weighting matrix. $\Phi^{-1} = Z'Z$ is used as a starting point.

This search is a non-linear search. The linear parameters $\widehat{\beta}$ can be expressed as a function of the non-linear parameters $\widehat{\alpha}$ and $\widehat{\sigma}$

$$\widehat{\beta} = (X'Z\Phi^{-1}Z'X)^{-1}X'Z\Phi^{-1}Z'\delta(\widehat{\alpha}, \widehat{\sigma}) \quad (19)$$

where $\widehat{\sigma}$ includes group and subgroup correlation parameters. The non-linear search can be, thus, limited to the non-linear parameters α and σ.

The quasi-Newton gradient-based algorithm is used as a search method[28]. The asymptotic variance-covariance matrix takes up the following form:

$$AvCov = inv((Z'XG)'w(Z'XG)) \quad (20)$$

where G is the gradient of the objective function with respect to price and group and subgroup correlation parameters, and w is some weighting matrix.

5.2.2 Substitution patterns

The two-level nested logit has the assumption that consumers tastes have an extreme value distribution but allows consumer tastes to be correlated (in a restrictive way) across product j (correlations between groups and subgroups are modelled in a simple way). This allows for more reasonable substitution patterns as compared to a simple logit. Consumer heterogeneity that enters through the price-income coefficient also allows getting more reasonable elasticities and markups as compared to the usual (restricted) two-level nested logit. The calculation of the own- and cross-price elasticities because of additional consumer heterogeneity becomes, however, more burdensome.

The own price elasticity E_{s_j/p_j} of the market share s_j of product j (taking into account heterogenous price-income coefficient) is:

$$E_{s_j/p_j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} = \frac{p_j}{s_j}\int_y -\alpha_i s_{ij}\left[\frac{1}{1-\sigma_{hg}} - \left(\frac{1}{1-\sigma_{hg}} - \frac{1}{1-\sigma_g}\right)s_{ij/hg} - \frac{\sigma_g}{1-\sigma_g}s_{ij/g} - s_{ij}\right]d\hat{P}^*(y) \quad (21)$$

where $s_{ij}, s_{ij/g}, s_{ij/hg}$ are estimated market shares and are defined as above, and where $\alpha_i = \frac{1}{y_i}$.

The cross-price elasticity E_{s_j/p_m} of the market share of product j with respect to the price of product m p_m, when j and m belong to the same subgroup, is given by:

[28] This method requires the calculation of a Hessian as well as gradients and Jacobians. The secant method (Broyden, Fletcher, Goldfarb, and Shanno) is used to update the Hessian instead of computing it at every iteration. The quasi-Newton methods are similar to Newton methods. They are both based upon the calculation of first and second derivatives. The only difference is that under the quasi-Newton methods the Hessian is not calculated but approximated (Gauss tutorial).

$$E_{s_j/p_m} = \frac{\partial s_j}{\partial p_m}\frac{p_m}{s_j} = \frac{p_m}{s_j}\int_y \alpha_i s_{ij}\left[\left(\frac{1}{1-\sigma_{hg}} - \frac{1}{1-\sigma_g}\right)s_{ij/hg} + \frac{\sigma_g}{1-\sigma_g}s_{im/g} + s_{im}\right]d\hat{P}^*(y) \quad (22)$$

The cross-price elasticity E_{s_j/p_k} of the market share of product j with respect to the price of product k p_k, when k belongs to a different subgroup in the same group, is given by:

$$E_{s_j/p_k} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \frac{p_k}{s_j}\int_y \alpha_i s_{ij}\left[\frac{\sigma_g}{1-\sigma_g}s_{ik/g} + s_{ik}\right]d\hat{P}^*(y) \quad (23)$$

The cross-price elasticity E_{s_j/p_l} of the market share of product j with respect to the price of product l p_l, when l belongs to a different group, is given by:

$$E_{s_j/p_l} = \frac{\partial s_j}{\partial p_l}\frac{p_l}{s_j} = \frac{p_l}{s_j}\int_y \alpha_i s_{il} s_{ij} d\hat{P}^*(y) \quad (24)$$

Each individual has a different price sensitivity, which is averaged to a mean price sensitivity using the individual probabilities of purchase as weights. The intergrals have to be calculated by simulation using the knowledge of the distribution of different types of consumers.

5.2.3 Estimation of conduct parameters

Conduct parameters for a product could be more precisely calculated once the marginal costs were known. Then having the information on the market shares and elasticities, the conduct parameters could be estimated from the first-order conditions. The pricing equation (9) is difficult to estimate at individual level for heterogenous products in practice. Nevo (1998) show the problem of identification of the conjectural variations parameters in the simplest case of two single-product firms. That is why, to calculate the market conduct, or conjectural variations parameters (which are difficult to identify otherwise at individual level for heterogenous products), I follow Brenkers and Verboven (2006a) approach and construct them after having estimated the demand side assuming that the marginal costs of producing a product j in a given country (subgroup hg group g) are the same as those in a reference country, which is taken to be Belgium (subgroup hg group g):

$$(p - \Omega^{-1}s)_{Belgium} = (p - \Omega^{-1}s)_{Germany} \quad (25)$$

Ω may be written down as $\triangle\varphi$, which is an element-by-element multiplication of two matrices of two dimensions.

Replacing zeros for competing products in subgroup hg group g of product j I define matrix $(\triangle\varphi)_f$ as:

$$(\triangle\varphi)_f = \begin{pmatrix} \psi\frac{\partial s\left(J_1^f\right)}{\partial p\left(J_1^f\right)} & ... & \psi\frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_1^f\right)} \\ ... & ... & ... \\ \psi\frac{\partial s\left(J_1^f\right)}{\partial p\left(J_{k(f)}^f\right)} & ... & \psi\frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_{k(f)}^f\right)} \end{pmatrix} \tag{26}$$

where $\psi_{ij} = 1$ if the products i and j are produced by the same firm, and $\psi_{ij} = \varphi_j$ if the products are produced by different firms in subgroup hg group g in market m in period t, and $J_{k(f)}$ is the number of products in subgroup hg of group g.

The implied φ for Belgium will be, thus, set to zero by default. Marginal costs could be different across countries, or market conduct could be different across countries. Because of these considerations it is important to perform sensitivity analysis with estimating only the hedonic pricing equation with multimarket contact and concentration measures in addition to the market conduct equation with multimarket contact and concentration measures.

5.2.4 Supply side

For the pricing/market conduct equations estimations, the data are pooled for all countries, and the equation is estimated using OLS, including fixed effects, and with robust standard errors to account for possible autocorrelation and heteroscedasticity (Huber-White sandwich estimator of the variance). In case of market conduct equations, the standard errors have to be adjusted as the dependent variable is estimated from the above step. Consumer list prices are recalculated into wholesale prices taking into account the information on VAT across countries as well as information on dealer markups[29]. In case of pricing equations the product characteristics enter the supply equation in the logarithmic form.

6 Estimation results

6.1 Demand side

The results from the demand-side estimations can be found in Table 1. The price is expressed in destination currency, including VAT and dealer markup. Horsepower, width and height have got positive and statistically significant signs. Thus, consumers have preferences for large and powerful cars. Fuel efficiency has got an expected negative and statistically significant sign, i.e., consumers will buy rather fuel-efficient vehicles. Dummy for a foreign car producer is negative and statistically significant. Therefore, consumers may have higher preferences towards domestic car brands.

[29] Goldberg and Verboven (2001) have experimented with consumer list prices and transaction prices taking into account the dealer discounts, but that had little influence on the estimation results.

Table 1. European car market: demand estimation results (two-level nested logit)

Nests: market segment, producer origin

Dependent variable: ln(sj)-ln(s0)	Estimation method: GMM	
Sample period: 1970-1999	No. observations: 11549	
	Coefficient	t-statistics
horsepower	0.01	3.82
fuel efficiency	-0.03	-3.13
width	0.03	6.90
height	0.01	2.95
foreign car	-0.72	-13.10
price-income	3.00	5.97
Sub-group correlation parameter (σ_{hg})		
subcompact	0.88	24.08
compact	0.74	18.73
intermediate	0.64	15.40
standard	0.82	18.75
luxury	0.30	3.37
Group correlation parameter (σ_g)		
subcompact	0.34	6.95
compact	0.67	13.17
intermediate	0.51	10.69
standard	0.74	14.35
luxury	0.04	0.36

Source: own estimations

Note: market/time fixed effects are included but are not reported.

The signs of the group and subgroup correlation parameters are in general consistent with a priori expectations. They are higher in the smaller car market segments, where the car customers are expected to be more homogenous (their preferences will be more correlated). The only exception is the standard market segment group correlation coefficient, which is difficult to interpret.

The group correlation parameters are lower than the subgroup correlation parameters, and both groups of parameters are between 0 and 1, which is consistent with random consumer utility maximization. The only problem is a low and statistically insignificant sign of the luxury segment group coefficient. The statistical significance and expected signs of the group and subgroup correlation parameters support the importance of the two principles of differentiation in the car market, namely market segment and producer origin.

The price-income coefficient, which captures the country-dependent effects of car prices on demand and allows for a more flexible demand model, is statistically significant and has got an expected negative sign.

The average own-price elasticities of demand and the estimates of price-cost margins under single-product and multi-product (firm) Bertrand-Nash pricing assumptions can be found in Table 2. Their pattern is in general consistent with a priori expectations, with the exception of probably the standard market segment, but this result may have been already anticipated from the group and subgroup correlation parameters estimates for this market segment. I find the lowest price elasticities in the luxury car market segment and the highest in the subcompact market segment. The difference between the price-cost margins under single-product and multi-product pricing assumptions is rather small since due to model aggregation many firms have got just one brand in a market segment and the cross-price elasticities with respect to the own products in the other market segments are usually found to be low.

T*able 2. European car market: own-price elasticities and price-cost margins (averages for market segments)*

	Own-price elasticity	Price-cost margins single	multi
subcompact	-4.73	0.07	0.10
compact	-2.70	0.11	0.12
intermediate	-1.83	0.13	0.14
standard	-2.64	0.05	0.05
luxury	-1.19	0.14	0.14

Source: own estimations

Note: Under 'single' single-product Bertrand-Nash assumption is meant. Under 'multi' multi-product (firm) Bertrand-Nash assumption is meant.

I have found the lowest own-price elasticities for the cars in Germany, followed by Belgium and France, and the highest elasticities in Italy and the UK. This pattern of the elasticities can be linked to different per capita income levels: the lower own-price elasticity of demand is expected with the higher per capita income (high-income consumers are less price-responsible). The lowest nominal GDP per capita in common currency is observed in Italy and the UK, while Germany has got the highest per capita incomes. Goldberg and Verboven (2001) find the lowest own-price elasticities for Italy, followed by Germany, France, Belgium, and the highest own-price elasticities in the UK. Their demand model is, however, different from the demand model estimation in this paper. Irandoust (1996) finds lower price elasticities in Japan, Germany and France than in the UK, Italy, Sweden and the US. Bourdet (1988) also finds higher own-price elasticities for the cars in Italy and the UK than in France. Elasticities may be also driven by consumer brand loyalty (as compared to income-driven elasticities), which one would have expected for example for Italy, where domestic brand loyalty for Fiat is perceived to be high, but this pattern (namely low own-price elasticities) has not been found in the obtained results.

6.2 Supply side and testing for mutual forbearance hypothesis

In this section I present the empirical results of testing for the mutual forbearance hypothesis in the European car market. The below presented several hypotheses have been formulated on the basis of the research objectives of this study (I have done this for the better presentation of the results in this Section):

Hypothesis H1: General overlap of the markets leads to more cooperative firm behaviour.

Hypothesis H2: For the mutual forbearance to hold, it may be not just enough to be present in several markets. It could be important for firms to have significant shares in those markets (impact of share-weighted multimarket contact measure). The effect of the multimarket contact on the firm behaviour is stronger in the more concentrated market.

Hypothesis H3: Concentration contributes to higher prices.

Hypothesis H4: I test directly for the impact of the "spheres of influence" on the firm behaviour considering the multimarket contact firms coalitions. The respect of the "spheres of influence" leads to more cooperative behaviour.

Hypothesis H5: The strategic effects of the multimarket contact could be observed, i.e., the redistribution of the market power from the more collusive to the more competitive markets. The result is that the effect of multimarket contact on prices could be weaker in the more concentrated markets.

6.2.1 *Market conduct equation estimations*

The following market conduct equations are estimated: base, with both multimarket contact and concentration (number of competitors) measures, and with an interaction term between multimarket contact and concentration (number of competitors) variables.

The number of markets in which a firm is present and the number of multiple contacts for a firm with its competitors have got a statistically insignificant effect on the market conduct parameter (see Table 3). The impact of the concentration on the market conduct is, however, negative and statistically significant. The lower concentration ratios are, the larger the number of firms that are present in the market is, the more competitively the firms are expected to behave relative to the Bertrand assumption. The constructed conjectures are found to be the lowest for France, Germany and Italy, and do not differ much in magnitude. France is the most concentrated market based on C1 concentration ratio, and Italy is the most concentrated market on the basis of C4 and C7 concentration ratios. Given this descriptive statistics, the found relationship between market conduct and concentration may be not that surprising[30].

Table 3. European car market: market conduct estimations (1)

Variable	Sp1	Sp2	Sp3	Sp4	Sp5	Sp6
MMC1	-0.001	-0.001	-0.001			
MMC2				0.0004	0.0003	0.0003
C1	-0.007***			-0.007***		
C4		-0.02***			-0.02***	
C8			-0.04***			-0.04***
R2	0.49	0.49	0.49	0.49	0.49	0.49

Source: own estimations

[30] Waldfogel and Wulf (2006) have found a negative effect of C-4 concentration ratio on prices in the radio broadcasting industry.

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts).

The simple count multimarket contact measure has got a statistically significant negative effect when C-1 concentration ratio is included (see Table 4) and the share-weighted multimarket contact measure has got a statistically significant positive effect in all specifications. The values are, however, very low in magnitudes. The higher the simple count measure in the contacts markets is, the lower is the market conduct parameter in the home market. This result is somewhat difficult to interpret as related to the mutual forbearance hypothesis. It should be noted also that there has been evolving theoretical literature that multimarket contact may actually raise the intensity of competition (e.g., Thomas and Willig, 2006). The higher the share-weighted measure due to high market shares in the contact markets is, the higher is the market conduct parameter in the market under consideration, the more collusively the firms behave. The concentration variables are statistically significant and negative as they have been also found above.

Table 4. European car market: market conduct estimations (2)

Variable	Sp7	Sp8	Sp9	Sp10	Sp11	Sp12
MMC3	-0.02***	0.003	0.007			
MMC4				0.0001***	0.0001***	0.0001***
C1	-0.007***			-0.008***		
C4		-0.02***			-0.03***	
C8			-0.04***			-0.05***
R2	0.49	0.49	0.49	0.49	0.49	0.49

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure).

I have also estimated specifications for the supply side, where instead of the concentration variables I include the number of competitors in the market (see Table 5). The number of competitors is positive and statistically significant in almost all specifications. The larger the number of competitors is in the market, the larger reactions of them are expected to the actions of the other firms. The sign and significance of the multimarket contact measures is similar as in case of including concentration measures.

Table 5. European car market: market conduct estimations (3)

Variable	Sp13	Sp14	Sp15	Sp16	Sp17
MMC1		-0.001			
MMC2			0.0003		
MMC3				-0.02**	
MMC4					0.0001***
No. Comp	0.02***	0.02***	0.02***	0.01	0.05***
R2	0.49	0.49	0.49	0.49	0.49

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts), MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure). 'No.Comp' stands for the number of competitors.

When the interaction term between multimarket contact and concentration is added (see Table 6), the negative sign of the interaction term is obtained, also statistically significant, which may speak in favour of the presence of the multimarket contact strategic effects. High multimarket contact combined with high market concentration leads to the lower market reactions of the firms.

Table 6. European car market: market conduct estimations (4)

Var	Sp18	Sp19	Sp20	Sp21	Sp22	Sp23
MMC1	0.03***	0.06***	0.30***			
MMC2				0.004***	0.008***	0.02***
C1	0.007***			0.009***		
C4		-0.01***			-0.008**	
C8			0.01			0.001
MMCc1	-0.08***			-0.009***		
MMCc4		-0.07***			-0.01***	
MMCc8			-0.31***			-0.02***
R2	0.49	0.49	0.49	0.49	0.49	0.49

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts).

When the interaction term is added in the regressions with simple and share-weighted multimarket contact measures, the sign of the interaction term is sensitive towards specifications and can be either positive or negative (see Table 7). If it is negative, this may be interpreted as the presence of the strategic effects due to the multimarket contact. If it is positive one could argue that the effect of the multimarket contact on the firm behaviour is stronger in the more concentrated market.

Table 7. European car market: market conduct estimations (5)

Var	Sp24	Sp25	Sp26	Sp27	Sp28	Sp29
MMC3	0.01	-0.10**	-1.28***			
MMC4				-0.0004***	-0.0004*	0.01***
C1	-0.0001			-0.02***		
C4		-0.04***			-0.03***	
C8			-0.20***			0.03*
MMCc1	-0.06***			0.0007***		
MMCc4		0.11**			0.0005**	
MMCc8			1.30***			-0.01***
R2	0.49	0.49	0.49	0.49	0.49	0.49

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure).

I have also estimated the market conduct specification with the interaction term between the number of competitors in a market and multimarket contact measures in that market (see Table 8). The interaction term is only positive and statistically significant in case of the multimarket contact measures at the firm level. This may be interpreted as the evidence for the presence of the strategic effects due to multimarket contact.

Table 8. European car market: market conduct estimations (6)

Var	Sp30	Sp31	Sp32	Sp33
MMC1	-0.03***			
MMC2		-0.002***		
MMC3			-0.02	
MMC4				0.0001***
No. Comp	-0.02*	-0.03**	0.01	0.05***
MMCnoComp	0.002***	0.0003***	-0.0001	0.000
R2	0.49	0.49	0.49	0.49

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts), MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure). 'No. Comp' stands for the number of competitors.

To sum up, it is rather difficult to interpret the whole picture about the multimarket contact effects in the European automobile markets on the basis of the market conduct equation estimations. Multimarket contact has been found positive and statistically significant only in case of share-weighted multimarket contact measure. Negative impact of simple count measure has been found. The impact of concentration on the market conduct parameters is negative and statistically significant. The number of competitors is positively and statistically significantly related to the conjectural variation parameters. Some evidence has been found about the existence of the strategic effects of the multimarket contact: higher multimarket contact and concentration in the market contribute to the larger deviations from non-cooperative pricing assumption, but alone both result in lower market reactions (after the interaction term is added). A firm with higher multiple multiple market presence will set lower prices in the more concentrated markets.

The above discussion (corresponding to the research objectives and the respective hypotheses) has been summarized in Table 9.

Table 9. European car market: summary of the evidence on mutual forbearance hypothesis (market conduct equation)

		Supported/Not supported/Inconclusive
H1	general overlap	not supported: negative impact of simple count measure, insignificant firm-level measures
H2	conc. matters	supported: positive impact of share-weighted measure
H3	concentration	not supported
H4	"spheres of influence"	supported (indirectly)
H5	strategic effects	supported

Source: on the basis of own estimations

6.2.2 *Pricing equation estimations*

In addition to the estimation of the market conduct equation, I study the effect of the multimarket contact and concentration directly on prices. This is done within the hedonic pricing model. The general reduced form for the pricing equation can be written down as $p_i = c_i + k_i p_i$, where k_i is a percentage markup. The following hedonic regression can be estimated for the European car market, where the price is expressed as a linear function of the cost and market power parameters:

$$\ln(p_{imt}) = x_{imt}\gamma + z_{imt}\beta + \alpha_s + \alpha_f + \alpha_m + \alpha_t + \alpha_{imt} \qquad (27)$$

where x_i are the product characteristics other than price, z_i are the parameters that measure the extent the prices diverge away from marginal costs, e.g., concentration, multimarket contact, etc., γ and β are the vectors of parameters to be estimated, α_s, α_f, α_m, α_i are the fixed effects for production locations, firms, markets, and time, respectively, and α_{imt} is an iid error term.

I expect the coefficient on the concentration variable in the pricing equation to be positive (the higher the market concentration is, the higher the prices can be charged). If the multimarket contact hypothesis is correct, I expect the positive coefficient on the multimarket contact variables. The coefficient on the interaction term between multimarket contact and concentration can be either positive or negative. If it is positive that could be interpreted that profits are higher in the markets where high firm concentration and high multimarket contact coincide. If the negative effect is found that may be attributed to the presence of the strategic effects due to the multimarket contact, i.e., the redistribution of the market power from the more collusive to the more competitive markets.

Prices, concentration and multimarket contact (also market conduct) may be rather endogenously determined. Thus, concentration and multimarket contact variables need to be instrumented in the pricing/market conduct equations. Some endogeneity may be captured by introducing market fixed effects. This is the strategy that I pursue in this paper (it has been rather difficult to find appropriate instruments).

Similar to the market conduct equation, several specifications for the pricing side have been estimated: base, with both multimarket contact and concentration (number of competitors) measures, and with an interaction term between concentration (number of competitors) and multimarket contact measures.

As for the first two variables to measure multimarket contact (i.e., the number of markets in which a firm is present, and the number of multiple contacts for a firm), they have been found to be positive and statistically significant (see Table 10), although their impact is quite low in magnitude. Thus, the higher multiple presence of a firm as well as the higher number of pairwise contacts may lead to higher prices.

As for the concentration ratios, only C4 has been found to be statistically significant, and higher in magnitude than the multimarket contact measure coefficient[31]. That is, concentration may facilitate higher prices and profits in the automobile markets.

Fixed effects allow estimating whether there are significant price differences across markets after adjusting for car model specification differences. Market-time fixed effects are the highest in Germany and the UK. Fixed effects for the market segments are the lowest in the subcompact and standard market segments.

Table 10. European car market: supply-side estimations (pricing equation (1))

Var	Sp1	Sp2	Sp3	Sp4	Sp5	Sp6	Sp7
horse	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***
weight	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***
width	-0.06	-0.06	-0.05	-0.06	-0.06	-0.05	-0.06
height	-0.02	-0.04	-0.04	-0.02	-0.02	-0.02	-0.02
const	3.34***	3.40***	3.24***	3.32***	3.41***	3.26***	3.33***
mmc1		0.002***	0.002***	0.002***			
mmc2					0.0002***	0.0002***	0.0002***
c1		-0.004			-0.005		
c4			0.09***			0.09***	
c8				0.05			0.05
R2	0.97	0.97	0.97	0.97	0.97	0.97	0.97

[31] This may be also the most adequate and suitable concentration measure for the automobile market.

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts).

The simple multimarket contact measure has been found to be positive and statistically significant (see Table 11). The sign and statistical significance of the share-weighted multimarket contact measure is not so straightforward. The quantitative impact of the multimarket contact measures on prices is quite low.

The share-weighted multimarket contact measure, which is constructed at the geographic-product market level, could be interpreted in the following way: the slack in the other markets (market power in the non-home markets as measured by concentration) due to multimarket contact enhances collusion in a market under consideration. This measure captures the trade-off between the benefit of the aggressive action in the focal market and the cost of retaliation in the other contact markets. This measure was found to be negative and not statistically significant in case of C1 and C8 ratios. It is positive and statistically significant in case of C4 ratio, but very low in magnitude. So when I account for concentration in the contact markets, the multimarket contact seems not to have any significant economic effect on prices.

Table 11. European car market: supply-side estimations (pricing equation (2))

Var	Sp8	Sp9	Sp10	Sp11	Sp12	Sp13
horse	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***
weight	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***
width	-0.05	-0.04	-0.05	-0.06	-0.05	-0.05
height	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
const	3.25***	3.16***	3.30***	3.34***	3.18***	3.24***
mmc3	0.004***	0.003***	0.004***			
mmc4				-0.000	0.000**	-0.0002*
c1	-0.01			-0.001		
c4		0.06***			0.09***	
c8			-0.04			0.06*
R2	0.97	0.97	0.97	0.97	0.97	0.97

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure).

I have also included the number of competitors in a market as a measure of competition intensity (see Table 12). It has been found negative and statistically significant. This could also shed light whether the entry of foreign producers, although small ones, has increased competition in the automobile markets. An increase in the number of competitors is correlated with a decrease in the price of products. The number of competitors might be a more suitable measure of market segment competition intensity (internal factor) as compared to the concentration measure.

Table 12. European car market: supply-side estimations (pricing equation (3))

Var	Sp14	Sp15	Sp16	Sp17	Sp18
horse	0.50***	0.50***	0.50***	0.50***	0.50***
weight	0.42***	0.42***	0.42***	0.42***	0.42***
width	-0.04	-0.05	-0.05	-0.04	-0.04
height	-0.02	-0.03	-0.03	-0.02	-0.01
const	3.26***	3.31***	3.32***	3.23***	3.19***
mmc1		0.002***			
mmc2			0.0002***		
mmc3				0.002***	
mmc4					-0.00001***
No. comp	-0.005***	-0.004***	-0.004***	-0.003***	-0.007***
R2	0.97	0.97	0.97	0.97	0.97

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts), MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure). 'No. comp' stands for the number of firms in a geographic-product market.

When the interaction term between concentration and multimarket contact is added to study the strategic effects of the multimarket contact (see Table 13), the sign of the interaction term is statistically significant and positive when C1 and C4 concentration measures are included[32]. This may be interpreted as that the multimarket contact measured at the firm level combined with higher concentration in a given market contributes to higher prices in the market under consideration. That is, multimarket contact leads to more collusion in the more concentrated markets.

Table 13. European car market: supply-side estimations (pricing equation (4))

[32] Jans and Rosenbaum (1996) have also found that multimarket contact and concentration have become statistically insignificant after the interaction term has been included. The interaction term itself was statistically significant and positive.

Var	Sp19	Sp20	Sp21	Sp22	Sp23	Sp24
MMC1	0.00	-0.005***	0.009**			
MMC2				-0.00	-0.001***	0.0005
C1	-0.07***			-0.11***		
C4		-0.05			-0.14***	
C8			0.18**			0.10
MMCc1	0.004***			0.001***		
MMCc4		0.008***			0.001***	
MMCc8			-0.01*			-0.0003
R2	0.97	0.97	0.97	0.97	0.97	0.97

Source: own estimations

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts). Product characteristics are included but are not reported.

The interaction term is statistically significant and negative for the simple count and share-weighted multimarket contact measures (See Table 14). Thus, I can argue that there is some evidence on existence of the strategic effects of the multimarket contact, i.e., the redistribution of the market power from the more collusive to the more competitive markets.

Table 14. European car market: supply-side estimations (pricing equation (5))

Var	Sp25	Sp26	Sp27	Sp28	Sp29	Sp30
MMC3	0.06***	-0.0001	0.04***			
MMC4				0.00005***	0.0001***	0.0005***
C1	0.04			0.09***		
C4		0.02			0.17***	
C8			0.36***			0.39***
MMCc1	-0.005*			-0.00008***		
MMCc4		0.004			-0.0001***	
MMCc8			-0.04***			-0.0005***
R2	0.97	0.97	0.97	0.97	0.97	0.97

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure). Product characteristics are included but are not reported.

I have also estimated the pricing equation with the interaction term between multimarket contact measures and the number of competitors in a market (see Table 15). It is negative and statistically significant, which may be interpreted that prices are lower in the markets characterized by higher multimarket contact and larger number of competitors (thus, higher competition intensity). This could be interpreted as some evidence in favour of the presence of the strategic effects due to multimarket contact.

Table 15. European car market: supply-side estimations (pricing equation (6))

Var	Sp31	Sp32	Sp33	Sp34
MMC1	0.006***			
MMC2		0.0008***		
MMC3			0.008***	
MMC4				-0.000***
No. Comp	0.003***	0.006***	0.005***	-0.008***
MMCnoComp	-0.0004***	-0.00006***	-0.0008***	-0.000***
R2	0.97	0.97	0.97	0.97

Note: Fixed effects (firm dummies, market segment dummies, market/time fixed effects) are included but are not reported. Prices and car characteristics are expressed in logarithms. ***, **, * mean statistical significance at 1%, 5%, and 10% significance level, respectively. Explanations: MMC1 (number of markets in which a firm is present), MMC2 (number of multiple contacts), MMC3 (simple count multimarket contact measure), MMC4 (share-weighted multimarket contact measure). 'No. Comp' stands for the number of competitors in a market. Product characteristics are included but are not reported.

To sum up, in general multimarket contact is positively related to prices (in most specifications) - a result, which is consistent with mutual forbearance reducing competition. Greater levels of mulimarket contact move prices above marginal costs. However, although the relationship is statistically significant, the multimarket contact effect has little economic influence on the prices of the car producers. Higher concentration leads to higher prices. Multimarket contact firms forbear from retaliating more in a concentrated market. Some evidence has been found about the existence of the strategic multimarket contact effects: higher multimarket contact and concentration contribute to lower prices. The summary of the found effects is given in Table 16.

Table 16. European car market: summary of the evidence on the mutual forbearance hypothesis (pricing equation)

		Supported/Not supported/Inconclusive
H1	general overlap	Supported
H2	conc. matters	Supported
H3	concentration	Supported
H4	"spheres of influence"	Supported (implicitly)
H5	strategic effects	Supported

Source: on the basis of own estimations

6.2.3 *Results from testing coalitions of multimarket firms*

The construction of the multimarket contact measures allows me to study the general effect of the multimarket contact presence, i.e., the extent of the market overlap in the industry, on facilitating collusive behaviour as well as the role of concentration. To some extent, the impact of the "spheres of influence" might have been captured through the construction of the share-weighted multimarket contact measure. To test explicitly for the effectiveness of the "territorial interests", or "spheres of influence" (i.e., Hypothesis H4) I have tried to point out the so-called multimarket contact firms coalitions. These coalitions have been pointed out on the basis of the constructed multimarket contact measures and on the basis of the discussed picture of multiple market presence in the European car market. The idea has been to test for collusive behaviour among these firms as it has been explained above (see Section 4.3).

The firms that are present in the largest number of markets and have got the largest number of multiple contacts over the considered period of time are VW, Fiat, GM, Ford and Peugeot. This coalition of firms could be treated as a multimarket contact firms coalition, and the collusive assumption among the firms in this coalition could be tested as a potential equilibrium outcome.

Not only the diversification aspect matters (to support collusion due to multimarket contact it is not enough to be present in several markets) but also the ability of the firms to use it in the creation of the transferrable slack should be taken into account. It is unlikely that the firms with a small market share will be able to generate the necessary slack (which is usually fostered by market concentration), which could be transferred to the other markets through the multimarket contact. On the basis of the above described picture of multiple market presence by the automobile companies, several potential multimarket coalitions can be pointed out. The firms that have more than 5% market share in each geographic market are Ford, GM, Peugeot, Renault, and VW. The firms that have more than 5% market share in each or at least four product markets are Fiat, Ford, GM, and VW, with 1% market share these are Fiat, Ford, GM, Peugeot, Renault, and VW. Firms that are present in all geographic-product markets and have more than 1% share in each geographic-product market are Fiat, Ford, GM, and VW.

Small firms like Daihatsu are unlikely to be engaged into implicit collusive arrangements with large players like VW. Such arrangements are most likely to be among the "influential" rivals. These "influential" players are likely to respect each other's "territorial interests". That is why, in addition I have considered defining an "influential firm" for each geographic-product market and for each year (i.e., a firm with the highest market share), and then testing collusive behaviour among such firms. This would allow me to test directly for the presence of the "spheres of influence" that could foster collusive behaviour. On the basis of such analysis, I have found that the same firms seem to dominate the markets during the observed period of time: Alfa Romeo (later belongs to Fiat), Fiat, VW, BMW, Mercedes, Peugeot, Renault, Ford, GM, and Rover (later belongs to BMW).

Under this approach (testing multimarket contact firms coalitions) I do not consider the possibility that there could be different degrees of cooperative behaviour across the markets. Basically I try to differentiate between the two extreme cases: no collusion at all (as represented by single-product, or multi-product assumptions), or collusive behaviour between multimarket contact firms in all markets, which I attribute to multimarket contact presence.

The following candidates for the equilibrium firm interactions in the European car market have been considered: A1: single-product assumption, A2: multiproduct (brand) assumption, A3: multiproduct (firm) assumption, A4: collusive assumption for firms that have more than 5% market share in each geographic market: Ford, GM, Peugeot, Renault and VW and single-product assumption for all other firms, A5: collusive assumption for firms that have more than 5% market share in each geographic market: Ford, GM, Peugeot, Renault and VW and multi-product (brand) assumption for all other firms, A6: collusive assumption for firms that have more than 5% market share in each product market: Fiat, Ford, GM and VW and single-product assumption for all other firms, A7: collusive assumption for firms that have more than 5% market share in each product market: Fiat, Ford, GM and VW and multi-product (brand) assumption for all other firms, A8: collusive assumption for firms that have more than 1% market share in each market: Fiat, Ford, GM, VW, Peugeot and Renault and single-product assumption for all other firms, A9: collusive assumption for firms that have more than 1% market share in each market: Fiat, Ford, GM, VW, Peugeot and Renault and multi-product (brand) assumption for all other firms, A10: collusive assumption for firms that have "spheres of influence": Alfa Romeo, Fiat, VW, BMW, Mercedes, Peugeot, Renault, GM, Ford and Rover and single-product assumption for all other firms, A11: collusive assumption for firms that have "spheres of influence": Alfa Romeo, Fiat, VW, BMW, Mercedes, Peugeot, Renault, GM, Ford and Rover and multi-product (brand) assumption for all other firms, A12: collusive assumption for firms that are present in the largest number of markets and have the highest number of multiple contacts: VW, Fiat, GM, Ford and Peugeot, and single-product assumption for all other firms, A13: collusive assumption for firms that are present in the largest number of markets and have the highest number of multiple contacts: VW, Fiat, GM, Ford and Peugeot, and multi-product (brand) assumption for all other firms.

On the basis of the multimarket contact firms coalitions that have been pointed out above I have tested for the best supply-side specification (i.e., the specification that best fits the data). I present and discuss the results from several testing procedures: information criteria, test for non-nested hypothesis (MacKinnon, White, and Davidson, 1983) and model selection test (Rivers and Vuong, 2002).

As it can be seen from Table 17, the single-product and multi-product (brand) Bertrand-Nash assumptions have got the lowest information criteria and sum of squared residuals (there is only a slight difference in the markups under these two assumptions). There appears also little difference between multi-product (brand) and multiproduct (firm) assumptions, which could shed more light on the intrabrand competition within an automobile manufacturer group. No multimarket contact firms coalition can be supported on the basis of these criteria.

Table 17. European car market: information criteria and sum of squared residuals (SSR) for different supply side specifications

Specifications	AIC	BIC	SSR
A1	9429.46	10054.58	1507.53
A2	9426.52	10051.64	1507.15
A3	9516.45	10141.57	1518.93
A4	9798.20	10423.32	1556.44
A5	9758.53	10383.65	1551.11
A6	9990.87	10615.99	1582.63
A7	9984.40	10609.52	1581.74
A8	9803.40	10428.52	1557.15
A9	9802.63	10427.75	1557.04
A10	9717.68	10342.80	1545.63
A11	9718.82	10343.94	1545.78
A12	10029.1	10654.22	1587.88
A13	10027.65	10652.77	1587.68

Source: own estimations

Note: 'AIC' stands for Akaike information criterion, 'BIC' stands for Bayesian information criterion, and 'SSR' stands for the squared sum of residuals.

In addition I have conducted the test for non-nested hypotheses by MacKinnon, White and Davidson (1983) (see Tables 18a,b). The intuition behind this test is that if the price-cost margin from a given model has a statistically significant impact on the price-cost margin from another model, that means that the latter model should be rejected. This test is very easy to implement in practice. Within this approach, the two non-nested models are embedded into a more general artificial model. On the basis of the test results, it is, however, difficult to choose the 'best' supply-side specification. When the alternative assumptions are A4-A9, all the null hypothesis are rejected, i.e., these should be the preferred specifications (but they perform only slightly better as compared to the other specifications). Given that the difference between single- and multi-product (brand) assumptions is small, basically for the A4-A9 assumptions the plausibility of the three coalitions of multimarket contact firms should be investigated: 1) Ford, GM, Peugeot, Renault, and VW; 2) Ford, GM, VW, and Fiat, and 3) Ford, GM, Peugeot, Renault, VW, and Fiat. The open question is how to choose among these "best" supply-side specifications.

T*able 18a. European car market: results of the test for the non-nested hypotheses (MacKinnon, White and Davidson, 1983)*

H0/H1	A1	A2	A3	A4	A5	A6	A7
A1		8.58	11.16	12.79	13.89	13.54	13.92
A2	-4.64		8.60	12.90	12.02	11.62	12.10
A3	1.73	1.47		12.99	10.79	8.13	9.01
A4	-10.04	-9.98	-9.92			-4.38	-4.33
A5	-9.91	-8.68	-1.32	24.39		3.88	4.21
A6	-1.25	-2.10	-6.86	9.19	7.94		5.65
A7	-1.61	-2.53	-7.68	9.28	7.70	-5.52	
A8	-4.57	-5.24	-7.49	-8.44	-2.09	-5.94	-5.61
A9	-4.75	-5.45	-7.76	-8.44	-2.38	-6.23	-5.93
A10	-10.05	-10.65	-12.29	-10.22	-9.77	-11.28	-11.12
A11	-10.04	-10.65	-12.28	-10.22	-9.76	-11.27	-11.12
A12	-2.90	-3.81	-7.82	5.22	4.90	-5.58	-4.81
A13	-3.16	-4.13	-8.30	5.27	4.65	-6.23	-5.59

Source: own estimations

T*able 18b. European car market: results of the test for the non-nested hypotheses (MacKinnon, White and Davidson, 1983) (continuation)*

H0/H1	A8	A9	A10	A11	A12	A13
A1	16.95	17.16	21.30	21.31	14.83	15.13
A2	15.70	19.95	20.46	20.47	13.18	13.54
A3	13.37	13.67	18.96	18.96	10.26	10.79
A4	12.43	12.43	14.62	14.62	0.21	0.28
A5	13.21	13.53	19.68	19.69	7.67	8.00
A6	12.55	12.85	18.83	18.83	7.98	8.66
A7	12.31	12.66	18.79	18.80	7.22	8.04
A8		4.57	15.49	15.49	-4.76	-4.33
A9	-4.48		15.35	15.36	-5.15	-4.76
A10	-11.28	-11.07		-0.35	-10.87	-10.70
A11	-11.27	-11.07	0.41		-10.87	-10.70
A12	11.00	11.39	18.35	18.35		5.29
A13	10.64	11.11	18.28	18.29	-5.18	

Source: own estimations

Note: t-statistics are given in the cells.

The results of Rivers and Vuong (2002) test could not shed more light on the above results. I have failed to select any supply-side specification on the basis of this test.

To sum up, on the basis of the statistical procedures that I have done it has been difficult to choose the model that best describes the firms' equilibrium interactions. That is why, I have to rely on the results from the estimation of market conduct and pricing equations estimations in the above sections to draw some conclusions about the effect of multimarket contact on the firm behaviour in the automobile markets.

7 Conclusions

The paper has been an attempt to analyze the conduct behaviour of the automotive firms in the European car market in a systematic way. I have extended the earlier models for the European car market in particular by augmenting the supply side through explicitly considering the factors that contribute to market conduct and pricing behaviour of the automotive firms. Most previous automotive industry studies have concentrated on explaining the international price differentials in the European car market. The focus of this paper has been to study the impact of the internal (concentration, number of competitors in a market) and external (multimarket contact) factors on the firm behaviour.

In addition, this study has been motivated by the presence of extensive multimarket contact in the automobile industry, which is generally argued to foster collusive behaviour and which has not received interest in the previous automotive studies. Industry consolidation has raised the level of the multimarket contact. The concentration ratios for the total European car market have stayed on average at the same level or declined during the considered period of time, while the multimarket contact has increased. The number of competitors has also grown, in particular due to the entrance of Japanese competitors.

Finally, the study has been motivated by the lack of conclusive empirical evidence (in general, not only for automobile markets) on the mutual forbearance hypothesis. It has been first formulated by Edwards (1955), i.e., the extended interdependence when firms meet each other in several markets may lead to tacitly collusive arrangements between the firms. The hypothesis has been formally described for the first time by Bernheim and Whinston (1990). The estimation of the conjectures equations helps me to see whether they can be really attributable to the multimarket contact, while some studies just estimated conjectures and attributed them to the mutual forbearance presence (e.g., Gelfand and Spiller, 1987).

It has been found that the general overlap of the markets may lead to more cooperative firm behaviour. For the mutual forbearance to hold, it may be, however, not just enough to be present in several markets. It could be important for firms to have "spheres of influence" in those markets. The effect of the multimarket on the firm behaviour is stronger in the more concentrated market. Concentration alone also contributes to higher prices. The strategic effects of the multimarket contact could be observed in the European car market, i.e., the redistribution of the market power from the more collusive to the more competitive markets. The result is that multimarket contact may lead to lower prices in the more concentrated markets. I have tested directly for the impact of the "spheres of influence" on the firm behaviour considering multimarket contact firms coalitions. However, it was difficult to choose the best supply-side model on the basis of the statistical procedures that I have applied. Thus, to sum up, the results of the study reveal some weak quantitative effect of multimarket contact on pricing/market conduct in the European car market as well as provide some evidence on designing strategic policies by the automotive firms and shifting their market power across the markets, in which they operate.

Because of weak economic impact of multimarket contact on competition, one may argue that multimarket contact notwithstanding its extensive presence in the automobile industry does not play a large role. The results of the study may, therefore, raise the question whether sector differences (e.g., industry structure, demand growth prospects) could account for the different effect of multimarket contact on competitive behaviour. In particular, the economic effects of the multimarket contact have been found to be much stronger for airlines, hotels, mobile telephone markets, etc. (e.g., Evans and Kessides (1994), Jans and Rosenbaum (1996), Parker and Roller (1997), Fernandez and Marin (1998)). In those industries a larger number of markets is observed. As compared to the other multimarket contact studies (that focus on local/regional geographical markets), I have focused on the combination of both geographic and product dimensions of markets to measure the degree of multimarket linkages for the automotive firms and study the impact of this degree on the firm behaviour. It should be noted that some studies report the economic significance of the effect similar to mine, especially when similar multimarket contact measures are constructed (e.g., Heggestad and Rhoades (1978), Waldfogel and Wulf (2006)). However, the studies by Evans and Kessides (1994) and Jans and Rosenbaum (1996) that use similar multimarket contact measures show much stronger economic effect of multimarket contact on prices. As compared to my study on the mutual forbearance hypothesis for the US car industry (Leheyda, 2007a), I was able to get more conclusive evidence on the multimarket contact effects in general. In addition, I could find some support for the presence of the strategic effects due to the multimarket contact, i.e., the redistribution of the market power from the more collusive to the more competitive markets.

Alternatively, one may argue that the construction of the multimarket contact measures as well as pointing out multimarket contact firms coalitions may be not suitable for studying the multimarket contact effect on the firm behaviour in the automobile industry and that some other approach could be thought of to investigate this issue more profoundly.

The "ideal" test to study multimarket contact effects on collusive behaviour would be to contrast the pricing behaviour in a single-product (e.g., two firms in one market M1) and a multiproduct context (e.g., these two firms move together to another market M1+M2) to test for incremental effects in the firm behaviour. In addition, one can take some period of time and compare the break-down of collusive prices in M1 world and M1+M2 world, and if this period of breakdowns under the latter scenario is shorter, then this is a hard test for showing that the multimarket contact effect leads to more collusion. This situation could be difficult to find in terms of the necessary data in general and for the automobile market in particular. That is why, I have been made restricted to applying the suggested in this paper methods to try to identify the effects of the presence of the multimarket situations on the firm behaviour in the automotive industry. The "ideal" and the developed in this paper methodologies could be applied in the context of other industries and markets.

8 References

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9 Appendix A. Multimarket contact measures

9.1 Simple multimarket contact measure

The simple count measure is constructed in the following way[33]. It is assumed that there are $k = 1, ..., K$ geographic-product markets and $n = 1, ..., N$ automotive manufacturers. In geographic-product market k there are N_k automotive firms. Let D_{nk} be a dummy variable, which is equal to 1 if firm n is present in market k and zero otherwise. Matrix $A = (a_{ij})$ should be constructed with $a_{ij} = \sum_{k=1}^{K} D_{ik}D_{jk}$. This is a symmetric matrix, where the diagonal elements a_{ii}

[33] Simple count and market-share weighted measures have been constructed in particular by Evans and Kessides (1992) and Jans and Rosenbaum (1996).

are the number of markets in which the firm i is present, and the off-diagonal elements a_{ij} are the number of markets in which both firms i and j are present:

$$A = \begin{pmatrix} a_{11} & ... & a_{1N} \\ .. & ... & ... \\ a_{N1} & ... & a_{NN} \end{pmatrix}$$

I calculate the average multimarket contact per firm-pair in market k in the following way:

$$AverMarketContact_k = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} a_{ij} D_{ik} D_{jk} / (N_k(N_k - 1)/2) \qquad (28)$$

where N_k is the number of firms in market under consideration k. $N_k(N_k-1)$ is the total number of possible pairs of firms in this market.

The example below (see Table 19) shows the construction of such a measure for a particular geographic-product market in a particular year (Italy, standard, 1999).

Table 19. European car market: example of construction of a multimarket-contact measure at the geographic-product market level

	BMW	Fiat	Ford	Honda	GM	Peugeot	VW	Daewoo	Sum
BMW	19	19	19	13	19	13	19	17	119
Fiat		25	25	14	25	19	25	18	126
Ford			25	14	25	19	25	18	101
Honda				14	14	13	14	12	53
GM					25	19	25	18	62
Peugeot						19	19	18	37
VW							25	18	18
Daewoo								18	
Sum									516
MMC									18.43

Source: own estimations

The diagonal elements in the above Table are the number of geographic-product markets, in which a firm is present. The off-diagonal elements show the number of geographic-product markets in which both firms meet each other. The number of these contacts (off-diagonal elements) is aggregated for each firm and is given in the last column. The contacts are aggregated for all firms (516) and then they are divided by the number of possible firm pairs in this market ($N_k(N_k - 1)/2$=28) to get the multimarket contact measure of 18.43 for Italy's standard market segment in 1999.

This measure is calculated for each geographic-product market and for each year (which is extremely time-consuming). If there is only one automotive firm in the market, the measure will be equal to zero.

The impact of this measure on the firm behaviour may be interpreted in the following way: facing a trade-off between the benefit of the aggressive action in the focal market (i.e., the market under consideration) and the cost of the rival retaliation in the other contact markets, the firms may tend to behave less aggressively.

9.2 Share-weighted multimarket contact measure

Relatively more important markets could be given some greater weight in the multimarket contact measure, which leads me to the construction of the next measure.

I construct a quadratic weighting multimarket contact measure in the following way. The revenue share of firm i from market k (R_{ik}) is multiplied by the revenue share of firm j from the same market k, which is then used to weight the contribution of the pairwise contact of firms i and j in market k. The following matrix is then constructed: $R = (r_{ij})$ with $r_{ij} = \sum_{k=1}^{K} R_{ik}R_{jk}$. This is a symmetric matrix.

I calculate the average revenue-weighted market contact in the following way:

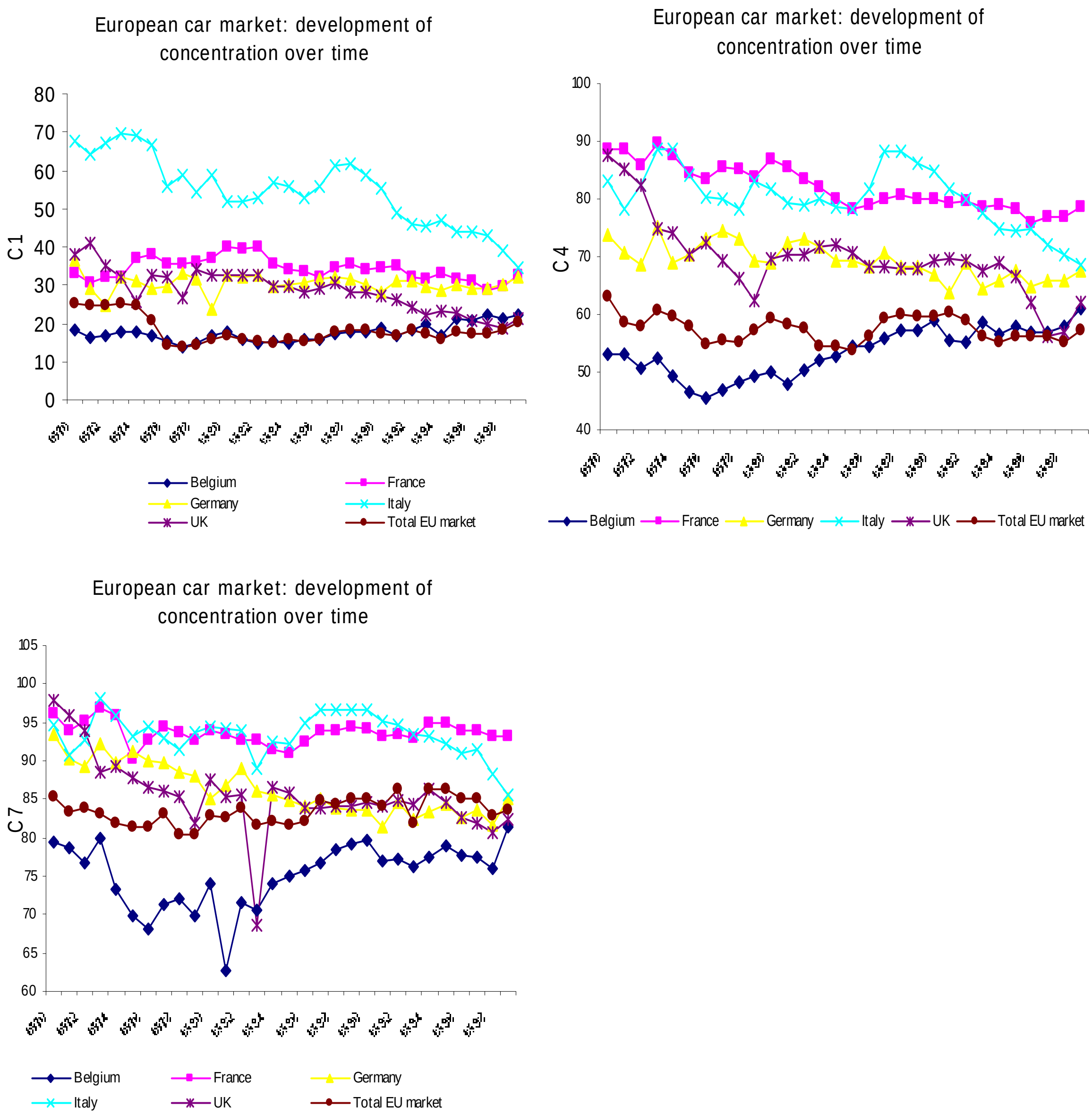
$$AverMarket\,\mathrm{Re}\,venueContact_k = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} r_{ij} D_{ik} D_{jk} / (N_k(N_k - 1)/2) \quad (29)$$

The construction of this measure is similar to the construction of the simple multimarket contact measure, except for the fact that the measure is weighted by the market shares of the firm.

The interpretation of this measure is similar to the one of the simple multimarket contact measure above. If this measure value is small, the potential cost of retaliation is low as compared to the benefit of the aggressive behaviour in the focal/home market (i.e., the market under consideration). If it is high, the multimarket contact may exert large influence upon the focal market behaviour, and higher prices in that market should be observed. This measure captures that in the more concentrated markets the firms might have more to lose, thus, they may withhold from competitive behaviour.

Appendix B. European car market: general descriptive statistics (concentration, multiple market presence and ownership)

Graph B1. European car market: development of concentration ratios (one-firm (C1), four-firm (C4), seven-firm (C7)) over time at country market level



Source: European car market database, own calculations

Table B2. European car market: purchase taxes on new vehicles, 1999

Country	VAT (%)	Purchase taxes	Registration fees (in local currency)
Belgium	21	Based on capacity and age	2500 FB
France	20.6	None	Local tax 102 to 195 FF (+ parafiscal charges)
Germany	16	None	50 DM
Italy	20	Provincial, based on fiscal power	300000 to 720000 L
United Kingdom	17.5	None	None

Source: Gaulier and Haller (2000)

Table B3. European car market: shares in a firm's total European sales, 1970 as compared to 1999

	Belgium		France		Germany		Italy		UK		‚Spheres of influence' (‚market dependence')	
	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999
Alfa Romeo	2.32		6.38		10.50		**79.01**		1.78		Italy	
BMW	5.93	3.88	5.30	8.52	**80.07**	**45.90**	5.89	12.01	2.80	29.69	**Germany**	**Germany**
Daihatsu		1.70				**68.03**		5.35		24.92		Germany
Fiat	3.43	2.15	20.76	10.68	11.57	10.54	**62.57**	**68.98**	1.66	7.65	**Italy**	**Italy**
Ford	4.97	4.11	6.74	13.75	32.30	28.33	10.08	17.41	**45.91**	**36.40**	**UK**	**UK**
Honda	18.22	4.19	**45.07**	7.69	36.71	29.64		10.67		**47.81**	France	UK
DeTomaso							**100.00**				Italy	
Hyundai		4.30		5.87		22.47		**37.81**		29.55		Italy
Kia		8.07		5.88		**66.83**		16.80		8.30		Germany
Mazda		7.02				**67.06**		4.10		15.94		Germany
Mercedes	3.91	3.37	5.28	7.54	**85.29**	**66.52**	4.65	11.83	0.88	10.74	**Germany**	**Germany**
Mitsubishi		13.22		3.25		**60.18**		4.11		19.23		Germany
Nissan	**100.00**	4.79		9.47		27.21		18.17		**40.37**	Belgium	UK
GM	4.83	4.34	4.93	10.78	**63.59**	**42.88**	8.34	15.93	18.31	26.07	**Germany**	**Germany**
Peugeot	5.54	5.82	**81.06**	**49.43**	10.91	10.96	2.49	12.75		21.04	**France**	**France**
Renault	5.28	4.77	**61.96**	**49.09**	22.06	19.20	6.05	11.82	4.65	15.12	**France**	**France**
FujiHi		**100.00**										Belgium
Rover	2.72		3.61		2.46		0.33		**90.89**		UK	
Saab	**56.73**				43.27						Belgium	
Suzuki		8.97		11.51		**39.89**		10.60		29.03		Germany
Toyota	**87.57**	8.94		11.80		**30.48**		20.05	12.43	28.73	Belgium	Germany
VW	3.60	5.03	2.93	12.63	**80.43**	**55.07**	8.77	14.94	4.28	12.33	**Germany**	**Germany**
Volvo	26.81		13.29		27.78		3.89		**28.22**		UK	
DAF	21.34		21.11		**33.53**		11.72		12.30		Germany	
TalbotSimcaHillmanSunbeam	5.71		**35.61**		15.94		16.54		26.21		France	
TalbotMatra	5.92		**94.08**								France	
Daewoo		4.13		10.18		9.52		**51.86**		24.31		Italy
Daimler (Smart)				7.29		**67.95**		24.76				Germany
Total market sales	4.66	4.57	21.91	19.85	**34.36**	**34.26**	23.15	20.74	15.93	20.58	Germany	Germany

Source: European car market database, own calculations
Note: 'Spheres of influence' ('market dependence') are defined as those geographical markets where a firm has the highest market share in a firm's total European sales.

Table B4. European car market: shares of a firm in total market sales, 1970 as compared to 1999

	Belgium		France		Germany		Italy		UK		Europe		‚Spheres of influence' (‚market share dominance')	
	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999
Alfa Romeo	0.77		0.45		0.47		**5.26**		0.17		1.54		Italy	
Daihatsu		0.07				**0.38**		0.05		0.23		0.47		Germany
BMW	2.46	4.86	0.47	2.45	**4.49**	**7.67**	0.49	3.31	0.34	8.25	1.93	5.72	Germany	Germany
Fiat	18.45	4.91	23.70	5.62	8.43	3.21	**67.63**	**34.71**	2.61	3.88	25.02	10.44	Italy	Italy
Ford	10.28	10.71	2.96	8.26	9.05	9.86	4.19	10.01	**27.73**	**21.09**	9.62	11.92	UK	UK
Honda	**0.21**	1.07	0.11	0.45	0.06	1.01		0.60		**2.72**	0.05	1.17	Belgium	UK
Hyundai		0.83		0.26		0.58		**1.60**		1.26		0.88		Italy
DeTomaso							**3.76**				0.87		Italy	
Kia		0.47				**0.52**		0.22		0.11		0.27		Germany
Mazda		1.84		0.36		**2.35**		0.24		0.93		1.20		Germany
Mercedes	2.55	3.85	0.73	1.98	**7.56**	**10.14**	0.61	2.98	0.17	2.73	3.04	5.22	Germany	Germany
Mitsubishi		**1.64**		0.09		0.99		0.11		0.53		0.57		Belgium
Nissan	**1.02**	2.54		1.16		1.93		2.12		**4.76**	0.05	2.42	Belgium	UK
GM	11.10	11.58	2.41	6.62	**19.81**	**15.27**	3.86	9.37	12.30	**15.45**	10.70	12.20	Germany	UK
Peugeot	7.29	16.70	**22.67**	**32.68**	1.95	4.20	0.66	8.07		13.42	6.13	13.13	France	France
Renault	13.25	10.48	**33.04**	**24.84**	7.50	5.63	3.06	5.72	3.41	7.38	11.68	10.05	France	France
FujiHi		0.04										0.00		Belgium
Rover	3.90		1.10		0.48		0.09		**38.14**		6.69		UK	
Saab	**0.21**				0.02						0.02		Belgium	
Suzuki		**0.62**		0.18		0.37		0.16		0.45		0.32		Belgium
Toyota	**3.59**	**4.54**		1.38		2.07		2.25	0.15	3.24	0.19	2.32	Belgium	Belgium
VW	12.06	22.06	2.08	12.76	**36.51**	**32.25**	5.91	14.46	4.19	12.02	15.60	20.06	Germany	Germany
Volvo	**2.96**		0.31		0.42		0.09		0.91		0.51		Belgium	
DAF	**2.87**		0.60		0.61		0.32		0.48		0.63		Belgium	
TalbotSimcaHillmanSunbeam	7.00		**9.28**		2.65		4.08		**9.39**		5.71		France, UK	
TalbotMatra	0.02		**0.08**								0.02		France	
Daewoo		1.18		0.67		0.36		**3.28**		1.55				Italy
Daimler				0.23		**1.22**		0.74				0.62		Germany
Total market sales	100.0		100.0		100.0		100.0		100.0		100.0			
C-1	18.45	22.06	33.04	32.68	36.51	32.25	67.63	34.71	38.14	21.09	25.02	20.06		
C-4	53.09	61.06	88.69	78.54	73.80	67.51	82.99	68.55	87.57	61.99	63.00	57.31		
C-7	79.44	81.30	96.14	93.24	93.35	85.01	94.68	85.66	97.78	82.38	85.44	83.51		

Source: European car market database, own calculations

Note: 'Spheres of influence' ('market share dominance') are reflected by the largest shares the firms hold in different geographical markets.

Table B5. European car market: shares of a firm in market segment sales, 1970 as compared to 1999

	Subcompact		Compact		Intermediate		Standard		Luxury		Total		‚Spheres of influence' (market share dominance)	
	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999
Alfa Romeo			3.89		**5.94**						1.54		Intermediate	
BMW		0.14	1.89	4.92	4.26		4.83	**44.06**	**12.30**	22.11	1.93	5.72	Luxury	Standard
Daihatsu		**0.50**				0.03						0.19		Subcompact
Fiat	**39.14**	**18.46**	7.51	4.89	24.97	3.80	12.44	12.90	0.99	6.61	25.02	10.44	Subcompact	Subcompact
Ford		11.32	16.40	**15.05**	**32.70**	13.06	19.64	5.05		3.40	9.62	11.93	Intermediate	Compact
Honda	**0.11**	0.28		2.29				**5.63**			0.05	1.17	Subcompact	Standard
Hyundai		**1.03**		1.00		0.94						0.88		Subcompact
DeTomaso	1.77										0.87		Subcompact	
Kia		0.31		0.09		**0.62**						0.27		Intermediate
Mazda		0.55		1.77		**2.32**						1.20		Intermediate
Mercedes				5.66					**82.06**	**62.79**	3.04	5.22	Luxury	Luxury
Mitsubishi				**0.56**		2.01						0.57		Compact
Nissan	**0.10**	3.20		1.70		**3.45**				0.37	0.05	2.43	Subcompact	Intermediate
GM		10.18	26.02	**16.82**	0.72	12.07	**30.70**	11.07	4.65	2.83	10.70	12.20	Standard	Compact
Peugeot	4.82	17.28	6.66	7.06	7.52	**22.23**	**11.03**	1.21			6.13	13.13	Standard	Intermediate
Renault	**18.87**	**16.11**	9.40	7.15		8.04		3.16			11.68	10.05	Subcompact	Subcompact
Rover	**9.48**		4.85				6.31				6.69		Subcompact	
Saab							**0.14**				0.02		Standard	
Suzuki		0.45				**0.58**						0.29		Intermediate
Toyota		2.24	**0.74**	2.63		**3.40**		0.19			0.19	2.32	Compact	Intermediate
VW	**17.24**	14.46	**17.88**	**27.13**	13.47	**26.45**	10.60	16.38		1.89	15.60	20.07	Subc., comp.	Comp., interm.
Volvo							**4.16**				0.51		Standard	
DAF	**1.27**										0.63		Subcompact	
TalbotSimcaHillmar	7.20		4.75		**10.42**						5.71		Intermediate	
TalbotMatra							**0.16**				0.02		Standard	
Daewoo		**1.86**		1.27		1.01		0.35				1.31		Subcompact
Daimler		**1.63**										0.62		Subcompact
Tot. segm. sales	100.00	100.00		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		

Source: European car market database, own calculations

Table B6. European car market: shares of a firm in a firm's sales, 1970 as compared to 1999

	Subcompact		Compact		Intermediate		Standard		Luxury		‚Spheres of influence' (market dependence)	
	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999	1970	1999
Alfa Romeo			**64.8**		35.2						Compact	
BMW		0.95	25.1	25.93	20.2		**31.0**	51.48	23.7	21.64	Standard	Standard
Daihatsu		**97.21**				2.79						Subcompact
Fiat	**76.89**	**66.89**	7.69	14.12	9.13	7.18	6.15	8.26	0.15	3.55	Subcompact	Subcompact
Ford		35.89	**43.69**	**38.07**	31.06	21.60	25.24	2.83		1.60	Compact	Compact
Honda	100.00	9.07		**58.83**				32.10			Subcompact	Compact
Hyundai		**44.47**		34.51		21.02						Subcompact
DeTomaso	**100.00**										Subcompact	
Kia		43.96		10.59		**45.45**						Intermediate
Mazda		17.41		**44.44**		38.15						Compact
Mercedes				32.66					**100.00**	67.34	Luxury	Luxury
Mitsubishi				29.80		**70.20**						Intermediate
Nissan	**100.00**	**49.95**		21.15		28.04				0.86	Subcompact	Subcompact
GM		31.55	**62.30**	**41.58**	0.61	19.50	35.47	6.07	1.61	1.30	Compact	Compact
Peugeot	**38.67**	**49.78**	27.85	16.21	11.22	33.39	22.25	0.62			Subcompact	Subcompact
Renault	**79.37**	60.64	20.63	21.47		15.78		2.11			Subcompact	Subcompact
Rover	**69.72**		18.61				11.67				Subcompact	
Saab							**100.00**				Standard	
Suzuki		**59.93**				40.17						Subcompact
Toyota		**36.46**	**100.00**	34.10		28.88		0.56			Compact	Subcompact
VW	54.32	27.25	29.39	40.78	7.89	25.99	8.40	5.46		0.53	Subcompact	Compact
Volvo							**100.00**				Standard	
DAF	**100.00**										Subcompact	
TalbotSimcaHillmar	**61.99**		21.33		16.68						Subcompact	
TalbotMatra							**100.00**				Standard	
Daewoo		**53.83**		29.20		15.20		1.77				Subcompact
Daimler		**100.00**										Subcompact
Tot. segm. sales	**49.15**	**37.83**	25.64	30.16	9.14	19.72	12.37	6.69	3.71	5.60	Subcompact	Subcompact

Source: European car market database, own estimations

Table B7. European car market: geographic-product market presence (defined by shares of a firm in a market segment ('market-share dominance')), 1999

	BMW	Daihatsu	Fiat	Ford	Honda	Hyundai	Kia	Mazda	Mercedes	Mitsubishi	Nissan	GM	Peugeot	Renault	FujiHI	Suzuki	Toyota	VW	Daewoo	Daimler
b_subc	0.07	0.25	6.67	9.44	0.49	0.72	1.02	1.61			2.62	11.52	21.61	14.67	0.14	0.99	4.24	22.44	1.49	
b_compt	1.68		3.09	10.52	1.69	1.17	0.05	2.54	3.69	0.92	2.81	17.03	10.51	13.44			**5.34**	24.30	1.21	
b_inte	0.00		1.90	13.47		0.88	0.67	2.09		**5.57**	3.28	6.08	**28.00**	5.37		**1.41**	**6.04**	24.02	1.22	
b_stan	39.40		14.67	7.54	4.53							8.63	2.24	3.98			0.42	18.04	0.56	
b_lux	24.60		6.59	11.22					**50.85**		0.58	4.80						1.36		
f_subc			8.41	6.58	0.15	0.15		0.16			1.09	6.69	**31.92**	**31.75**		0.17	1.54	10.31	0.59	0.48
f_comp	3.16		3.64	13.72	1.03	0.54		0.58	3.06	0.14	0.91	8.71	20.23	**20.98**			1.31	20.96	1.03	
f_inte			1.04	7.35		0.26		0.61		0.26	1.81	4.77	**53.35**	17.05		0.43	1.46	11.07	0.53	
f_stan	33.53		11.76	1.91	3.81							6.60	7.50	**25.60**				8.70	0.61	
f_lux	22.29		6.20	5.94					**61.52**			2.56						1.49		
g_subc	0.28	**1.50**	7.48	12.25	0.58	0.65	0.64	1.44			2.74	14.79	8.50	13.33		0.77	2.29	27.17	0.58	**4.99**
g_comp	1.48		1.34	11.61	1.60	0.52	0.23	2.91	9.14	0.91	1.51	**20.96**	2.09	4.05			2.31	**38.98**	0.37	
g_inte		0.08	1.60	10.27		1.12	**1.36**	**4.62**		3.22	3.27	14.57	6.40	4.39		0.86	3.21	**44.61**	0.43	
g_stan	**51.94**		4.52	4.13	3.25							11.29	0.46	0.13			0.19	24.10		
g_lux	22.77		1.52	2.14					**69.63**		0.37	1.25						2.32		
i_subc	0.06	0.09	**42.73**	7.96	0.31	**2.15**	0.24	0.21			2.68	7.40	9.78	9.46		0.13	2.26	9.54	3.72	1.30
i_comp	5.03		18.46	17.08	1.45	1.09		0.33	4.93	0.29	0.82	17.23	3.50				2.82	23.96	3.02	
i_inte			22.24	10.70		1.18	0.75	0.39		0.42	**3.74**	8.34	15.35	3.19		0,80	2.83	**26.60**	**3.47**	
i_stan	28.78		**48.74**	4.58	1.77							3.75	0.32					10.45	1.61	
i_lux	16.90		**31.91**	3.09					**45.38**			1.72						0.99		
u_subc	0.32	0.69	6.38	**22.48**		0.85	0.32	0.40			**7.54**	13.69	20.12	10.10		0.88	2.70	11.50	2.04	
u_comp	12.83		2.94	**21.64**	5.05	2.08		1.39	2.25	0.34	2.93	14.72	8.55	6.79			3.31	13.37	1.80	
u_inte			1.31	**24.58**		1.24		1.50		1.89	**5.34**	**19.04**	16.88	7.49			**5.40**	14.21	1.13	
u_stan	**44.16**		5.60	8.55	**15.19**							**19.04**		0.28			0.41	6.77		
u_lux	24.12		1.44	5.70					**55.51**		0.95	10.98						1.31		
t_subc	0.14	0.50	18.46	11.32	0.28	1.03	0.31	0.55			3.20	10.18	17.28	16.11		0.45	2.24	14.46	1.86	1.63
t_comp	4.92		4.89	15.05	2.29	1.00	0.09	1.77	5.66	0.56	1.70	16.82	7.06	7.15		0.00	2.63	27.13	1.27	
t_inte	0.00	0.03	3.80	13.06		0.94	0.62	2.32		2.01	3.45	12.07	22.23	8.04		0.58	3.40	26.45	1.01	
t_stan	**44.06**		12.90	5.05	5.63							11.07	1.21	3.16			0.19	16.38	0.35	
t_lux	22.11		6.61	3.40					**62.79**		0.37	2.83						1.89		
‚Spheres of influence' (‚market share dominance ')	b_stan, g_stan, u_stan	g_subc	i_subc, i_stan, i_lux	u_subc, u_comp, u_inte	u_stan	i_subc	g_inte	g_inte	**luxury**	b_inte	u_subc	g_comp, u_inte, u_stan	b_inte, f_subc, f_inte	f_subc, f_comp, f_stan		b_inte	b_inte	g_comp, g_inte, i_inte	i_inte	g_subc

Source: European car market database, own calculations

Table B8. European car market: geographic-product market presence (share of a market segment in the total sales of a firm (‘market dependence’)), 1999

	BMW	Daihatsu	Fiat	Ford	Honda	Hyundai	Kia	Mazda	Mercedes	Mitsubishi	Nissan	GM	Peugeot	Renault	FujiHI	Suzuki	Toyota	VW	Daewoo	Daimler	Total segment sales
b_subc	0.02	1.70	0.85	1.05	0.56	1.09	5.07	1.77			1.43	1.25	2.18	1.93	100.00	4.58	2.42	1.48	1.51		1.33
b_comp	0.46		0.47	1.40	2.28	2.12	0.28	3.36	1.12	2.59	1.84	2.21	1.27	2.12			3.65	1.92	1.47		1.59
b_inte	0.00		0.20	1.22		1.09	2.72	1.89		10.64	1.46	0.54	2.31	0.58		5.33	2.81	1.29	1.01		1.08
b_stan	2.40		0.49	0.22	1.35							0.25	0.06	0.14			0.06	0.31	0.15		0.35
b_lux	0.99		0.15	0.22					2.25		0.06	0.09						0.02			0.23
f_subc			7.50	5.14	1.16	1.56		1.23			4.18	5.11	22.64	29.42		5.68	6.18	4.78	4.22	7.29	9.31
f_comp	2.58		1.63	5.39	4.12	2.90		2.27	2.74	1.13	1.76	3.34	7.22	9.78			2.65	4.89	3.70		4.68
f_inte			0.47	2.90		1.41		2.38		2.12	3.52	1.84	19.15	8.00		7.05	2.97	2.60	1.92		4.71
f_stan	4.34		0.84	0.12	2.41							0.40	0.42	1.89				0.32	0.35		0.74
f_lux	1.59		0.24	0.20					4.80			0.09						0.03			0.41
g_subc	0.41	65.24	6.02	8.63	4.18	6.20	20.17	10.08			9.50	10.18	5.44	11.14		22.66	8.27	11.37	3.71	67.95	8.40
g_comp	3.14		1.56	11.83	16.65	7.16	10.31	29.46	21.28	19.46	7.55	20.88	1.93	4.90			12.10	23.61	3.45		12.16
g_inte		2.79	1.09	6.16		9.11	36.36	27.52		40.72	9.63	8.53	3.48	3.12		21.44	9.86	15.89	2.36		7.15
g_stan	28.85		1.38	1.10	8.82							2.94	0.11	0.04			0.25	3.82			3.18
g_lux	13.50		0.50	0.61					45.24		0.52	0.35						0.39			3.39
i_subc	0.12	5.35	48.23	7.86	3.17	28.79	10.43	2.02			13.03	7.14	8.78	11.09		5.38	11.44	5.60	33.47	24.76	11.78
i_comp	4.23		8.51	6.89	5.94	5.95		1.33	4.54	2.43	1.64	6.79	1.28				5.84	5.74	11.09		4.81
i_inte			4.85	2.04		3.07	6.37	0.75		1.69	3.51	1.56	2.66	0.72		6.35	2.77	3.02	6.03		2.28
i_stan	5.18		4.81	0.40	1.56							0.32	0.03					0.54	1.27		1.03
i_lux	2.48		2.56	0.22					7.29			0.12						0.04			0.84
u_subc	0.40	24.92	4.29	13.22		6.82	8.30	2.31			21.80	7.87	10.75	7.05		21.52	8.15	4.02	10.93		7.01
u_comp	15.52		1.95	12.56	29.84	16.38		8.02	2.98	4.20	8.37	8.35	4.51	4.68			9.86	4.61	9.50		6.92
u_inte			0.57	9.28		6.34		5.61		15.04	9.91	7.03	5.79	3.36			10.47	3.19	3.88		4.50
u_stan	10.69		0.74	0.99	17.97							2.16		0.04			0.24	0.47			1.39
u_lux	3.08		0.10	0.35					7.76		0.29	0.66						0.05			0.73
Total firm sales	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
‚Spheres of influence’ (‚market share dependence’)	g_st	g_su	i_su	g_co, u_su, u_co	u_co	i_su	g_in	g_co, g_in	g_lu	g_in	u_su	g_co	f_su, f_in	f_su	b_su	g_su, g_in, u_su	g_co, i_su, u_in	g_co	i_su	g_su	

Source: European car market database, own calculations

Table B9. European car market: automotive manufacturer groups

Firm (equivalent to corporate group)	*Brands*
Alfa Romeo	Alfa Romeo (till 1986 (including 1986))
BMW	BMW, Rover Triumph (1994-1999)
Daihatsu	Daihatsu (starting 1979)
Fiat	1970: Citroen, Fiat, Lancia, Autobianchi; 1971: Citroen, Fiat, Lancia; 1972-1974: Citroen, Fiat, Lancia, Autobianchi; 1975: Citroen, Fiat, Lancia; 1976-1986: Fiat, Lancia; 1987-1989: AlfaRomeo, Fiat, Lancia; 1990-1996: Alfa Romeo, Fiat, Lancia, Innocenti; 1997-1999: Alfa Romeo, Fiat, Lancia
Ford	Ford, Volvo (1999)
Honda	Honda
Hyundai	Hyundai (starting 1980)
DeTomaso	Innocenti (1970-1989)
Kia	Kia (starting 1993)
Mazda	Mazda (starting 1972)
Mercedes	Mercedes
Mitsubishi	Mitsubishi (starting 1976)
Nissan	NissanDatsun
GM	OpelVauxhall, Saab (starting 1990)
Peugeot	Peugeot, Citroen (starting 1976), Talbot (1980-1986)
Renault	Renault
Rover	RoverTriumph (1970-1993), Rover (1970-1979), Triumph (1970-1979), Princess (1976-1979)
Saab	Saab (1970-1989)
Seat	Seat (1983-1985)
Fujuhi	Subaru (starting 1979)
Suzuki	Suzuki (starting 1981)
Toyota	Toyota
VW	Audi, Volkswagen, Seat (starting 1986), Skoda (starting 1993)
Volvo	Volvo (1970-1998)
Yugo	Yugo (1981-1991)
Daewoo	Daewoo (starting 1995)
Daimler	MMC (1998-1999)
DAF	DAF (1970-1975)
TalbotSimca HillmanSunbeam	TalbotHillmanChrysler (1970-1979), TalbotSimca (1970-1977), TalbotSimca (1978-1979), TalbotMatra (1978-1979)
TalbotMatra	TalbotMatra (1970-1977)
Lancia	Lancia (1971)

Source: European car market database, own calculations

Table B10. European car market: cross-ownership changes

Firm (equivalent to corporate group)	Brands
Ford Group	Mazda (33%)
GM Group	Subaru (20%), Suzuki (20%), Isuzu (12%), Fiat (10%)
RenaultNissan Group	Nissan (44%)
Toyota	Daihatsu (52%)
DaimlerChrysler	Mitsubishi (24.7%)
Hyundai	Kia (60%)

Source: Deustche Bank (2004)
Note: The shares are given as of 2004; they may have been changing over time.

Appendix C. European car market: descriptive statistics for concentration ratios and multimarket contact measures

Table C1. European car market: descriptive statistics for multimarket contact measures (averages across years and firms))

Firm	*Number of markets in which a firm is present*		*Number of multiple contacts*	
	Mean	Std. deviation	Mean	Std. deviation
Alfa Romeo	12.74	0.12	126.86	1.88
BMW	15.54	0.20	131.40	2.52
Daihatsu	4.20	0.12	53.42	1.56
Fiat	21.99	0.08	202.15	1.14
Ford	19.00	0.11	200.28	1.71
Honda	12.72	0.24	138.51	2.37
Hyundai	9.46	0.29	123.52	4.15
De Tomaso	2.26	0.14	19.21	1.34
Kia	8.96	0.35	122.22	5.14
Mazda	12.79	0.12	152.25	1.84
Mercedes	5.46	0.09	28.07	1.52
Mitsubishi	9.53	0.11	117.5	1.33
Nissan	15.64	0.12	174.04	1.62
GM	21.91	0.12	210.28	1.78
Peugeot	19.73	0.02	208.83	0.64
Renault	17.32	0.12	183.46	1.72
Rover	14.84	0.12	155.93	1.80
Saab	5.72	0.29	54.38	2.26
Seat	5.18	0.27	53.29	3.21
Fujihi	1.59	0.09	20.34	1.16
Suzuki	6.58	0.29	80.18	4.00
Toyota	14.42	0.12	166.44	1.71
VW	20.90	0.07	213.94	1.10
Volvo	13.14	0.23	125.64	2.37
Yugo	2.71	0.10	28.86	1.13
Daewoo	14.36	0.56	185.44	7.30
Daimler	2.5	0.50	37.50	7.50
DAF	4.79	0.12	36.86	1.08
Talbotsimca	14.03	0.16	121.94	2.10
Talbotmatra	3.17	0.16	27.91	1.69
Lancia	8.00	0.00	71.00	0.00

Source: own estimations

Table C2. European car market: descriptive statistics for multimarket contact measures and number of competitors (averages across years and geographic-product markets))

Firm	*Simple count*		*Share-weighted*		*No. of competitors*	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Belgium: compact	10.69	0.08	740.19	8.14	14.47	0.08
Belgium: intermediate	11.88	0.05	810.88	10.48	12.86	0.09
Belgium: luxury	9.93	0.21	1866.22	92.68	5.85	0.11
Belgium: standard	11.41	0.13	938.40	16.70	12.59	0.10
Belgium: subcompact	9.99	0.08	770.99	5.69	12.33	0.07
France: compact	12.36	0.07	889.63	6.96	12.95	0.06
France: intermediate	13.20	0.06	992.52	12.46	11.53	0.10
France: luxury	10.08	0.28	2738.35	179.06	5.14	0.13
France: standard	12.14	0.15	1142.59	22.60	11.01	0.10
France: subcompact	11.96	0.12	1043.22	10.36	10.39	0.05
Germany: compact	11.99	0.08	849.39	6.28	12.93	0.07
Germany: intermediate	12.76	0.09	943.21	14.07	11.65	0.11
Germany: luxury	10.08	0.22	1976.58	74.06	5.65	0.12
Germany: standard	12.16	0.12	1079.97	15.53	10.72	0.08
Germany: subcompact	11.60	0.09	965.55	11.02	10.90	0.09
Italy: compact	13.53	0.09	1282.32	16.58	10.48	0.11
Italy: intermediate	14.07	0.09	1412.00	27.84	9.68	0.14
Italy: luxury	9.34	0.28	2138.78	76.93	5.05	0.10
Italy: standard	12.66	0.16	1420.79	20.08	8.86	0.07
Italy: subcompact	11.81	0.10	1227.70	14.60	9.49	0.09
UK: compact	11.49	0.09	794.58	4.77	13.32	0.08
UK: intermediate	12.32	0.05	863.61	11.10	12.49	0.11
UK: luxury	9.69	0.23	2136.97	146.41	5.71	0.14
UK: standard	11.67	0.15	1020.77	19.30	11.56	0.11
UK: subcompact	11.36	0.09	933.01	8.00	11.21	0.08

Source: own estimations

Table C3. European car market: descriptive statistics for concentration ratios (across geographic-product markets)

	No. obs.	*C1*		*C4*		*C8*	
		mean	std. dev.	mean	std. dev.	mean	std. dev.
Belgium: compact	618	23.13	0.18	60.96	0.24	87.19	0.17
Belgium: intermediate	588	24.80	0.19	67.25	0.32	90.70	0.17
Belgium: luxury	211	61.80	0.66	96.63	0.18	100	0
Belgium: standard	514	26.89	0.33	70.66	0.31	91.89	0.35
Belgium: subcompact	742	24.44	0.12	66.73	0.18	93.18	0.11
France: compact	541	33.44	0.27	80.36	0.19	95.47	0.08
France: intermediate	488	48.47	0.34	88.43	0.18	97.83	0.09
France: luxury	165	63.13	0.81	97.41	0.15	100	0
France: standard	426	46.05	0.48	87.44	0.18	97.69	0.08
France: subcompact	645	40.85	0.24	87.76	0.21	99.43	0.02
Germany: compact	518	40.71	0.19	80.16	0.16	93.16	0.17
Germany: intermediate	509	43.61	0.25	83.88	0.30	95.87	0.15
Germany: luxury	199	73.58	0.66	98.48	0.10	100	0
Germany: standard	422	38.14	0.43	86.76	0.22	98.05	0.07
Germany: subcompact	635	28.41	0.38	76.74	0.38	97.26	0.09
Italy: compact	447	38.18	0.56	81.85	0.36	97.88	0.14
Italy: intermediate	418	42.57	0.86	83.03	0.46	97.29	0.19
Italy: luxury	175	49.94	0.84	97.91	0.10	100	0
Italy: standard	353	43.33	0.43	86.07	0.31	98.68	0.08
Italy: subcompact	634	64.71	0.41	89.98	0.25	99.44	0.06
UK: compact	557	32.49	0.30	74.76	0.38	92.28	0.15
UK: intermediate	531	34.81	0.51	78.98	0.32	95.34	0.12
UK: luxury	176	45.75	1.08	96.74	0.22	100	0
UK: standard	439	31.36	0.58	74.56	0.52	93.82	0.23
UK: subcompact	598	31.73	0.53	72.68	0.31	97.50	0.07

Source: own calculations

Note: in some geographic-product markets less than three firms can be present.

Appendix D. European car market: descriptive statistics (dataset)

Table D1. European car market: descriptive statistics for the European car market

	mean	*std. err.*	*min*	*max*
Total European (No. observations: 11549)				
price/income	0.83	0.41	0.24	6.47
sales	19813.24	37719.92	51	433694
horsepower	57.14	23.88	13	169.5
weight	978.87	225.41	520	1910
width	164.38	9.62	122	188
height	140.43	4.62	117.5	173.5
fuel efficiency	8.18	1.72	4	18.6
domestic car dummy	0.19	0.39	0	1
Belgium (No. observations: 2673)				
price/income	0.72	0.34	0.25	3.45
sales	3925.42	4453.51	51	62410
horsepower	56.53	23.71	13	165
weight	976.00	227.46	520	1750
width	164.16	9.82	122	188
height	140.34	4.63	117.5	173.5
fuel efficiency	8.22	1.76	4.5	18.6
domestic car dummy	0	0	0	0
France (No. observations: 2265)				
price/income	0.75	0.32	0.27	3.59
sales	23305.81	38090.45	279	300395
horsepower	56.17	23.02	13	169
weight	973.02	220.39	520	1750
width	164.28	9.46	122	188
height	140.46	4.85	117.5	173.5
fuel efficiency	8.12	1.66	4.5	15.5
domestic car dummy	0.25	0.43	0	1
Italy (No. observations: 2027)				
price/income	0.99	0.49	0.28	5.35
sales	24292.14	45754.1	291	433694
horsepower	57.22	24.86	13	169.5
weight	978.69	229.32	520	1910
width	164.06	9.99	122	188
height	140.63	4.68	117.5	173.5
fuel efficiency	8.08	1.69	4.6	18
domestic car dummy	0.24	0.42	0	1
Germany (No. observations: 2283)				
price/income	0.65	0.27	0.24	2.45
sales	31002.55	50282.04	350	414132
horsepower	57.45	24.27	13	169
weight	983.05	228.66	520	1750
width	164.57	9.74	122	188
height	140.49	4.66	117.5	173.5
fuel efficiency	8.24	1.77	4	18
domestic car dummy	0.27	0.44	0	1
UK (No. observations: 2301)				
price/income	1.05	0.45	0.32	6.47
sales	19784.34	29875.92	296	193784
horsepower	58.42	23.61	13	165
weight	984.00	221.13	520	1825
width	164.82	9.06	129.5	188
height	140.27	4.29	122	173.5
fuel efficiency	8.22	1.68	4.5	18
domestic car dummy	0.23	0.42	0	1

Source: European car market database, own estimations

Chapter 4. Private Incentives to Innovate: Interplay of New Products and Brand-Name Reputation

Private Incentives to Innovate: Interplay of New Products and Brand-name Reputation*

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April 14, 2008

Abstract

This paper studies the introduction of new products (increase in product variety) in the automobile industry. The focus is on the two sources of market power that may allow the firms to get higher profits (and, thus, recoup investments): new products and brand-name reputation. The effects of new products on the private incentives to innovate are investigated on the basis of the dataset for the German car industry for 2003. The dataset is rather unique in the sense that it contains detailed information on the technical characteristics of cars, prices and sales as well as information on the introduction of new car models (including new variants and versions) into the German car market at a very disaggregate level. It has been found that both a new model and brand-name reputation may allow the innovative firms to get some market power and recoup their investments. Competition is, however, not localized within a market segment and the class of new, or old models, i.e., products from different market segments, new and old products compete with each other (coexisting and not eliminating each other) and do not constitute separate market niches. On the other hand, new (old) models are perceived to be closer substitutes than old (new) models. Consumer preferences towards brand and new products vary depending on their age.

*I am thankful for the financial support from the German Research Foundation (Deutsche Forschungsgemeinschaft (DFG)) and the Center for European Economic Research (Zentrum für Europäische Wirtschaftsforschung (ZEW)) during my doctoral studies at the Center for Doctoral Studies in Economics (CDSE), University of Mannheim. I am very grateful for the comments to Dr. Georg Licht, Prof. Konrad Stahl, Prof. Eric Soerensen, Prof. Frank Verboven, and Prof. Dr. Ulrich Kaiser. The comments of the participants of the INIR Doctoral Workshop (KU Leuven), ZEW Brown-Bag seminar (Mannheim), CDSE Doctoral seminar (Mannheim), SFB seminar (Mannheim), ZEW PhD Student Workshop, 2007 Scottish Economic Society conference (Perth), 22nd EEA Annual Congress during the 2007 ESEM-EEA Joint Meeting (Budapest), 2007 EARIE Conference (Valencia), and 2007 Annual Congress of French Economic Association (Paris) are very appreciated.

1 Introduction

There has been a growing stream of literature, devoted to the introduction of new goods. The major developments directions in this literature have been summarized by Bresnahan and Gordon (1997). These are the historical treatment of new goods and their diffusion over time, measurement of recent and on-going innovations, in particular, quantifying social and/or private returns to innovation, and adjustment for quality changes in the official price indices.

The notion of product innovations, which can be used in empirical studies, has been conceptualized by Trajtenberg (1989). Product innovation has been defined as the introduction of goods new to the market, or with improved quality of the existing products.

Private returns from investment and consumer benefits from new goods can be evaluated. A number of papers concentrates on the measurement of the social welfare from the introduction of new products, or quantification of the economic value of innovation (e.g., Trajtenberg, 1989 (for computed tomography scanners), Hausman, 1994 (for a new brand of cereal), Hausman, 1997 (for cellular phones), Hausman et al., 1997 (for new services in telecommunications), Bresnahan et al., 1997 (for personal computers), Petrin, 2002 (for automobiles), Goolsbee and Petrin, 2002 (for direct broadcast satellites), Hausman and Leonard, 2002 (for tissue paper), Cleanthous, 2004 (for pharmaceuticals), Gentzkow, 2005 (for online news)). The new products allow the firms to enjoy some transitory market power, which allows them to pay for innovation (Arrow, 1962).

Competition behavior and private incentives to innovate (also role of a brand name) are explicitly addressed in a few empirical papers (e.g., Stern, 1996, Bresnahan et al., 1997). Stern (1996) finds the pioneer (branded) products to be closer substitutes with each other and to be substantially differentiated from generic products. Bresnahan et al. (1997) find that moving forward a technological frontier and relying on a brand-name reputation allowed innovative PC firms to get transitory market power. They argue that the new products can be protected from competition as they cannot be perfectly substituted with the existing goods because of some novel features, or they may be cheaper to produce. Product segmentation due to a brand name is another source of innovative rents to the innovators. The role of brand-name reputation as a premium for high quality has been addressed in a number of theoretical papers (e.g., Shapiro, 1982, Wernerfelt, 1988). It has been found that consumers are willing to pay a premium for high-quality products, and the protective umbrella of a brand can be extended over the other products of a firm.

Hedonic prices indexes literature (e.g., Pakes, 2002) addresses a problem of new goods in the price indexes and defends the use of such indexes as compared to alternative price indexes.

Automobile industry appears to be interesting to study different aspects of the economics of innovation. The industry is highly innovative and competitive (with a lot of product and process innovations, product variation and proliferation). Simultaneously, there are high development costs, and reduced model cycles due to increased competition put additional pressure on the automobile producers. The introduction of new, differentiated from existing products, models and the creation of new market niches may give the automotive firms some transitory market power. This can yield profits to the innovators and allow them to recoup their investments, and may also bring gains to the consumers.

On the other hand, brand differentiation is a good strategy against price competition. Pricing pressure in the premium and luxury car market with more differentiated products may be rather moderate as compared to the volume-end car segment, and higher profit margins can be obtained. Competition may rather concentrate on brand and product attributes and innovations, consequently, there is more competition in quality. Through the establishment of strong brands, the margins can be secured rather permanently. In addition, the protective umbrella of a premium brand may be extended over the new products of a premium car producer. This generates larger cash flows, which leads to more investment being undertaken by the premium and luxury car manufacturers. This, in turn, allows them to become the creators of competence and technology.

To sum up, there could be two major sources of market power, which may allow the automotive firms to recoup their investments: through building brand-name reputation and the establishment of strong brands, which is rather permanent, and through the introduction of new products and the creation of new market niches, which is rather temporary[1].

Automobile industry literature seems to be not so rich in terms of studies about the effects of the introduction of new products, or rents from innovative investment. However, there is a number of studies, which construct hedonic price indices for the automobile industry (e.g., Court, 1939, Griliches, 1961, Ohta and Griliches, 1983). The studies that look explicitly at the economic effects of new products introduction in the US automobile industry are the ones by Petrin (2002) and Berry, Levinsohn and Pakes (2004).

Petrin (2002) assesses the economic effects of the minivan introduction (Dodge Caravan by Chrysler). He measures the change in the consumer welfare as well as changes in the producer surplus through evaluating the extent of the first-mover advantage and profit cannibalization by innovator (his profits were found to be higher than development costs) and imitators (their variable profits were falling each year). Potential demand for new products and the impact on the market shares of the existing products has been evaluated by Berry, Levinsohn and Pakes (2004). The authors study this effect on the example of the introduction of new 'high-end' SUVs. In another prediction exercise they look at the effects of the close-down of the GM Oldsmobile division in 2000 and find the car models that have most benefitted from this closure. In general, in automobile industry studies it has been found that higher quality cars appear to have higher margins (e.g., Berry, Levinsohn, and Pakes, 1995).

The purpose of this research paper has been to look whether it pays off

[1] Intellectual property rights protection could be another mechanism to enjoy some rent before the innovators catch up (as it has been in particular mentioned by Bresnahan et al., 1997). This aspect is, however, beyond the scope of this paper.

to produce new models, i.e., whether there are mark-ups on new car models specifications, which would allow the firms to cover the product development costs and provide enough incentives to develop new products, and to investigate the role of the brand-name reputation in the ability of the firm to get market power and recoup its investments. In addition, I have intended to see whether the competition is localized within volume or premium market segments (new vs. old classes). The two mentioned above sources of market power may be quite interlinked, which leads me to the empirical investigation whether both new model and brand-name reputation contribute to the higher market power (as compared e.g., to the introduction of new products by volume manufacturers). That is, I have aimed to study the (simultaneous) impact of a new model (innovation) and brand name (reputation) on the ability of the innovative firms to get market power (i.e., whether the protective umbrella of a brand-name reputation can be extended over new products, or continuous innovation creates brand-name reputation).

The questions are investigated on the basis of the aggregate product-level data for the German automobile market in 2003. This paper rather concentrates on the measurement of the private benefits, as compared to the assessment of the general welfare effects, due to the introduction of new car model specifications (which differ in innovation value), and investigates this linkage to the role of brand-name reputation to get market power, which has not been addressed in the previous automotive industry studies. The importance of the principles of differentiation such as market segment and new vs. old model for the automobile markets is also addressed in this study.

New products in this paper are viewed as rather those new car model specifications that fill in the product space (product characteristics) and products new to the firm (i.e., completely new products). Thus, another major difference to the other papers is that my research focus is not on drastic, but rather incremental innovations, or changes in the products' features/products' quality. The advantage of the data for the German car market that I use in this research is that one can study highly differentiated products at really a very disaggregate level, so that all the product variety could be really captured[2]. It should be also noted that in general in other industries a lot of products are introduced into the market, which are not completely new products, but rather the existing products with added new or improved features. This also involves research and development costs, therefore, it would be interesting to see whether this strategy pays off. The continuation of the old model with new specifications is an alternative to the introduction of a completely new model, concerning which the firms should make strategic decisions[3].

[2] The car model variant is the major item of competition in the automobile markets at present. Firms compete in rather standardized product lines (models and their variants) and not on individual car sales (Kaiser and Sofka, 2006).

[3] The literature that deals with modelling of the entry and exit in the differentiated products industries should be mentioned. The firms, both incumbents and entrants, face several decisions concerning the placement of their products in the market. In general, the firm can place its products close to its existing products, known as 'cannibalization' (e.g., Schmalensee,

The German car market is characterized by a high degree of new product introductions, a large role of brand-name reputation and consumer loyalty, and presence of important domestic premium and volume car manufacturers. It is also a lead market for many innovations. All this makes it together to be suitable and interesting to study the above stated research questions.

The incentives to innovate are studied within the context of a discrete choice model. The structural oligopoly model for differentiated products is estimated on the basis of the market-level data on prices, quantities, and product characteristics. It has been found that both brand-name reputation and a new model have positive impact on the market shares of firms. Consumers are rather heterogenous within a market segment, however, there are more correlated preferences for the cars of the same market segment than for the cars of different market segments. New products do not constitute a separate market niche, they compete with old products. However, there exists some differentiation between new and old car model specifications, which may allow the firms to enjoy some market power due to the new products introduction. It has been also found that consumer preferences towards brand and new cars vary depending on their age.

The paper proceeds as follows. In the next section I discuss competition, innovation, and brand-name reputation in the automobile markets, finishing with the discussion of new product development in the German car market. After that empirical structural framework, estimation procedure and ways to address the research objectives of this paper are discussed, followed by the descriptive statistics for the whole data sample and for the new models. The paper concludes with the presentation of the empirical findings and discussion of the results.

2 Competition and new products introduction in the automobile markets

Increased global competition in the automobile markets has put pressure on the global automotive players to direct their efforts to build up reputation and pursue R&D activities to maintain, or increase their market shares. The competition and innovation trends, role of brand-name reputation, and new product development in the German automobile industry are discussed in the next subsections.

2.1 Competition and innovation developments

Recently price competition has been growing in virtually each car market segment. It has become especially fierce in the volume car segment, where product differentiation has faded away, and the products offered are rather similar and

1978, Eaton and Lipsey, 1979), or it can prempt the entire market (e.g., Spence, 1976, Brander and Eaton, 1984, Bonnano, 1987).

commoditised. In this case, the price becomes a major factor behind the purchasing decision of a consumer. The volume producers pursue cost-price leadership strategies to increase the market shares and profits. Competition may have increased among premium producers as well, especially, under the weakening role of brand-name reputation and quality problems by the premium car producers.

As a general trend, there has been increasing competition for the premium producers from the volume manufacturers attracted by higher profit margins. On the other hand, some premium brand producers move to the lower-end car market (e.g., Mini and BMW 1er by BMW, Smart by DaimlerChrysler), establishing premium niches in the entry segments in order to capture customers already at the time of entering the car market for the first time. Competition between premium and volume cars (in the same market segment) may intensify when consumer demand stagnates. Another important trend is rising competition for European luxury brands from Asian ones. Japanese competitors are gaining, in particular, reputation for building reliable cars.

Increased global competition in the automobile markets has put pressure on the OEMs to look through their competitive strategies. The automobile industry is characterized by the continuous product development and the introduction of new products into the market (completely new models, models with new and improved features and designs). There has been more electronics being put into the car, more safety innovations, improvements in steering and breaking systems, more innovations in the sphere of comfort and convenience, more environmentally driven innovations and innovative materials.

The OEMs can respond to the competitive pressures by going to new market segments or niches, which may help to maintain or increase market shares and earn considerable returns. They may add new functional features to their vehicles to differentiate their products. This differentiating advantage can however rather rapidly disappear as the other firms can do the same rather fast. Thus, the competitive advantage can be only incremental but not sustainable if the innovation is easy to copy. Furthermore, the car producers may increase the quality of their cars but other global competitors may respond also rather quickly to this. New models, new product segments and niches can offer better pricing resistance. Furthermore, the new models can be generally cheaper produced than the previous generation after the adjustment for content differences (because of learning curve effect, efficiency gains in the production process, etc.). The strategy of new products segments and niches is not so easy to implement as many key automobile players are present in almost all existing niches and first-mover advantages may dissipate rather quickly. The above described developments sharpen market fragmentation further. Higher competition results in the shorter product life of many products.

The above mentioned product innovations are accompanied by process innovations, namely, the introduction of labour-saving, capital-saving, and input-saving techniques. This can allow to generate economies of scale and scope, which may help to cover high investment costs for model development and considerable fixed costs in the industry. The long life of a car model (6-7 years) is under pressure towards shortening under the growing competition. Platform strategies (identical platforms are used for various models) have been pursued by the automotive players.

The process of constant product and process innovations involves high product development costs. For example, the joint development of Toyota Aygo, Citroen C1 and Peugeot 107 has cost EUR 1.3 bn of investments (Sofka and Zimmermann, 2005).

To sum up, the car manufacturers compete not only in price but new products development for maximum profits. The results are the proliferation of new products and the growing fragmentation of markets (customers are increasingly demanding and differentiated, with preferences towards a broad variety of models and variants). Simultaneously, the product innovations can be relatively easily adopted by the other car manufacturers, that is why, they cannot be viewed as a permanent answer to the new competitive challenges. Here, the development of a brand name can become an important factor of rather permanent market power.

2.2 Brand-name reputation and premium brands

It has been argued that largely the premium and luxury car market introduces new technologies. Usually the competitive advantage from a single functional feature is rather short-lived, as it may be rather quickly adopted by the volume segment of the market. The rivals' technologies and new products features are quickly followed in this market segment.

The strategy of continuous technological improvement is being pursued by some OEMs such as Mercedes, which allowed them to create a leading edge brand image. European car manufacturers are argued to have a competitive edge because they can differentiate by model, in addition to brand identity (McKinsey Global Institute, 2005). The premium OEMs differentiate also in style, as it is important not to have scaled-down, or upscaled versions of each other. The luxury producers may rather concentrate on the consistency of the model designs over time, which helps them to build consumer loyalty (Thomas and Weigelt, 2000). The addition of new features may not make the consumers switch to competing models. Thus, there will be less intrasegment competition as compared to the volume segment. Because of the consumer loyalty, the OEMs, both premium and volume, try to capture the customers already in the entry-level car market segments.

Premium brand customers exhibit higher brand loyalty and consumer inertia, which may alleviate the competition pressure, reduce marketing costs and, consequently, lead to the higher profit margins by the premium brand producers than by the volume manufacturers.

As a result of the above described developments, there appears to be a shift in the traditional pattern of the European automobile demand, the so-called "loss of the middle" (Dudenhoeffer, 2006). The traditionally strong middle car market segment appears to be less important, while the OEMs' success appears to be to a large extent determined in the premium and entry market segments.

The automobile manufacturers in the traditional middle car market segment such as Ford, Opel or VW lose their market shares, while the premium segment producers such as BMW or Mercedes, or producers in the entry market segment such as Toyota, Peugeot, Renault or Hyundai win market shares. As a result, brand differentiation seems to be even more important as it is difficult to reduce the gap between the entry and premium market segments.

As for brand consumer loyalty, there have been some surveys done (e.g., Dralle, 2006). Audi has the highest share of loyal customers (74%), followed by BMW and Mercedes (71%). The mentioned criteria behind the Audi's success are clear positioning and product success, while BMW is argued to bind its customers through the introduction of new products.

To sum up, brand strength and quality reputation could be important sources of pricing power, in addition to cost factors such as features, performance and design of a car. The OEMs try to win consumer loyalty (already in the entry-level segment) and build up long-term relationships with their customers.

2.3 Product development in the German automobile market

Generally several major terms could be distinguished while talking about product development in the automobile markets that have been described by Diez (2001). These are product innovation, model changeover and product variation, and product proliferation.

Product innovation is defined in the automobile industry as the introduction of a completely new model by a producer. The value of the innovation of a new product can be measured by a change of technical-quality and/or formal-aesthetic features of a vehicle. Here it is possible to differentiate between two cases: the introduction of a new model to widen the product program, and the introduction of a new model to change an already existing in the market model (i.e., model changeover). The product development processes are very similar in both cases.

For the model change-over policy there are two very much connected variables: degree of innovation value and duration of a model cycle. Product variation (also Relaunch) is defined as the change of an already existing in the market model while keeping the major construction features. In the automobile economics the product variation is usually characterized as face-lifting. The role of the face-lifting is a technical and optical updating of a model. In this case further product development as by a model changeover is not implied. The objective of the face-lifting is to support a planned model cycle. The advantage of the face-lifting as compared to the model change-over is that the existing in the market products are not sold at strongly reduced prices. The most often used measures of face-lifting are the introduction of a new aggregate or component (e.g., motor); change of an exterior or interior; widening of a model equipment (e.g., special equipment becomes standard model equipment).

Product proliferation is defined as widening of a product program through product differentiation and widening of a product width. Product differentiation implies the classification of a model into different types depending on motor performance, mode of drive, build, and equipment packages. The widening of a product width means the introduction of an additional model. One of the objectives of the product proliferation is the support of a model cycle. As compared to the face-lifting, the product proliferation has an innovative character. Three types of strategies can be distinguished: full-line-producer (both vertical and horizontal product differentiation), specialized producers (either vertical or horizontal product differentiation) and niche producers. The major risk by product differentiation are substitution effects between different types of a model or between different models ('cannibalization'). There are costs risks: product development (type-specific R&D expenses), production (type-specific investments are needed), sales and service. There is a risk of not achieving economies of scale effect.

The German car market is characterized by a lot of new models introductions. These introductions and product variety are at different levels: model, model variant and version (see Table 1).

Table 1. German automobile market: levels of model disaggregation

Category	Example
group	VW Group
brand	VW
line	Passat
model	Passat Variant
model variant/version	Passat Variant 4Motion Highline 85 kw

Source: Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA))

Each car model specification in my dataset has the year and month of introduction into the German car market (the detailed descriptive statistics of this dataset will follow later). Within those models that are characterized by 2003 year of introduction several classes can be distinguished[4] (see Table 2):

Group 1. Entirely new models (e.g., Smart forfour).

Group 2. Supplemental items: existing products with some new features added (with added functional features, improved quality, higher performance (e.g., diesel variant, higher horsepower), etc.).

Group 3. Replacement items: e.g., a new generation of a car (e.g., Lancia Ypsilon).

Table 2. German automobile market: model policy of car manufacturers

[4] The classification of new models that I use is based upon the classification by Armknecht, Lane and Stewart (1997) in Bresnahan and Gordon (1997) who distinguish among the following cases of new products:

1. Replacement items: these are new models, which are previously available items that are or soon will be discontinued, such as the current year's automobile models.

2. Supplemental items: they include newly added brands of currently available goods (e.g., cereal) and new ways to sell a service (e.g., airline travel).

3. Entirely new items: these are those, which are not closely tied to any previously available item.

	No. and best-selling models	New (by KBA)	Entirely new	Supple mental	Replace ment
Mini	(16) Renault Twingo, Smart, VW Polo	Lancia Ypsilon (09/2003)		Smart& prabus; Ka SportKa	Lancia Ypsilon
Small	(37) VW Polo, Opel Corsa, Ford Fiesta, Skoda Fabia	Citroen C2 (08/2003), Mazda 2 (01/2003), Smart Forfour (09/2003)	Citroen C2, Smart Forfour	A2 1.4 TDI; Fiat Punto 1.3 JTD Dynamic	Mazda 2
Low middle	(32) VW Golf, Bora, Opel Astra, Ford Focus	Mazda 3 (08/2003)		Megane 2.0 Luxe Privilege	Mazda 3
Middle	(38) BMW 3er, VW Passat, Mercedes C-Klasse	Daewoo Evanda (02/2003), Mazda RX-8 (11/2003)		320 cd; VW Variant TDI Highline	Daewoo Evanda, Mazda RX-8
Upper middle	(23) Mercedes E-Klasse, BMW 5er, Audi A6, S6	Kia Opirus (05/2003), Nissan 350Z (10/2003)	Kia Opirus	Nissan 350Z	

Source: own classification on the basis of the Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)) data

The value of innovation is different for all these three classes of new products. As it has been mentioned above, the value of the innovation can be measured by a change of technical quality and/or formal-aesthetic features of a vehicle[5]. The highest innovation value is by the entirely new items, followed by the replacement models and supplemental items. The product development processes are very similar in case of entirely new and replacement models. In my dataset the new models are mostly the so-called supplemental items (new variants and versions of cars, or variants/versions with added new features) (for some examples, see Table 2 above).

For my estimations I define all these classes as a new product group. This combined definition of new products seems to be suitable for investigating my re-

[5] Clark et al. (1987) discuss the product development in the automobile industry and argue in general: "New products may simply be those incorporating minor changes to the established designs (for example, a washing machine with an almond cabinet instead of a white one), or they may use new technology to create new markets (the Xerox 914 copier)".

search objectives. Many of these new car specifications capture product proliferation, which has an innovative character, and not just face-lifting[6]. In addition, as I have mentioned before, the new products in this paper are viewed as rather those new car model specifications that fill in the product space (product characteristics) and products new to the firm (i.e., completely new products). My research focus is not on drastic but rather incremental innovations, or changes in the products' features/products' quality. Not so many completely new models and replacement items were introduced in 2003.

3 Empirical structural framework and estimation procedure

3.1 Empirical structural framework

3.1.1 Demand

Utility (McFadden's (1978) utility specification) Assume that consumer i, $i = 1, ..., n$ has utility $u_{ij} = u\left(x_j, \xi_j, p_j; \theta\right)$ from consuming product j, $j = 1, ..., J$, where $j = 0$ is an outside good, x_j and ξ_j are observed (e.g., horsepower, engine size) and unobserved (e.g., style, image) product characteristics, p_j is the price of product j, and $\theta = (\alpha, \beta)$ are the parameters to be estimated.

The linear version of the random indirect utility is given by:

$$u_{ij} = \delta_j + \epsilon_{ij}, i = 1, ..., n, j = 0, ..., J \tag{1}$$

where ϵ_{ij} is assumed to be identically and independently distributed across consumers and products.

The mean valuation for product j common to all consumers is:

$$\delta_j \equiv x_j\beta - \alpha p_j + \xi_j \tag{2}$$

It is assumed that a consumer purchases one unit of good that brings him the highest utility. Therefore, consumer i purchases one unit of product j if and only if

$$u_{ij} > u_{ik}, 0 \leq k \leq J, k \neq j \tag{3}$$

Consequently, the probability s_{ij} that the consumer i purchases the product j is:

$$\begin{aligned} s_{ij} &= \Pr\{\delta_j + \epsilon_{ij} > \delta_k + \epsilon_{ik}, j \neq k\} = \\ &= \Pr\{\epsilon_{ik} < \epsilon_{ij} + \delta_j - \delta_k, j \neq k\} = \\ &\int_{-\infty}^{\infty} F_j\left(\epsilon_{ij} + \delta_j - \delta_0, ..., \epsilon_{ij}, ..., \epsilon_{ij} + \delta_j - \delta_J\right) \end{aligned} \tag{4}$$

[6] Announced for 2003 facelifts include Ford Mondeo, and Alfa Romeo 156 (Autobild, 2003).

where F_j are the partial derivatives of the joint cumulative distribution function F of $(\epsilon_{i0}, ..., \epsilon_{iJ})$ with respect to its jth argument.

Different specifications of the discrete choice models for the demand side can be derived depending on the assumptions about the distribution of the random utility term ϵ_{ij}, in particular, simple logit, multinominal nested logit, principles of differentiation generalized extreme value (PD GEV[7]) and random coefficients models. Below I present the empirical framework and later discuss the results on the basis of the two-level multinominal nested logit (the estimations results are, however, also presented for the one-level nested logit).

Two-level multinominal nested logit It is assumed that there are $G+1$ exhaustive and mutually exclusive groups, $g = 0, ..., G$, where 0 is an outside good. In each group there are further subgroups H_g, $h = 1, ..., H_g$. Utility u_{ij} of household i for product j in subgroup h of group g is given by[8]:

$$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}, j \in h_g \subset g, \forall i, \forall j \quad (5)$$

where $\delta_j \equiv x_j\beta - \alpha p_j + \xi_j$ and $\epsilon_{ij} = \varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}$. Variation in consumer tastes enters through the last term.

The error term ϵ_{ij} is decomposed into an iid shock, a group-specific component and a sub-group specific component. $\varepsilon_{ig}, \varepsilon_{ih}, \varepsilon_{ij}$ are standard for the nested logit distributions, ε_{ig}, $\varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg}$ and $\varepsilon_{ig} + (1-\sigma_g)\,\varepsilon_{ihg} + (1-\sigma_{hg})\,\varepsilon_{ij}$ are assumed to have an extreme value distribution. It is assumed that ε_{ij} are uncorrelated across customers; for a particular customer, ε's, which belong to the same group, will be more correlated with each other than with the ε's that belong to any other group (ε_{ig}[9]); and for a particular customer, ε's, which belong to the same subgroup, will be more correlated with each other than with the ε's that belong to any other subgroup (ε_{ihg}). That is, the products of the same sub-group or group share common features, for which consumers may have correlated preferences. Nesting parameters σ_{hg} and σ_g can be interpreted as random coefficients on discrete dummies for subgroups and groups rather than on variables that are continuously measured (e.g., performance or size)[10].

σ_{hg} measures the degree of substitutability of products in a subgroup, and σ_g is the degree of substitutability of products in a group. The following $0 \leq \sigma_g < \sigma_{hg} < 1$ should hold to be consistent with random utility maximization. That is, consumer preferences will be more correlated across all products of the same subgroup than across products of the same group but a different subgroup. Consequently, relatively plausible substitution patterns can be obtained, and

[7] This model has been first suggested by Bresnahan et al. (1997).

[8] In the exposition below, I follow Berry (1994), Verboven (1996) and Brenkers and Verboven (2006), after McFadden (1978) and Ben-Akiva and Lehrman (1985).

[9] For consumer i, the variable ε is common to all products in a group g and has a distribution function that depends on σ_g. Similar interpretation is for a subgroup.

[10] In my estimations I do not allow the correlation parameters to vary across groups and subgroups.

localized competition between the products from the same group or subgroup can be allowed.

The above mentioned assumptions upon the aggregation of choices across all consumers result in the well-known formulas of the nested logit model for the conditional choice probabilities. The mean utility for the outside good is normalized to zero, $\delta_0 = 0$. The market share for a car j in subgroup h, group g can be written down as:

$$s_j = \frac{e^{\delta_j/(1-\sigma_{hg})}}{e^{I_{hg}/(1-\sigma_{hg})}} \frac{e^{I_{hg}/(1-\sigma_g)}}{e^{I_g/(1-\sigma_g)}} \frac{e^{I_{hg}}}{e^{I}} \quad (6)$$

where I_{hg} , I_g and I are called "inclusive values" , which are defined in the following way:

$$I_{hg} = (1-\sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} e^{\delta_l/(1-\sigma_{hg})}, I_g = (1-\sigma_g) \ln \sum_{h=1}^{H_g} e^{I_{hg}/(1-\sigma_g)}, I = \ln \sum_{g=1}^{G} e^{I_g} \quad (7)$$

with J_{hg} being the set of cars in a subgroup h of a group g, and H_g being the set of subgroups in a group g.

Berry (1994) suggested the log-linearization of the above formula for the market share. The demand equation that can be taken to the estimations can be written down as:

$$\ln(s_j/s_0) = x_j\beta - \alpha p_j + \sigma_{hg} \ln\left(s_{j/hg}\right) + \sigma_g \ln\left(s_{h/g}\right) + \xi_j \quad (8)$$

where s_j is the share of product j in the total market, s_0 os the share of the outside good in the total market, $s_{j/hg}$ is the market share of product j in subgroup h of a group g, $s_{h/g}$ is the share of all products in subgroup h in a group g.

Substitution patterns The two-level nested logit has the assumption that consumers tastes have an extreme value distribution but allows consumer tastes to be correlated (in a restrictive way) across product j (correlations between groups and subgroups are modelled in a simple way). This allows for more reasonable substitution patterns as compared to a simple logit. Nevertheless, as compared to the more general random coefficients model, the correlation patterns depend on the groupings of products, which are determined prior to the estimation. They do not depend on the values of continuous variables. The group dummy variables could be viewed at least as a partial proxy for the omitted continuous variables (e.g., the cars from the same group are likely to have similar performance, size, and other characteristics) (Nevo, 2000).

The own price elasticity E_{s_j/p_j} of the market share s_j of product j is:

$$E_{s_j/p_j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} = -\alpha p_j \left[\frac{1}{1-\sigma_{hg}} - \left(\frac{1}{1-\sigma_{hg}} - \frac{1}{1-\sigma_g}\right) s_{j/hg} - \frac{\sigma_g}{1-\sigma_g} s_{j/g} - s_j\right] \quad (9)$$

The cross-price elasticity E_{s_j/p_m} of the market share of product j with respect to the price of product m p_m, when j and m belong to the same subgroup, is given by:

$$E_{s_j/p_m} = \frac{\partial s_j}{\partial p_m}\frac{p_m}{s_j} = \alpha p_m \left[\left(\frac{1}{1-\sigma_{hg}} - \frac{1}{1-\sigma_g} \right) s_{m/hg} + \frac{\sigma_g}{1-\sigma_g} s_{m/g} + s_m \right] \tag{10}$$

The cross-price elasticity E_{s_j/p_k} of the market share of product j with respect to the price of product k p_k, when k belongs to a different subgroup in the same group, is given by:

$$E_{s_j/p_k} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \alpha p_k \left[\frac{\sigma_g}{1-\sigma_g} s_{k/g} + s_k \right] \tag{11}$$

The cross-price elasticity E_{s_j/p_l} of the market share of product j with respect to the price of product l p_l, when l belongs to a different group, is given by:

$$E_{s_j/p_l} = \frac{\partial s_j}{\partial p_l}\frac{p_l}{s_j} = \alpha p_l s_l \tag{12}$$

Introducing consumer heterogeneity (age differentiation) As it has been mentioned above, the two-level nested logit still results in rather restricted substitution patterns. Some consumer heterogeneity could be introduced into the model through interacting product characteristics with consumer characteristics, e.g., age in some flexible way. The likely constraints that age imposes on preference-based consumer car choices could be, therefore, exploited: a consumer has a different probability of choosing a specific car depending upon his age.

Such type of estimation may allow getting more reasonable substitution patterns (consumers' valuation for cars will vary across consumers of different age) without adding up any computational burden to the estimation procedure. The idea is to compute a purchase probability for an "average" consumer in each age group and sum up these probabilities to generate the market shares for each product j. The total market size will be the population of this age in the country in a given year.

The above demand equation (8) is, thus, estimated for each age group:

$$\ln(s_j^a/s_0^a) = x_j\beta_i - \alpha_i p_j + \sigma_{ihg}\ln\left({s^a}_{j/hg}\right) + \sigma_{ig}\ln\left({s^a}_{h/g}\right) + \xi_{ij} \tag{13}$$

where a_i stands for a respective age group, s_j^a is the share of product j in the total market for age group a, s_0^a is the share of the outside good in the total market for age group a, $s_{j/hg}^a$ is the share of product j in subgroup h of group g for age group a, $s_{h/g}^a$ is the share of all products in subgroup h in group g for age group a. Product characteristics and prices are the same for each age group. The coefficients β_i and α_i will be different for each age group.

In this case each age group has a different price sensitivity that is averaged to a mean price sensitivity using the age-group specific probabilities of purchase as weights.

3.1.2 Costs and firm behaviour

The log-linear marginal cost function is assumed:

$$\ln(c_j) = w_j \gamma + \omega_j \tag{14}$$

where w_j and ω_j are observed and unobserved product characteristics, respectively, and γ are the parameters to be estimated.

Assume F sellers of a differentiated product[11].

Firm f produces J_f of F total differentiated products. The demand for a product j is given by $Ms_j(p, X; \theta)$, where M is the market size.

Let P_{J_f} be the set of prices that the player f sets. Product characteristics for any year are assumed to be exogenous.

Assume that the outside good is competitively supplied.

The firm f chooses P_{J_f} to maximize its profits, for given J and p_j with $j \in J_f$:

$$\max_{p_{J_f}} \pi_f = \sum_{j \in J_f} (p_j - c_j) M s_j(p) - \sum_{j \in J_f} F_j \tag{15}$$

where c_j is the constant marginal cost of a brand j, $s_j(p)$ is the market share of a brand j, being a function of all brands' prices, and F_j is a fixed cost.

The first-order conditions for the manufacturer f's profit maximization problem are (assuming that a pure-strategy Nash equilibrium in prices exists and that prices are strictly positive):

$$s_j(p) + \sum_{r \in J_f} (p_r - c_r) \frac{\partial s_r(p)}{\partial p_j} = 0 \tag{16}$$

Let firm f have $k(f)$ products, which are indexed by $j = J_1^f, ..., J_{k(f)}^f$, with $J_1^1 = 1$ and $J_{k(F)}^F = J$.

Define the matrix of own- and cross-price elasticities Δ_f as:

$$\Delta_f = \begin{pmatrix} \frac{\partial s\left(J_1^f\right)}{\partial p\left(J_1^f\right)} & ... & \frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_1^f\right)} \\ ... & ... & ... \\ \frac{\partial s\left(J_1^f\right)}{\partial p\left(J_{k(f)}^f\right)} & ... & \frac{\partial s\left(J_{k(f)}^f\right)}{\partial p\left(J_{k(f)}^f\right)} \end{pmatrix} \tag{17}$$

In vector notation, the first-order conditions for J total products simultaneously can be written down as:

[11] In the exposition below, I follow Berry, Levinsohn and Pakes (1995).

$$\underbrace{\begin{pmatrix} s_1 \\ ... \\ s_J \end{pmatrix}}_{\mathbf{s}} + \underbrace{\begin{pmatrix} \triangle^1 & & 0 \\ & ... & \\ 0 & & \triangle^F \end{pmatrix}}_{\mathbf{\Omega}} \underbrace{\begin{pmatrix} p_1 - c_1 \\ ... \\ p_j - c_j \end{pmatrix}}_{\mathbf{p-c}} = 0 \tag{18}$$

Assume that $\mathbf{\Omega}$ is a non-singular matrix. Therefore, the first-order conditions can be expressed as:

$$p = c + \Omega^{-1}s \tag{19}$$

with the marginal cost equation taking up the following form:

$$\ln(p - \Omega^{-1}s) = w\gamma + \omega \tag{20}$$

The term $\Omega^{-1}s$ is a mark-up. Therefore, variable profits can be calculated on the basis of the estimated structural model for differentiated products.

Within the last equation, most often Bertrand-Nash behaviour with single-product firms, or Bertrand-Nash behaviour with multi-product firms is assumed.

3.2 Estimation strategies for the demand- and supply-side equations

In general, the demand and pricing equations can be estimated either separately, or jointly. Under the separate, or step-by-step, estimation, the demand equation is estimated first, after which the matrix of own- and cross-price elasticities is constructed on the basis of the estimated demand parameters. The pricing equation is estimated in the second step after having substituted into it the matrix of the elasticities. The standard errors of the pricing equation parameters have to be corrected. There are several advantages of this two-step procedure, e.g., reduction in the computational burden, experimenting with different supply specifications without re-estimating the demand function, no impact from possible supply model misspecification on the demand side results (Goldberg and Verboven, 2001)[12]. The major drawback of this procedure is the loss in the efficiency of the estimated parameters. In this paper step-by-step estimation results are presented.

3.3 Instruments

Prices and market shares are endogenous, correlated with the error term ξ_j. The prices will be collinear with the product characteristics that are not observed (e.g., quality). The introduction of product fixed effects to control for the unobserved characteristics can lead to an identification problem due to the correlation between fixed effects and product characteristics.

The detailed discussion of the choice of the efficient instruments for differentiated products models can be found in Berry, Levinsohn and Pakes (1995).

[12] Step-by-step estimations are also performed by Nevo (2001).

The best candidates for the instruments in the differentiated product markets are the model characteristics, which are usually treated to be exogenous, based on the assumption that in the short run they cannot be quickly adjusted by a firm. Thus, the matrix Z of instruments includes the product's own characteristics (which decreases the number of necessary additional instruments) and other exogenous variables used in the estimations.

The car's own price and demand will be correlated with the physical characteristics of the other products, and depend on the degree and closeness of competition that the firms face with the other competitors. The distance from the nearest neighbouring product will determine the markup of each brand. The functions of the exogenous physical characteristics (own and competitors') can be used as instruments (sums and averages).

Bresnahan et al. (1997) suggest the following groups of instruments: principles of differentiation (defined on a group-specific basis), ownership (defined on a firm-specific basis, making use of the economics of the multiproduct pricing) and ownership with principles of differentiation (combination of a group-specific and a firm-specific basis).

The set of instrumental variables can be expanded by including the prices of products in the other markets, suggested by Nevo (2000), following Hausman et al. (1984) and Hausman (1996).

Another important set of instruments comes from the supply side. Supply-side intruments will be not related to the car demand: these are the variables that enter the cost and do not enter the demand equation.

4 Measurement of private incentives to innovate: an empirical approach

The previously described empirical framework allows studying the research questions in the following way: look at the impact of a premium brand and a new product on the market shares, study different principles of differentiation to make inferences about competition patterns (in particular, concerning new products), investigate substitution patterns and compare markups for new and old products.

4.1 Principles of differentiation for the car market: new vs. old models classes and premium vs. volume market segments

The car market can be characterized by different principles of differentiation. The most obvious one is by market segment. Another principle of differentiation such as new vs. old model may appear at the first sight not so obvious, but still it could be an important principle of differentiation, taking also into account a recent increased emphasis on the introduction of new models and growing model proliferation by the car manufacturers. This principle of differentiation will be discussed in more detail in Section 6.2.

Two issues have to be taken into account here: the definition of a premium brand and the definition of a new product, or model. This will allow defining new and old car models classes as well as premium and volume car market segments.

The estimation of the nested logit, or PD GEV model with the above principles of differentiation appears to be suitable for studying the consumer preferences within the market segment, however, the grouping choice matters for inference. Segment correlation coefficients can be interpreted in terms of products substitutability and competition patterns.

The idea behind this approach is to see whether and to what extent the premium products are insulated from competition from the volume products. The same is for the new vs. old products, i.e., to see whether the new and old products compete with each other, or the new products enter a separate market niche. The answers to these questions depend on the degree of heterogeneity of consumers in their willingness to pay for a new and/or premium product[13]. Counterfactuals (introduction of a hypothetical new product into a particular group, or a model discontinuation) can be conducted to get some idea whether the products in various groups are protected from competition as it is reflected by the substitution parameters.

The application of this approach will help to get some inferences about competition behaviour in each market segment and the interaction of competition between the market segments as well as allow to study the simultaneous impact of a brand-name reputation and a new model on market power (namely, one could expect that new and branded products will have the highest market power).

4.2 Impact of a premium brand and a new product on market shares

The coefficient on the premium brand preference can be interpreted as for whether the consumers prefer premium products over volume ones, whether they place greater value on the premium products. Similar interpretation will hold for the new model coefficient. Many people prefer (e.g., because of individuality, fashion, desire to have a sports car version, or a more powerful car) new car model specifications despite the availability of old, or existing in the market car model specifications. Individual brand dummies can be included into the demand equations to investigate the difference in the impact between premium and volume brands.

This approach will help to answer whether there is a reward for innovation, and will allow to study the simultaneous impact of a brand-name reputation and a new model on the market shares (whether they help to maintain/increase market shares).

[13] This has been first suggested by Bresnahan et al. (1997) for a personal computer industry.

4.3 Investigation of substitution patterns and estimation of markups for new and old products

On the basis of the estimated demand parameters, the matrix of own- and cross-price elasticities can be constructed and markups can be calculated.

High values of own-price elasticities could be interpreted as a sign of intense price competition. The cross-price elasticity is an appropriate measure of the distance between the two goods, a measure of how close the consumers find both goods to be substitutes. The high cross-price elasticities can be interpreted as consumers viewing the products to be close substitutes and also as a sign of intense price competition. To sum up, when the segment own- and cross-price elasticities are found to be large and significant, that may be interpreted as a sign of significant competition, or "cannibalization" between the brands within a particular market segment.

One could compare the cross-price elasticities of products with respect to the cars from the same sugbroup (e.g., the sugbroup is premium vs. volume model[14]) within a market segment, with respect to the cars from a different subgroup within the same market segment, and with respect to the cars from different market segments. In the volume car segment, the products are closer substitutes, so that higher cross-price elasticities will be expected. In the premium car segment, the products are more differentiated, so that lower cross-price elasticities should be observed. The cross-price elasticities with respect to a different subgroup or market segment could be interpreted concerning the competition pattern in the given market segment (i.e., cross-price elasticities between volume and premium cars, or e.g., between small and medium cars (compare elasticities between any two premium (volume) cars and cross-price elasticities between premium and volume cars)). The cross-price elasticities for the premium/volume products should be higher within the subgroup as compared to the cross-price elasticities of the premium/volume products with respect to volume/premium products outside of the subgroup. This could be interpreted as isolation of competition. The cross-price elasticities with respect to the cars from different market segments should be lower.

Similar analysis could be done for new vs. old products. The new products may have lower price elasticities (within-group) as compared to the existing products (within-group) because they may face less price competition. The fact how close substitutes the new and existing products are will determine the consumer and producer surplus.

The estimation of the structural model for differentiated products allows to recover the marginal costs. Thus, markups (and price-cost margins) for new premium and volume products can be estimated to see whether there is a premium for a brand, and to compare how they differ to the ones on the existing products. Models with similar vehicles characteristics, which differ mainly in the brand name, could be compared to see, whether there is a price premium for a brand (estimation of the rents attributable to brand name). If there are

[14] The examples of the nesting order in this case could be: 1) segment, premium vs. volume, or 2) segment, premium vs. volume, new vs. old.

price differentials between new and old models, usually the question is whether the higher prices are caused by marginal costs, or by higher markups[15].

This method will allow to quantify a reward for innovation, study the simultaneous impact of a brand-name reputation and a new model as well as help to investigate the competition patterns within and across car market segments and sub-segments.

For the investigation of the effects from the introduction of completely new models, which could probably be a closer approximation to the quantification of the rents from innovation and could provide basis for a richer analysis (including in particular the investigation of static and dynamic effects, also direct comparison of producer profits from new products introduction and product development costs), one would need to have a much longer dataset (including pre- and post-introduction new model period[16]). In this case the methodology will be similar to the one by Petrin (2002), which is described below.

Petrin (2002) assesses the economic effects of the minivan introduction (Dodge Caravan by Chrysler). He measures the change in the consumer welfare as well as changes in the producer surplus through evaluating the extent of the first-mover advantage and profit cannibalization by innovator (his profits were found to be higher than development costs) and imitators (their variable profits were falling each year). He finds that the consumer welfare was raised as well as the innovator's profits increased at the expense of the other car producers who could not respond quickly to the minivan introduction. He estimates both the demand and cost side, after which these estimates are used to recompute the equilibrium prices and quantities when the new minivan is not included into the choice set. The simulated and observed prices and quantities are summarized into the welfare. The author argues that the new products that are substantially differentiated from the existing products can bring large profits to the innovator and considerable gains to the consumer. The author finds that competition leads to the improvement of the consumer welfare because the firms tend to cannibalize each other's profits when they search for new goods that would give them some temporary market power.

Because the data on the cost of new product development is not available and I have got only one cross-section of data, I am using the described above in

[15]The change in the producer variable profits from a new product introduction could be calculated.

[16]To investigate the difference in the rents to innovation attributable to a brand, one could then investigate whether a premium car producer gets a higher return to each euro invested in innovation (development of a new model) than a volume car producer. One could also then study the impact of the introduced new models on the prices of the existing products. The estimation of the consumer welfare will also make sense in such a situation.

The estimated welfare gains from new products, or services introduction vary in different papers. The welfare gains are likely to be small when the new products are similar to the products that are already in the market (e.g., different brands of cereals (Hausman, 1994)). Considerable consumer gains have been found by Hausman (1997) from a cellular phone introduction, Hausman et al. (1997) from the introduction of new services in telecommunications, by Cleanthous (2004) from pharmaceutical innovations in the US antidepressant market. Rather low welfare gains have been found by Goolsbee and Petrin (2002) from the introduction of direct broadcast satellites as an alternative to cable television.

this Section approaches to answer my research questions (mainly following the approach by Bresnahan et al., 1997).

5 Data description

The dataset for the German automobile industry in 2003 has been constructed on the basis of two data sources: Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)), which collects information on new car registrations by car model, registrations across state, age, gender, and corporate status[17], and car evaluation company Eurotax Schwacke, which provides information on prices and quality vehicles characteristics. These two datasets have been merged together. The data on registrations, prices and quality vehicles characteristics are very disaggregate and are at the level of model/type/variant/version.

The dataset has been further enriched by the data on advertising expenditures, environmental statistics, reputation ranking, loss in value, and the number of defects. The data sources for these variables and a more detailed description are discussed below. These data are, however, mostly available for the higher levels of aggregation, not at the variant, or version level.

The data on advertising expenditures is available from the publication "Der ADAC[18]-AutoMarxX im Dezember 2003" issued by the Center of Automotive Research, Fachhochschule Gelsenkirchen, for 33 brands. The reputation ranking has been also taken from this publication[19]. This publication contains also the data on a value loss.

The data on environmental and ecological statistics (e.g., fuel consumption in litres/100 km, ecotest overall points), available at a rather disaggregate level, to measure economic and ecological efficiency are provided by the ADAC and are available in the publication "Der ADAC EcoTest: 300 Automodelle im Umweltranking".

The data on defects statistics are taken from the publication by the ADAC "Die ADAC-Pannenstatistic 2003". The available series is the number of technical defects per 1000 automobiles. The level of disaggregation is a model

[17] The available dataset contains the data on sales for both physical and corporate persons. Among the five market segments, small and lower middle car markets are the largest ones for physical buyers, while for corporate persons lower middle and middle car segments are the most important ones. The estimation results are based on the total industry sales (except for age differentiation case), not distinguishing between the sales for physical persons and fleet sales. The purchasing decisions could be quite different for physical persons and for institutional buyers. All other automobile market studies are also done for the total sales, so that for the better comparison of the results it seems worthwile to proceed as it is. It should be, however, acknowledged that the corporate car sales may not be that important for the other car markets as they are for the German car market. The sensitivity of the results has been performed with respect to the sales for physical persons only, and no significant differences in the results have been found.

[18] ADAC stands for the General German Automobile Club (Allgemeiner Deutscher Automobil-Club). This is one of the largest German transport clubs.

[19] According to this ranking, the top ten brands are Mercedes, BMW, Audi, Volkswagen, Porsche, Volvo, Opel, Jaguar, Renault, and Toyota. The brands with the lowest reputation are Lancia, Rover, Subaru, Daihatsu, and Suzuki.

level (e.g., BMW Mini, Mitsubishi Colt, Toyota Yaris, Audi A4/S4, etc). Another source is "Der ADAC-AutoMarxX im Dezember 2003", where the results of the TÜV (Technischer Überwachungs-Verein stands for Technical Inspection/Control Association in Germany) report are published (number of significant defects per 1000 vehicles), available at a brand level.

The potential market is approximated by the number of households, which is taken from the German Ministry of Statistics (Statistisches Bundesamt).

Given a large set of technical and other vehicles characteristics, I have faced a problem of what ones to include into my model specification. Finally, the choice of variables for my specifications has been driven by two factors: a trade-off between characteristics that consumers care about while purchasing a car[20] and availability of the data on technical characteristics as well as addressing the problem of multicollinearity among the technical characteristics[21].

The descriptive statistics for the chosen variables can be found in Table 3. There could be several alternatives to represent various groups of factors behind the consumer car purchasing decision. The idea was to choose a variable with the least correlation with the other variables in the model specification, although for some variables the correlation levels remain pretty high. As a result, the following variables have been selected (whose descriptive statistics are given in the Table below): number of doors (basic characteristics), engine power (car's performance), diesel dummy (economic and ecological efficiency), ABS and transmission-slip control (safety), dummy for luxurious, e.g., wood interior decoration, navigation system, and leather seats (convenience/amenity, comfort, entertainment), and number of technical defects per 1000 automobiles (reliability).

Table 3. German automobile market: descriptive statistics, 2003

[20] The survey conducted by the German magazine Stern (Stern, 2006) has found the following purchasing criteria to be important: reliability, safety, price-quality relationship, driving comfort, technologically advanced, good customer service, fuel consumption, suitable for me, costs of maintaining a car, has a good reputation, dealer rebate, internal equipment, a lot of space, service network, resale value, base equipment, styling/outlook, ecological efficiency, speed acceleration, new model/version, financing possibilities, low price, free time and hobby, city wagon, convertible, driving gears. According to this study, about 27% of the interviewed people consider the presence of a new model or version to be an important purchasing criterion (compare, e.g., to 76% by a reliability criterion).

[21] The estimations results in general are very sensitive to the choice and scaling of variables.

Variable	Meaning	Mean/share	Std.dev	Min	Max
price		25020.3	10806.4	6150	133516
sales		1896.3	4293.7	10	50818
kw3	Kilowatts of engine power	97.2	40.0	30	368
tuer	Number of doors	4.4	0.9	2	5
abs	Dummy for ABS	0.98	0.2	0	1
innendekor	Dummy for decorative wood interior	0.5	0.5	0	1
navi	Dummy for a navigation system	0.03	0.2	0	1
dieseldum	Dummy for a diesel engine	0.3	0.5	0	1
defect	Number of defects per 1000 vehicles	15.0	4.5	0	26
mediapercar	Advertising expenditures per car	457.0	1289.9	107.9	16525.3
leder	Dummy for leather seats	0.4	0.5	0	1
asr	Dummy for transmission-slip control	0.5	0.5	0	1
modelyear	Dummy if a model is introduced in 2003	0.2	0.4	0	1

Source: Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)), Eurotax-Schwacke

Note: descriptive statistics are given for the following market segments: mini, small, lower middle, middle, and upper middle.

The models in the dataset are distinguished by the year of introduction into the German car market on the basis of the Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)) data. A new model is introduced into the model specification as a dummy variable for a model being introduced in 2003. Some descriptive statistics for the new car models within different market segments can be found in Table 4.

Table 4. German automobile market: descriptive statistics for new models by market segment, 2003

Variable	No.obs.	Mean	Std.dev.	Min	Max
Total					
price	188	26968.9	8999.9	9500	85000
sales	188	1966.8	3128.9	14	22639
engine power	188	105.2	36.4	44	265
Mini					
price	4	13592.5	3433.8	9500	17895
sales	4	3158.8	3923.7	143	8486
engine power	4	55	11.0	44	70
Small					
price	29	15042.9	2205.0	11390	19900
sales	29	2543.5	2886.2	124	11359
engine power	29	63.6	16.6	44	120
Lower middle					
price	31	22086.2	3838.6	16550	34800
sales	31	1632.5	3138.8	14	13303
engine power	31	93.5	27.7	60	177
Middle					
price	101	30129.8	6990.6	22500	85000
sales	101	2039.0	3363.7	15	22639
engine power	101	115.2	30.7	66	265
Upper middle					
price	23	37032.9	5753.4	27690	54150
sales	23	1165.7	2024.5	38	7858
engine power	23	138.1	32.7	96	220

Source: Federal Bureau for Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)), Eurotax-Schwacke, own calculations

Another important question has been how to define a premium brand. In this paper a premium brand including Mercedes, BMW, Audi is defined[22], and all the models of these premium brands are grouped together to constitute the premium car market. A premium brand dummy variable has been constructed, which is equal to 1 if a car is from Audi, BMW, and Mercedes, and zero otherwise. Some examples for volume and premium brands across different market segments can be found in Table 5.

Table 5. German automobile market: premium vs. volume manufacturers across market segments

[22] In general, the definition of a premium brand is rather a subjective issue. According to the survey conducted by the Automotive News (Automotive News Europe, 2005), the premium vehicles should possess the following features: some appropriate brand image, which would form the basis of premium pricing, about 15% transaction price markup as compared to a comparable volume brand vehicle, higher residual values, greater consumer loyalty, older buyers, global market presence, low volumes, and a lot of electronics. As for the last two points, there has been no common agreement among the experts. A premium brand definition will also be different for Europe and the US.

Segment	Major selling brands	Market shares, %
Mini	Renault Twingo	22.8
	Smart	18.2
	VW Lupo	16.6
Small	VW Polo	17.7
	Opel Corsa	11.3
	Ford Fiesta	7.2
	Skoda Fabia	7.2
Low middle	VW Golf, Bora	27.9
	Opel Astra	10.7
	Ford Focus	9.9
Middle	BMW 3er	17.9
	VW Passat	15.9
	Mercedes C-Klasse	15.2
	Audi A4, S4	14.4
Upper middle	Mercedes E-klasse	41.8
	BMW 5er	21.3
	Audi A6, S6	17.9
Luxury	Mercedes S-klasse	26.3
	BMW 7er	21.0
	Audi A8, S8	18.6

Source: Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)), own calculations

Car market segmentation that is used in this paper is the one developed by the Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt (KBA)). This classification is defined on the basis of optic, technical and market-oriented factors, which have been approved by the industry representatives. The market is divided into the following segments: mini, small, lower middle, middle, upper middle, luxury, SUVs, cabriolets (including roadster), vans, and utilities. This is a broad definition of a light vehicles market.

The current analysis concentrates on the five market segments: mini, small cars, lower middle, middle and upper middle. There are several arguments for this decision. These car segments constitute the traditional car segment (with the exception of luxury and sports cars). They also represent about 80% of the total light vehicles sales in Germany in 2003. Second, luxury and sports cars may be driven by somewhat different supply and demand factors, thus, there could be problems with the model specifications and the choice of instruments. Third, most new models seem to be concentrated in the above-mentioned five segments in my dataset. The new models sales in these five segments make up about 74% of the total new light vehicles sales in Germany in 2003.

6 Principal findings

6.1 Estimation results of one-level nested logit (nest is market segment)

The estimation of the one-level nested logit allows studying the impact of brand-name reputation and a new model on market shares as well as to obtain the estimates of the correlation parameters within the market segments in order to get inferences about competition patterns.

Demand estimation

The following demand specifications have been estimated: base (Specification A), with a new model dummy and a premium brand dummy (Specification B), and with a new model dummy and brand dummies (Specification C) (see Table 6).

Table 6. German automobile market: estimations results of one-level nested logit

Nest is market segment

Variable	Spec.A	Spec.B	Spec.C
α	-0.00004	-0.0001***	-0.0001***
σ_g	0.28***	0.32***	0.43***
asr	0.36***	0.36***	0.26***
engine power	0.001	0.01	0.01**
doors	0.10**	0.16***	0.16***
abs	0.54**	0.47*	0.41**
decoration	-0.02	0.12	0.01
leather seats	-0.08	0.28***	0.25***
navigation	-0.28	0.40	0.23
diesel	0.27**	0.38***	0.28***
defect	-0.04***	-0.04***	-0.003
const	-8.87***	-8.61***	-8.69
new model		0.32***	0.28***
premium brand		1.26***	
mercedes			1.68***
bmw			1.42***
audi			1.01***
jaguar			0.88**
vw			0.55*
honda			0.48*
daihatsu			-0.62*
Hansen J-statistic	Chi-sq(1) p-val=0.62	Chi-sq(1) p-val=0.78	Chi-sq(4) p-val=0.37

Source: own estimations

Note: ***, **, * mean significance at 1%, 5%, and 10% levels, respectively. Spec.

A: without a new model and premium brand dummies. Spec. B: with a new model dummy and a premium brand dummy. Spec. C: with a new model dummy and brand (manufacturer) dummies. For brand dummies only statistically significant variables are presented. Kia is used as a reference group.

The table shows that the parameters of most characteristics are of expected sign and statistically significant. Engine power, presence of transmission-slip control (ASR) and ABS system, the number of doors, some fancy decoration and being a diesel model positively impact the mean valuation of consumers, while the number of defects has negative impact. The engine power appears to be not always significant[23]. The coefficients for specifications B and C appear to be quite similar in magnitudes. The price coefficient is of similar magnitude in all specifications[24].

The magnitude of the segment correlation parameter is less than 1, and, thus, it is consistent with random utility maximization assumption. The magnitude of the correlation coefficient can be interpreted as some evidence for the rather low correlation of consumer preferences, or low degree of substitution among the products within the segments, so that the products within the market segment are not perfect substitutes. This can be interpreted as rather not isolated competition in the market segments. However, the preferences are, still, more correlated for the cars of the same market segment than for the cars of different market segments (because 0.28-0.43 is significantly different from zero).

The impact of the premium brand and new model on the market shares is positive and statistically significant in Specification B. The brand dummies for premium producers, Mercedes, BMW, and Audi, as well as a new model dummy are also statistically significant and positive in Specification C. This implies that German premium producers have a competitive advantage over other domestic and foreign volume producers. Besides, consumers value "newness", or "fashion" of a car as indicated by the significance of the new model dummy coefficient. The new model variable may also capture the positive effect of a broader choice of products as well as improved/increased quality of the existing products.

Based on the estimation results, Mercedes enjoys the highest market power, followed by BMW and Audi. This estimated ranking of premium brands seems to be consistent with the tastes of German customers. This ranking also reflects the reputation ranking constructed by the ADAC[25]. This may say in favour

[23] A similar problem has been also encountered in other studies (e.g., Verboven, 1996).

[24] Fershtman and Gandal (1998) have also found a rather lower price coefficient: $\alpha = 2.1x10^{-6}$ and $\sigma = 0.70$ in the one-level nested logit. The low price coefficient, of a similar magnitude, has been found by Bresnahan et al. (1997). I have found the price coefficient of a similar magnitude in my panel data estimations of the one-level nested logit for the US automobile market (Leheyda, 2007). The magnitude may be, however, not so surprising. This is not the direct measure of the price elasticity of demand. The coefficient rather gives the constant proportional, or relative change in the market share ratio for a given absolute change in the value of price. The magnitude of the variables can be also connected to the scaling of variables.

[25] In general, there exists a number of rankings on brand loyalty and reputation. According to the ADAC ranking, the brands with the highest reputation are Mercedes, BMW, Audi, VW, Porsche and Volvo. The ranking of cars is also available from Auto Motor and Sport magazine (Auto Motor and Sport, 2006). According to this publication, Mercedes, BMW,

of the correctness of my model specification. The other statistically significant positive coefficients are for Jaguar, VW, and Honda. Jaguar and VW are also among the top 10 brands in Germany. There is also a statistically significant negative coefficient for Daihatsu.

To sum up, brand-name reputation and new models allow the car producers to get higher market shares. Competition is not localized within market segments.

Supply estimation

The pricing and marginal cost equations can be found in Table 7. The supply side is estimated under three assumptions concerning the firms' equilibrium interactions: competitive, single-product, and multi-product. The coefficients of the attributes in the hedonic price regression can be interpreted as average marginal implicit prices for each attribute. ABS and a diesel motor contribute most to the price of a car among the technical characteristics in the specification. In the marginal cost equations, the higher the value of a car model characteristic, the larger is its impact on the marginal cost. As it can be seen, ABS and a diesel motor contribute most to the marginal cost of a car. In general, the technical characteristics contribute significantly to the prices and marginal costs. The brand dummies could be viewed as the relative price markup that a customer is willing to accept for the brand of his car as compared to what he would be willing to pay for an equally equipped reference car (in my estimations this is Kia).

Table 7. German automobile market: pricing/marginal cost equations estimations

Porsche and Audi have enjoyed the highest rankings in 2003.

Variable	Competitive	Single-product	Multi-product
engine power	0.01***	0.01***	0.01***
doors	0.01***	0.02*	0.02***
asr	0.07***	0.11***	0.10***
abs	0.17***	0.39***	0.37***
decoration	0.12***	0.17***	0.18***
leather seats	0.06***	0.09***	0.10***
navigation	0.12***	0.14***	0.12***
diesel	0.13***	0.19***	0.19***
mercedes	0.52***	0.74***	0.68***
mitsubishi	0.36***	0.56***	0.56***
audi	0.34***	0.49***	0.52***
subaru	0.34***	0.56***	0.53***
jaguar	0.33***	0.46***	0.40***
vw	0.32***	0.48***	0.45***
bmw	0.32***	0.48***	0.45***
volvo	0.31***	0.47***	0.44***
saab	0.31***	0.47***	0.44***
honda	0.30***	0.48***	0.47***
nissan	0.26***	0.41***	0.41***
renault	0.25***	0.39***	0.38***
mazda	0.25***	0.40***	0.39***
mgrover	0.23***	0.37***	0.35***
fiat	0.21***	0.34***	0.33***
opel	0.21***	0.34***	0.32***
peugeot	0.21***	0.32***	0.31***
ford	0.20***	0.32***	0.29***
skoda	0.19***	0.28***	0.28***
citroen	0.18***	0.28***	0.27***
toyota	0.17***	0.29***	0.28***
chrysler	0.15*	0.27**	0.25***
seat	0.14***	0.25***	0.25***
hyundai	0.13**	0.21***	0.22***
suzuki	0.10*	0.16	0.17***
daihatsu	0.09	0.09	0.09
daewoo	-0.02	-0.07	-0.06
smart	-0.02	-0.27**	-0.31***
const	8.80***	7.87***	7.79***
R-2	0.87	0.90	0.90

Source: own estimations

Note: ***, **, * - mean significance at 1%, 5%, and 10% significance level, respectively. Kia is used as a reference group.

6.2 Estimation results of two-level nested logit (two nests: market segment and new vs. old model)

The estimation of the two-level nested logit allows me to study the impact of brand-name reputation and new model on the market shares as well as to obtain the estimates of the correlation parameters within market segments and the classes of new and old products in oder to get inferences about competition patterns.

The clustering of products is used to incorporate consumer heterogeneity into the nested logit model. Two principles of differentiation in the automobile markets are explicitly incorporated in the two-level nested logit: differences among market segments[26] and the distinction of being a new product (i.e., a car model specification is introduced into the German car market in 2003). Therefore, the consumer heterogeneity associated with the tastes for a particular market segment and the taste for a new model are explicitly parameterized in the model. Such a principle of differentiation as a new model seems to be quite reasonable. As it has been mentioned, 27% of the interviewed consumers consider being a new model to be an important car purchasing criterion. Another factor used by the construction of image rankings (e.g., the one used by ADAC[27]) is the fact of being a leader in the automobile research, or product development.

Each car is, therefore, evaluated by consumers along three principal dimensions. The first dimension is a market segment (the segmentation is based upon prices, content, etc.). The cars from the same market segment share features such as size and prestige. Second, there are differences between new and old car model specifications. Many people prefer (e.g., because of individuality, or fashion, or desire to have a new sports car version, some additional features) new car model specifications despite the availability of old, or existing in the market car model specifications. The cars from the same subgroup share additional features, e.g., newness, or style. Finally, the individual demand is affected by price and technical characteristics.

The results of the estimations of the two-level nested logit can be found in Table 8. As in case of one-level nested logit, three model specifications have been estimated: base (Specification A), with a new model dummy and a premium brand dummy (Specification B), and with a new model dummy and brand dummies (Specification C).

Table 8. German automobile market: estimations results of two-level nested logit: market segment and new vs. old model

Nests are market segment and new vs. old model

[26] Instead of a premium vs. volume market segment, the market segmentation principle could be used as a more natural way for nests in the consumer purchasing decision. In any case, mini, small and lower middle car segments can be treated as volume car segments as they are dominated by volume brands, and middle and upper middle market segments can be viewed as premium market segments as they are dominated by premium brand sales.

[27] The top 10 brands in this ranking are Mercedes, BMW, Audi, VW, Porsche, Volvo, Renault, Toyota, Opel, and Ford.

Variable	Spec.A	Spec.B	Spec.C
α	-0.000049*	-0.00005***	-0.00007***
σ_{hg}	0.34	0.33***	0.35***
σ_g	0.09***	0.18	0.20*
asr	0.31***	0.37***	0.30***
engine power	0.003	0.005	0.005
doors	0.10***	0.15***	0.16***
abs	0.54**	0.50**	0.36
decoration	0.03	0.14	-0.02
navigation	-0.16	0.28	0.16
diesel	0.27*	0.34**	0.20*
defect	-0.05***	-0.04***	-0.005
const	-8.59***	-8.81***	-9.06***
premium brand		1.10***	
mercedes			1.42***
bmw			1.29***
audi			0.88***
daihatsu			-0.77*
Hansen J-statistic	Chi-sq(2) P-val=0.29	Chi-sq(2) P-val=0.11	Chi-sq(2) P-val=0.13

Source: own estimations

Note: ***, **, * - mean significance at 1%, 5%, and 10% significance level, respectively. Spec. A: without a new model and premium brand dummies. Spec. B: with a new model dummy and a premium brand dummy. Spec. C: with a new model dummy and brand (manufacturer) dummies. For brand dummies (Specification C) only statistically significant variables are included. Kia is used as a reference group.

The magnitude and ranking of the correlation parameters are consistent with random utility maximization assumptions. The correlation of the consumer preferences within the subgroup (new, or old car model specifications class) is higher that the correlation of the consumer preferences in the group (market segment). Competition between new cars and old cars is relatively weak as there is some difference between the correlation parameters σ_{hg} and σ_g. Consumer preferences are more correlated for the cars of the same subgroup (0.35) than for the cars from the same market segment but a different subgroup (Specification C). This means that consumers have more homogenous valuations concerning the cars that come from the same subgroup (new vs. old) than for the cars just from the same market segment. Thus, there appears to be some additional segmentation or differentiation between new and old models. The preferences are more correlated for the cars of the same market segment than for the cars from different market segments since 0.20 is significantly different from zero (Specification C). Similar to the one-level nested logit results, there is some evidence for not isolated competition in the market segments.

The premium brand dummy has a positive statistically significant impact on the market shares. Similar to the estimations results of the one-level nested logit, Mercedes, BMW and Audi enjoy considerable brand-name reputation power as compared to all other car manufacturers.

To sum up, as in case of one-level nested logit, brand-name reputation and new model lead to the higher market shares. In addition, there appears to be some additional differentiation around new/old products, which may allow the automotive firms to get some market power to recoup their investments.

6.3 Estimation results of nested logit with age differentiation

As I have mentioned above, I estimate age-specific nested logits for each age group. In such a way I interact consumer heterogeneity with product characteristics to get more flexible substitution patterns. Each age group has a different price sensitivity that is averaged to a mean price sensitivity using the age-group specific probabilities of purchase as weights.

Taking into account age differentiation (for more discussion, see Section 3.1.1), the demand equation is estimated separately for each age group under three specifications similar to the above estimations: base (Specification A), with a premium brand and a new model dummies (Specification B), and with a new model dummy and brand dummies (Specification C). The same set of instruments is used for each age group. I differentiate between five different age groups: car customers aged up to 29, customers between 29 and 39, customers between 39 and 49, customers between 49 and 59, and customers older than 60 years. The estimation results of the one-level nested logit with age differentiation for base specification A (without a new model and premium brand dummies) can be found in Table 9[28].

The most important for me are the estimates of the price and correlation parameter coefficients that are further used in the calculation of substitution patterns and markups. The higher absolute values of price and segment correlation coefficients imply higher elasticities of substitution. Lower price sensitivity for premium products should drive down their elasticities. It has been found that price sensitivity coefficient, in accord with a priori expectations, decreases with the age of customers. Price sensitivity is the largest for the youngest age group. Price age sensitivity is to a great extent linked to price income sensitivity as there will be a positive relationship between the age of customer and his income up to a certain age. The preferences of customers older than 60 and young customers up to 29, are least correlated (0.19 and 0.27, respectively), so that the products are perceived to be the least substitutes by these customer groups. The lower estimated price coefficient and correlation parameter for the age group of people older than 60 could be attributed to especially large consumer heterogeneity in the old age market segment[29]. This large consumer

[28] As for the two-level nested logit estimation with age differentiation, where the two nests are the market segment and new vs. old model, it has been difficult to get the results, consistent with random utility maximization.

[29] Marketing studies show that older customers have other demand preferences towards car

heterogeneity could be explained by the higher incomes of older people, their higher valuation of brand, and their ability to afford themselves some different from others model due to e.g., the previously saved incomes. The lower segment correlation coefficient for the customers up to 29 may be also reasonable to expect: young customers, although mostly with low incomes, are likely to strive for individuality. The preferences are most correlated for the customers of 29-39 and 39-49 age groups (0.33 and 0.34, respectively). In general, the pattern of the correlation parameters is consistent with apriori expectations.

Table 9. German automobile market: estimation results of age-specific models (one-level nested logit, nest is market segment)

Specification A: base (without premium brand and new model dummy)

Variables	up to 29	29-39	39-49	49-59	older than 60
α	-0.00013***	-0.00007***	-0.00006***	-0.00005**	0.000008
σ_g	0.27***	0.33***	0.34***	0.31***	0.19**
asr	0.25***	0.29***	0.30***	0.33***	0.40***
engine power	0.01***	0.00	0.00	-0.00	-0.02**
doors	-0.02	0.13***	0.12***	0.10***	0.08*
abs	0.44**	0.47**	0.43**	0.55***	0.65**
decoration	-0.02	-0.06	-0.08	-0.00	0.06
leather seats	-0.02	-0.03	-0.04	-0.01	-0.04
navigation	-0.63***	-1.09***	-0.47**	-0.41*	-0.41*
diesel	0.62***	0.34***	0.23***	0.02	-0.69***
defect	-0.03***	-0.04***	-0.05***	-0.05***	-0.07
media	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
const	-10.43***	-9.58***	-8.92***	-9.04***	-9.98***
Adj. R2	0.50	0.57	0.60	0.56	0.44

Source: own estimations

Note: These are the GMM estimation results with robust standard errors. ***, **, * - mean significance at 1%, 5%, and 10% significance level, respectively.

Table 10 presents the results of the estimations for Specification B when both premium brand and new model dummies are included into the estimated model specification. The pattern of the correlation parameters and price sensitivity is similar to the one estimated on the basis of Specification A.

The coefficients for a new model are the highest for 49-59 and older than 60 groups of customers. They are very low for the customers up to 29 years old. The young customers may also tend to buy used cars, the market for which is, however, not modelled in this paper.

There is a substantial price premium paid for premium cars. Brand dummy coefficient is the highest for the older than 60 customers, followed by the younger

design and equipment and that they are more brand-loyal as compared to younger car customer groups (Autohaus, 2006). The car comfort is very important for them.

customers (up to 29). The high premium brand coefficient for the young customers could be somewhat rather unexpected, but it may be attributed to high preferences towards BMW and Audi as it could be inferred from the high shares of those cars in the total sales of this age group. Mercedes cars make up a lower share in the sales of this age group as compared to the older age groups. But it can be seen that older car customers have strong preferences for new and premium car models.

Table 10. German automobile market: estimation results of age-specific models (one-level nested logit, nest is market segment)

Specification B: with premium brand and new model dummies

Variables	up to 29	29-39	39-49	49-59	older than 60
α	-0.0002***	-0.00012***	-0.00011***	-0.00009***	-0.00005
σ_g	0.24***	0.32***	0.32***	0.30***	0.15
new model	0.08	0.21**	0.23***	0.30***	0.35***
premium brand	1.14***	1.02***	1.00***	1.05***	1.21***
asr	0.29***	0.33***	0.32***	0.35***	0.44***
engine power	0.02***	0.00	0.01	0.00	-0.01
doors	0.05	0.20***	0.18***	0.17***	0.16***
abs	0.31	0.45*	0.34	0.43*	0.46
decoration	0.06	0.01	-0.02	0.07	0.14
leather seats	0.23***	0.21***	0.21***	0.26***	0.25***
navigation	-0.23	-0.95***	-0.17	-0.06	0.11
diesel	0.70***	0.36***	0.27***	0.06	-0.68***
defect	-0.03***	-0.03***	-0.04***	-0.05***	-0.06***
media	-0.00***	-0.00***	-0.00***	-0.00***	-0.00**
const	-10.62***	-9.71***	-9.08***	-9.16***	-10.17***
Adj. R2	0.45	0.56	0.57	0.54	0.41

Source: own estimations

Note: These are the GMM estimation results with robust standard errors. ***, **, * - mean significance at 1%, 5%, and 10% significance level, respectively.

The estimation results for specification C when brand dummies and a new model dummy are included can be found in Table 11. The expected ranking of Mercedes, BMW and Audi has been found as above. The highest preferences for Audi are by up to 29 customers. The car customers between 29 and 39 value BMW and Mercedes most among all customer groups. Each age group values Mercedes cars most of all. VW is most valued by youngest car customers. Peugeot and Renault coefficients are both highly significant and positive for the youngest car customers, the same is true for Skoda and Seat. As for consumer preferences towards Japanese car brands, the German car customers seem not to value them as much as domestic brands. Nissan coefficient has been found not to be significant at all. Toyota has been found positively significant by 39-49 and 49-59 age customers. Only Honda has been found to be quite highly valued by the German car customers. Domestic and Japanese cars may, therefore, have different images by the German car customers.

Table 11. German automobile market: estimation results of age-specific models (one-level nested logit, nest is market segment)

Specification C: with brand dummies and a new model dummy

Variable	up to 29	29-39	39-49	49-59	older than 60
α	-0.00021***	-0.00017***	-0.00014***	-0.00012***	-0.000079***
σ_g	0.35***	0.40***	0.45***	0.42***	0.30***
new model	0.17*	0.23***	0.23***	0.27***	0.29***
asr	0.18*	0.16*	0.23***	0.28***	0.35***
engine power	0.03***	0.02***	0.02***	0.01**	0.00
doors	0.07*	0.18***	0.15***	0.14***	0.12***
abs	0.33*	0.40**	0.45***	0.44**	0.61***
decoration	0.04	0.05	0.01	0.06	0.11
leather seats	0.29***	0.30***	0.24***	0.26***	0.30***
navigation	-0.01	0.04	0.26	0.31	0.29
diesel	0.65***	0.48***	0.31***	0.16	-0.46***
defect	-0.09***	-0.02	0.01	0.01	-0.06**
media	0.00**	0.00	-0.00	0.00	-0.00
const	-9.40***	-9.54***	-9.19***	-9.37***	0.49***
audi	1.37***	1.26***	0.91***	1.00***	0.81***
bmw	1.64***	1.73***	1.27***	1.32***	1.02***
citroen	0.92*	0.56	0.05	0.07	0.00
daewoo	-0.46	-0.47	-0.51	-0.65*	-0.85*
daihatsu	-0.96**	-0.64	-0.47	-0.48	-1.25***
mercedes	1.87***	1.92***	1.81***	1.91***	1.26***
chrysler	-1.25*	-0.70	-0.69	-1.15*	-0.24
fiat	0.77*	0.30	-0.07	-0.10	-0.43
ford	0.64	0.41	0.20	0.31	0.24
honda	0.76**	0.69**	0.62**	0.60*	0.30
hyundai	-0.20	-0.23	-0.26	-0.22	-0.21
mazda	0.32	1.03*	1.28**	1.29**	0.14
mgrover	0.26	0.60	0.64	0.63	-0.76
mitsubishi	0.54	-0.47*	-0.90***	-0.83	-0.12
nissan	0.01	0.63	0.59	0.55	-0.25
opel	0.73*	0.05	0.15	0.32	0.19
peugeot	1.25***	0.45	0.19	0.24	0.26
renault	1.04**	0.73	0.29	0.26	0.15
saab	-0.19	0.57	0.12	0.18	-0.85***
seat	1.13**	-0.26	-0.20	-0.01	-0.29
skoda	1.13***	0.10*	-0.25	0.37	-0.11
smart	-1.02**	0.72	0.38	0.33	-1.65***
subaru	-0.47	0.14	0.16	0.42	-0.35
suzuki	-0.65*	-0.26	-0.09	0.10	-0.15
toyota	-0.17	0.30	0.42*	0.53**	-0.29
vw	1.23***	0.94***	0.59*	0.54*	0.23
volvo	0.11	0.03	-0.07	-0.10	-0.52
Adj. R2	0.60	0.62	0.68	0.67	0.61

Source: own estimations

Note: These are the GMM estimation results with robust standard errors. ***, **, * - mean significance at 1%, 5%, and 10% significance level, respectively.

To sum up, the qualitative conclusions concerning brand-name reputation and new products are similar as in case of more restricted nested logits. Some additional inferences have been obtained about the role of brand-name reputation and new car models for different types of customers depending on their age. The estimated price and correlation parameters coefficients are further used in the construction of the matrix of own- and cross-price elasticities and calculation of markups, which is discussed in the next section.

6.4 Analysis of substitution patterns and markups

The results of the estimated own-price elasticities on the basis of the age-specific nested logits can be found in Table 12. They are first calculated separately for each age consumer group (up to 29, between 29 and 39, between 39 and 49, between 49 and 59, and older than 60) and then the weighted averages are calculated (the weights are determined by the share of the population of the given age in the total population). It has been found that the own-price elasticities are the lowest for the older car customers, which could be already inferred from the pattern of the above discussed price and correlation parameters estimates of demand. The youngest car customers are most price-sensitive.

Table 12. German automobile market: comparison of own-price elasticities at market segment level for age groups (one-level nested logit with age differentiation)

	up to 29	29-39	39-49	49-59	older than 60	weighted	nested logit
TOTAL	8.30	7.21	6.26	5.37	2.83	6.14	4.30
new	8.94	7.78	6.75	5.79	3.05	6.62	3.94
old	8.18	7.11	6.17	5.29	2.79	6.05	4.26
MINI	3.89	3.38	2.93	2.52	1.33	2.88	2.01
new	4.49	3.90	3.38	2.90	1.53	3.32	2.32
old	3.83	3.32	2.88	2.47	1.31	2.83	1.98
SMALL	4.92	4.28	3.72	3.19	1.68	3.65	2.55
new	4.99	4.34	3.76	3.23	1.70	3.69	2.59
old	4.91	4.27	3.71	3.18	1.68	3.64	2.55
LOWER MIDDLE	7.04	6.13	5.32	4.56	2.41	5.22	3.65
new	7.32	6.37	5.53	4.74	2.50	5.42	3.80
old	7.02	6.10	5.30	4.55	2.40	5.20	3.64
MIDDLE	9.58	8.33	7.23	6.20	3.27	7.09	4.97
new	9.99	8.69	7.54	6.47	3.41	7.40	5.18
old	9.44	8.21	7.13	6.12	3.22	6.99	4.90
UPPER MIDDLE	13.35	11.61	10.08	8.65	4.56	9.89	6.92
new	12.28	10.67	9.26	7.94	4.19	9.09	6.36
old	13.53	11.76	10.21	8.76	4.62	10.02	7.01

Source: own estimations

Note: Under 'nested logit' the estimates of the own-price elasticities from one-level nested logit (nest is market segment) are presented.

The average own-price elasticities for age groups go down in magnitudes for all market segments as one goes to the older age groups. But within the age group, one gets higher own-price elasticities as one moves to the larger car segments. This could be, on the one hand, a limitation of a nested logit estimation[30]. On the other hand, these results might be true, e.g., one could expect higher elasticities in the middle car segment, which is overcrowded with products and where fierce competition could be expected. The alternative explanation could be that including consumer heterogeneity into the demand equation does not always help to get the substitution patterns that one would expect a priori (here individual-level data could be then rather preferred). It should be also mentioned that the empirical studies do not give a one-way answer on the magnitude of the elasticities and markups. In particular, Jaumandreu and Moral (2006) also find higher elasticities and markups for the larger car mar-

[30]Namely, higher prices imply higher own-price elasticities. The problem of cross-price elasticities is solved with respect to the car models in the other market segments, but not within the same market segment. The independence of irrelevant alternatives (IIA) property implies that the customers will tend to substitute away, say from Mercedes, to the other popular cars as measured by the market shares, and not to the other similar products.

ket segments on the basis of the BLP random coefficients demand estimation (following Berry, Levinsohn and Pakes, 1995). The range of their own-price elasticities ranges from 2.72 for the small cars to 3.84 for the cars in the luxury car segment. The range of the price-cost margins is from 64% for the small cars to 38% for the luxury cars. Mariuzzo (2005) also finds lower price elasticities in the small car segments on the basis of the random coefficients model estimation, which he interprets as the higher market power in those market segments.

Higher own-price elasticities for the new models than for the old models have been found in the mini, small, lower middle, and middle car market segments. Only in the upper middle car market segment the own-price elasticities for the new car models are lower than those for the old car models. This market segment is dominated by the premium class models. The best-selling models in this segment are Mercedes E-Class, BMW 5er, and Audi A6/S6. Therefore, it could be an indication that the new and branded models are protected from competition from the old and volume car models, so that the competition in the new models subgroup of the upper middle market segment is rather limited as it could be inferred from the estimated elasticities.

As compared to the own-price elasticities estimated on the basis of the restricted one-level nested logit, I have got somewhat higher own-price elasticities on the basis of the estimated age-specific nested logits. But the pattern of the own-price elasticities for the new and old car models has remained the same, except for the average own-price elasticities for new and old models in the total German car market.

The pattern of markups for different market segments, also calculated on the basis of the age-specific nested logits, can be found in Table 13. The markups (under single-product Bertrand-Nash assumption) are calculated separately for each age group and then the weighted averages are calculated using the shares of the car sales of each particular age group in the total car market sales (for private persons only).

The pattern of markups for new and old models varies across customer groups and across market segments. The markups are higher for the larger car market segments. They are higher for the new products in the mini and middle car market segments. The best selling cars in the mini car segment are Renault Twingo, Smart and VW Lupo, while in the middle class these are BMW 3er, VW Passat, and Mercedes C-class. The middle car segment is characterized by the highest number of introduced new models and new models sales in the total segment car sales. High competition may be expected in this market segment so that the new products introduction may somehow allow the firms to get some market power to recoup their investments, notwithstanding high competition in this market segment.

Table 13. German automobile market: comparison of markups at market segment level for new and old models (one-level nested logit with age differentiation)

	weighted mean	std.dev.	min	max	nested logit mean
TOTAL	5262.54	882.23	3463.50	8823.35	5817.26
new	5226.81	893.57	3694.94	7327.63	5816.63
old	5269.20	880.39	3463.50	8823.35	5817.23
MINI	4737.59	510.30	3795.44	5982.14	5868.52
new	4785.62	339.22	4454.95	5256.32	5867.29
old	4732.25	529.16	3795.44	5982.14	5868.65
SMALL	4892.80	622.63	3631.25	7201.16	5818.12
new	4665.88	463.18	4023.61	5663.12	5818.09
old	4928.18	637.68	3631.25	7201.16	5818.13
LOWER MIDDLE	5215.28	949.13	3493.49	8823.35	5813.93
new	4844.63	938.25	3694.94	7323.50	5812.85
old	5249.79	944.13	3493.49	8823.35	5814.03
MIDDLE	5434.46	882.99	3463.50	7988.76	5813.10
new	5456.82	902.41	4034.45	7327.63	5814.74
old	5427.24	877.98	3463.50	7988.76	5812.57
UPPER MIDDLE	5546.23	865.46	4023.38	7795.33	5821.59
new	5515.84	781.05	4486.07	6908.14	5819.00
old	5551.19	880.93	4023.38	7795.33	5822.01

Source: own estimations

Note: Under 'nested logit mean' the markups calculated on the basis of the restricted one-level nested logit are presented.

As compared to the markups calculated on the basis of the restricted one-level nested logit, there is more variety in the markups calculated on the basis of the age-specific nested logits.

To sum up, it has been difficult to get a full comprehensive analysis of the pattern of the elasticities and markups on the basis of the above estimates, which has been initially planned. The IIA property appears not to have been solved completely within the nests. The results might be improved through extending the time dimension of the dataset and introducing more consumer heterogeneity within random coefficients framework. The numder of markets and other sources of identification are very important in such type of estimations.

7 Conclusions

The automobile industry is one of the most innovative sectors in the economy and has become also very competitive in spite of its oligopolistic market structure. The automobile industry is characterized by a lot of new products introductions and considerable product proliferation. Besides, the triad traditional automotive markets (Japan, USA, and Western Europe) are very satiated markets and are mostly driven by car replacement purchases. Thus, there should be some market power enjoyed by the automobile manufacturers to be able to pay for costly (and often risky) innovations and new products introductions.

The major approach pursued in this paper to study the effects of new products introduction has been to evaluate the competition pattern in the new and old models classes and look at the interaction in the competition between them as well as to study the impact of new models and premium brand on market shares.

I have found that in general both new products and brand-name reputation allow the automobile manufacturers to increase market shares. My results are similar to the results by Bresnahan et al. (1997), which is the closest study for the comparison of the results. It should be emphasized that the focus of the paper, as compared to the above and other studies, has been not on drastic innovations, or drastic changes in the quality of the existing products, but rather on incremental ones. The methodology has allowed me to draw some implications whether the proliferation strategy by the automotive manufacturers pays off, and what the effect of additional product variety is. The approach pursued in this paper appears to be the most suitable one to study the role of brand-name reputation and new models in the German car market given the data restrictions that I have got.

I have found that both premium brand, and new products may increase demand market shares. This is in line with an already rather standardized fact that premium car producers are drivers of modern technology. This could support the fact that the two sources of market power may be quite interlinked in the automobile industry: continuous innovation, which is embodied in the introduction of new products, leads to higher brand-name reputation in the automobile industry, while the protective umbrella of a brand may be extended over the new products. Brand-name reputation is very important in the automobile industry. Brand differentiation may limit the intensity of competition in the automobile industry.

When a new principle of differentiation such as new vs. old model is added to the market segment differentiation, there appears to be some additional market fragmentation with respect to new vs. old model. Competition is not isolated in the new or old models segments. Presence of substantial heterogeneity of consumer preferences implies that new and premium products can be protected from competition from old and volume products. The groups of old and new products coexist, neither eliminating each other. Premium brand allows the firms to get higher markups in general and on new products. Therefore, the automotive firms might have enough incentives for new product development.

Rather low correlation of consumer preferences has been found, which can be interpreted as a sign of rather not isolated competition between the products within the market segments. This may bear implications for the use of market segment definitions by industry and authorities representatives. Consumer tastes are quite differentiated. The product space is quite overcrowded with different models. Products overcrowdedness may contribute to the higher products rivalry and lower rents than otherwise obtained. The firms may cannibilize each other's profits by introducing a lot of similar products. To study this issue more profoundly, the estimation of more reliable substitution patterns could be worthwile. The analysis of own- and cross-price elasticities has been somewhat limited in this paper.

To sum up, a new model and brand-name reputation may allow the innovative firms to get some market power and recoup their investments, so that there is some reward for a new model specification. Competition is, however, not localized within a market segment and the class of new, or old models, i.e., consumers are rather heterogenous based on these principles of differentiation.

The differentiated products demand in this paper has been derived from the discrete choice framework. The use of the multinominal nested logit model in this paper, except for its computational tractability, can be justified by the dependence of the substitution effects between the cars on the predetermined classes of products in the automobile industry as well as an attractive way to address the posed issues within this research project.

Some consumer heterogeneity has been introduced into the model through incorporating consumer age differentiation that allows for more flexible substitution patterns without adding up any computational burden (I use the information on sales for different age groups and federal territories in Germany for this purpose). The estimation of age-specific nested logits has allowed me to study the demand for cars across age groups and differentiate between the impact of a premium brand and a new model on different types of customers. Youngest and oldest car customers appear to care most about a premium brand. Older car customers have been found to have strongest preferences for new and premium products.

Product characteristics are treated to be exogenous in this model. The questions are addressed within a static framework. The discounted value of rents in each period will determine the private incentives to innovate. The measurement of transitory market power in each period can contribute to understanding innovative investment in dynamic markets (Bresnahan et al., 1997). The decision where a firm should put a car in the product space is not modelled in this paper. However, the static models could be estimated for separate years and could be viewed as a proxy for optimal dynamic decisions. New goods introduction and termination of old models should be viewed as a joint decision. Simulations could be performed in the future for all models in 2003 dataset and all models in 2003 dataset plus models that have been terminated in the previous years if the data become available. The change in producer variable profits could be then investigated in an intertemporal context. This could allow getting better approximation of the rents from innovative investment.

Usually empirical studies find low general welfare effects, in particular effects on the consumer welfare, when the new products do not differ significantly from the existing products. The evaluation of the consumer welfare (whether the new models lead to the improvements in the consumers' standard of living) could be, however, a possible research extension of this paper to verify the findings of the previous studies.

A new product introduction, especially the introduction of a product very different in quality from the existing products may have dynamic effects, e.g., it may evolve the creation of a whole new market segment (involving subsequent 'me-too' introductions). The car manufacturers may immitate/follow each other in the introduction of models (e.g., by size, or characteristics). As I have got only one cross-section of data, this in the first turn has prevented me from studying these effects. Petrin (2002) has studied the effects of new models introduction for the US car market on the basis of the static models (minivan introduction, evaluating innovators' and immitators' payoffs). The author estimated that the profits from the minivan introduction exceeded the reported costs of its development by far. The effects of the similar, or other "me-too" strategies could be evaluated in the future studies on the basis of entry and profitability models for the car industry. This research paper has been rather limited in terms of the data available to study such effects.

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Chapter 5. Conclusions and Future Research

Conclusions and Future Research

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April 14, 2008

1 Summary of conclusions

In my dissertation I have focused on competition trends and new products developments in the automobile markets. In the first essay I have investigated the mutual forbearance hypothesis and firm equilibrium interactions in the US automobile market. In the second essay I have focused on the impact of the degree of geographical and multiproduct market linkages on the firm behaviour in the European car market. In the third essay I have looked at the innovation and competition patterns in the German automobile market. In this section I present the overview of the major conclusions from these three papers.

The study of the extent of the competition in any industry has both academic and policy interest. In the first two essays some inferences have been derived about the firm behaviour and equilibrium pattern in the US and European car markets.

I have found that multimarket contact may influence competition in the US automobile markets and may increase the firms' strategic interdependence. This effect is, however, difficult to disentangle from the effect of the market concentration in the US automobile market (dominance of the market by the American Big Three) on the firm behaviour. In other words, it is difficult to argue whether coordination is due to market concentration, or due to multimarket contact, or it can be attributed to both. Concentration is argued to foster the slack, which is transferred through the multimarket contact.

A major difference of this study to the other papers on the US automobile market is that I study the behaviour of different coalitions of firms in the US car market on the basis of the multimarket contact differentiation and try to derive some more complex picture of the firm interrelationships rather than just assuming oligopolistic interactions in the form of single-product, or multi-product Bertrand Nash equilibrium (and not considering at all other possible market equilibria). In particular, the previous automotive studies have not considered the possibility of collusive behaviour, except for the early studies by Bresnahan (1981, 1987). These early studies have found support for collusive behaviour in the US automobile industry for separate years. Feenstra and Levinsohn (1985) and Bresnahan (1987) seem to be the only studies that have applied the statistical tests to choose the equilibrium competition pattern to best describe the firm behaviour in the US car market.

The second paper investigates the link between multimarket contact and firm performance in the European car market. As compared to the first paper on the relevance of the mutual forbearance hypothesis for the US light vehicles market, in this paper the longer period of time and a greater number of markets allow me to study a richer number of the research objectives (including the strategic effects of the multimarket contact) and apply other approaches to study the multimarket contact (as well as concentration) effects on the firm behaviour. Geographical aspect of the multimarket contact is added to the multi-product context of the automotive industry, which increases the number of markets, across which the automotive firms interact.

The results of the study on the multimarket contact effects in the European car market reveal some weak quantitative effect of multimarket contact on competition in the European car market as well as provide some evidence on the redistribution of the market power from the more collusive to the more competitive markets. In this study, as compared to the other existing studies on the mutual forbearance hypothesis, I use both 'menu' and 'conjectural variation' approaches to identify the firm behaviour pattern in the European car market. I have tried to study the impact of internal (e.g., concentration) and external (e.g., multimarket contact) factors on the prices and market conduct parameters. To the best of my knowledge, it has been done for the first time in case of differentiated products models. Possible coalitions of multimarket contact firms have been pointed out and tested. As compared to the European car market papers (e.g., Verboven, 1996, Goldberg and Verboven, 2001, Brenkers and Verboven, 2006 a,b), I have tried to investigate more complex firm equilibrium interactions in the European car market and develop further the methods of the identification of the firm behaviour in the European car market.

A puzzle concerning firms' interactions in the automobile industry still remains given the weak (although statistically significant) economic effect of the multimarket contact on the firm behaviour. It seems to remain unclear whether the multimarket contact plays a large role but other methods are required to identify this effect, or whether it is so extensive that the firms do not care about it at all, thus, it has no implications for the firms' equilibrium interactions. The argument of extensive multimarket contact may hold true for other industries as well, where, however, a stronger quantitative effect of multimarket contact on the firm behaviour has been found.

Market conduct studies have been quite limited due to the rather unsatisfactory performance of statistical tests to choose the pattern of the firm behaviour given the absence of real industry markups. The performance of the statistical tests is problematic since several hypotheses can be accepted or rejected as I could see from my experience, and one has to choose some subjective criterion to pick up the model specification that best describes the data at the end. Notwithstanding all the weaknesses, the market conduct studies appear to be interesting from the academic point of view. Their conclusions could be useful for antitrust authorities.

Economics of new goods is another interesting subject that I have pursued in the third essay of my dissertation. The automobile industry has been recently characterized by a lot of product variation and proliferation. The effects of the new products introduction have been investigated on the basis of the German car market, which is a very innovative market and which is clearly segmented into premium and volume car brands. The investigation of the introduction of new products usually involves the evaluation of producer and consumer welfare. In this paper I have focused on the private incentives to innovate and linked it to the role of brand-name reputation. The question here involved whether the new products compete with the existing products, or they form a new market niche, and, thus, face less competition from the existing products. This could allow the firms to get some market power to recoup their investments.

As compared to the papers by Petrin (2002) and Berry, Levinsohn and Pakes (2004), who study the introduction of new products in the US automobile industry, the focus of this study has been not on drastic but rather on incremental innovations/changes in the quality of the existing products, and on the private incentives to innovate. This is also the major difference to the other new products papers (e.g., Bresnahan et al., 1997). As compared to Petrin (2002) and Berry, Levinsohn and Pakes (2004), other empirical approaches are used to investigate the effects from new products introduction in the automobile industry. The role of brand loyalty in the ability of the automotive firms to maintain and/or increase their market shares has been also addressed in the paper.

It has been found that both a new model and brand-name reputation may allow the innovative firms to get some market power and recoup their investments. Competition is, however, not localized within a market segment and the class of new, or old models, i.e., products from different market segments, new and old products compete with each other and do not constitute separate market niches. On the other hand, new (old) models are perceived to be closer substitutes than old (new) models. Consumers appear to value the broader choice of new products as well as improved/increased quality of the existing car models. They also value premium brands (Mercedes, Audi, BMW) more than volume ones. Domestic car brands are more highly valued by the German car customers than foreign car brands.

The results of my study show also different attitude of consumers towards brand, new products and product characteristics depending on their age. These inferences could be useful for the OEMs in their product development policy. Population ageing in Germany may play an even higher role in the new car development in the future.

The methodology that has been applied in my paper proves to be useful to study the private incentives to innovate and could be pursued in other studies, for other industries. I have found the results similar to Bresnahan et al. (1997) that both a new model and brand name influence market shares. This could be interpreted as the reason for why the premium/branded producers are the leaders in innovation and technology: they rely on continuous innovation to build up and maintain their brand-name reputation, on the other hand, they can extend premium brand umbrella over their new products. The existing literature on the new products in general and for the automotive industry in particular is in the infancy stage. There are some more interesting topics that could be pursued in the future (they are discussed below).

Finally, the estimation of the discrete choice models on the demand side in all three essays of my dissertation has allowed me to derive some implications about consumer preferences. In the German car market the consumers are rather heterogenous within a market segment (on the basis of a separate study for the German car market in 2003). The consumer preferences in the US (data for 2001-2003) and European (data for 1970-1999) car markets are strongly correlated within a market segment. The higher the correlation of consumer preferences within a market segment is, the closer substitutes the products are perceived to be in that market segment, the more competitive behaviour within the market segments could be expected.

Consumer heterogeneity is important in the estimation of discrete choice models in order to get reasonable substitution patterns. An important source of consumer heterogeneity is income. Higher-income consumers are less price-sensitive and are more willing to buy high-quality premium cars. The information on the income distribution has been used to identify the demand pattern in the US and European car markets. Age heterogeneity is another important source of consumer heterogeneity in the automobile markets: depending on their age, consumers have different preferences towards car models and their characteristics. This source has been exploited to identify the substitution patterns in the German car market. This approach has allowed me to introduce consumer heterogeneity and its interactions with product characteristics into the model in a flexible way.

2 Future research

More generally (in addition to the more concrete suggestions to extend the current papers that have been pointed out in the main text of my dissertation), there are several groups of topics that could be pursued in the future in the direction of the further investigation of the automobile industry and the estimation of the structural oligopoly models with product differentiation.

With respect to the market conduct studies, the firm behaviour during recessions and booms in the European car market could be investigated in more detail. The long period of time covered by the dataset could allow identifying the periods of more collusive and more competitive behaviour and linking it to the existing theories of the pricing behaviour during booms and recessions. Some references in this respect are Rotemberg and Saloner (1986), Haltiwanger and Harrington (1991), Knittel and Lepore (2006), etc.

The second group of topics is related to the further investigation of new products effects. Here two areas could be looked at in more detail for the European car market: the introduction of new products on the basis of static models and entry and profitability of firms on the basis of dynamic models. The new products are here implied rather in the sense of entirely new car models that have been introduced into the European car market during 1970-1999. My present paper concentrates on the introduction of new model variants and versions, i.e., more incremental changes in the quality of the existing products. In addition to the private incentives to innovate (first-mover advantage and profit dissipation for followers), social welfare could be measured, which is expected to be high in case of entirely new products.

The impact of brand-name reputation across countries and affiliation of domestic buyers towards domestic brands and attitude towards foreign brands (investigation of the liability of foreigners across the European car market) could be investigated. In addition, the dataset allows differentiating between model predecessors and successors, so that customers' expectations might be investigated, in particular, whether they postpone a car purchasing decision while awaiting model changeovers.

As for the entry and profitability models, one could start with two-stage entry models (e.g., Bresnahan and Reiss, 1991, Berry, 1992) and move to the development of the more advanced two-stage entry models (e.g., Mazzeo, 2002, Seim, 2004) and/or more complex dynamic models (e.g., Pakes, Porter and Wolfram, 2003, Pakes, Ostrovsky and Berry, 2005). Brand as a dynamic concept could be investigated in those models. The development of the dynamic models remains a very challenging but promising in terms of possible important academic contributions field.

Modeling manufacturer-retailer relationships could be also another interesting topic for future research, as well geographical product differentiation in the car market (on the basis of the available data on sales across federal territories (Bundesländer) for the German car market).

Further investigation of the interfirm relationships and their impact on the firm behaviour in the automobile markets (possibly, comparison in these effects importance between the US and European car markets), which has been briefly discussed in the current papers, could be investigated in more detail in the future research.

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