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

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Non-Technical Summary

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. Besides, the triad traditional automotive markets (Japan, USA, and Western Europe) are very satiated markets. 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.

This paper concentrates on studying the introduction of new products in the automobile industry, in particular, on the measurement of the private returns to innovations for automobile manufacturers. 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. On the one hand, margins can be secured temporarily through the launch of new products and the creation of new market niches due to less pricing pressure. 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, the margins can be secured rather permanently through the establishment of strong brands. This generates larger cash flows, which leads to more investment being undertaken by the premium and luxury car manufacturers.

The objective of this paper is thus to look whether there is a reward for innovation in the automobile market. The incentives to innovate are studied for the German automobile market, which is characterized by a high degree of new product introductions to boost sales and a large role of brand-name reputation, being also a lead market for many innovations. The results of the study show a new model and brand-name reputation appear to allow the innovative firms to get some market power and recoup their investments. New products however do not constitute a separate market niche but compete with old models.

Das Wichtigste in Kürze

Die Automobilindustrie ist einer der innovativsten Wirtschaftszweige und zeichnet sich trotz seiner oligopolistischen Marktstruktur [in jüngster Zeit] durch hohe Wettbewerbsintensität aus. Da die traditionellen Triadeautomobilmärkte (Japan, USA und Westeuropa) gesättigte Märkte sind, sollten die Automobilhersteller gewisse Marktmacht aufweisen**,** um teuere und risikobehaftete Innovationen und Neuprodukteinführungen zu finanzieren.

Der Fokus dieses Beitrags ist die Untersuchung von Produkteinführungen in der Automobilindustrie, und insbesondere die Schätzung von Erträgen aus Innovationen. Zwei Ursachen von Marktmacht, die den Unternehmen höhere Gewinne (und damit einen Ausgleich der Investitionen) erlauben, werden untersucht: erstens neue Produkte und zweitens Markenreputation (‚brand-name reputation'*)*. Einerseits können die Einführung neuer Produkte und die Schöpfung neuer Marktnischen die Gewinnmargen vorübergehend aufgrund eines geringeren Preisdrucks sichern. Dies führt zu erhöhten Gewinnen der Investoren bzw. Innovatoren, hat aber auch u.U. Vorteile für den Konsumenten. Andererseits können die Margen eher dauerhaft durch die Etablierung starker Marken gesichert werden. Das generiert höhere Cash-Flows und kann zu höheren Investitionen seitens der Premium- und Luxus-Automobilherstellern führen.

Dieser Beitrag untersucht, ob Innovationsinvestitionen auf den Automobilmärkten lohnenswert sind. Untersucht werden vor allem Innovationsanreize auf dem deutschen Automobilmarkt, der ein LEAD-Markt für viele Innovationen ist. Dieser Markt ist charakterisiert durch den hohen Grad von Neuprodukteinführungen, um die hohen Umsatzsteigerungen zu generieren, und durch die große Rolle der Markenreputation. Die Ergebnisse dieser Studie zeigen, dass ein neues Modell und die Markenreputation den innovativen Unternehmen erlauben können, eine gewisse Marktmacht zu erlangen und ihre Investitionen zu amortisieren. Dabei stellen die neuen Produkte keine separate Marktnische dar, sondern stehen im Wettbewerb mit den alten Modellen.

Private Incentives to Innovate:

Interplay of New Products and Brand-Name Reputation[1]

Nina Leheyda*

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.

Keywords: discrete choice models, automobile industry, new products, innovations, brand-name reputation

JEL-Classification: L13, L62, D43

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1. Introduction

There has been a growing stream of literature, devoted to the introduction of new goods. The major developments directions in this literature 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 (Bresnahan and Gordon, 1997). Product innovation has been defined as the introduction of goods new to the market, or with improved quality of the existing products (Trajtenberg, 1989).

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 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[2].

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 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 study 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.

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[2] 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.

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.[3] 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.[4]

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 heterogeneous 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

[3] 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).

[4] 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, 1978, Eaton and Lipsey, 1979), or it can preempt the entire market (e.g., Spence, 1976, Brander and Eaton, 1984, Bonnano, 1987).

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 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.

More fierce 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. These 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 generating economies of scale and scope, which may help to cover high investment costs for model development and considerable fixed costs in the industry. Platform strategies 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 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. 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 and product variety 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 (see Table 2): [5]

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

	No. and best-selling models	*New (by KBA)*	*Entirely new*	*Supplemental*	*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

[5] 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.

quality and/or formal-aesthetic features of a vehicle.[6] 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 research objectives. Many of these new car specifications capture product proliferation, which has an innovative character, and not just face-lifting.[7] 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 $u_{ij}=u(x_j,\xi_j,p_j;\theta)$ 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:

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

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

$$u_{ij}>u_{ik}, 0\le k\le J, k\ne j \tag{3}$$

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

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6 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)".

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

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

where F_j are the partial derivatives of the joint cumulative distribution function F of $(\varepsilon_{i0}, ..., \varepsilon_{iJ})$ with respect to its j th 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[8]) 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:[9]

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

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

The error term e_{ij} is decomposed into an iid shock, a group-specific component and a sub-group specific component. ε_{ig}, ε_{ih}, ε_{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}[10]); 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).[11]

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

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8 This model has been first suggested by Bresnahan et al. (1997).

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

10 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.

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

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 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:

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

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

$$I_{hg} = (1-\sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} e^{\delta_l/(1-\sigma_{hg})}$$

$$I_g = (1-\sigma_g) \ln \sum_{h=1}^{H_g} e^{I_{hg}/(1-\sigma_g)} \tag{7}$$

$$I = \ln \sum_{g=1}^{G} e^{I_g}$$

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 is specified as follows:

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

where s_j is the share of product j in the total market, s_0 is 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:

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

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:

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

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:

$$E_{s_j/p_l} = \frac{\partial s_j}{\partial p_l}\frac{p_l}{s_j} = \alpha p_l s_l \quad (12)$$

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:

$$\ln(s_j^a / s_0^a) = x_j \beta_i - \alpha_i p_j + \sigma_{ihg} \ln(s_{j/hg}^a) + \sigma_{ig} \ln(s_{h/g}^a) + \xi_{ij} \quad (13)$$

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.[12] 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 $j \in J_f$:

$$\max_{p_{J_f}} \pi_f = \sum_{j \in J_f} (p_j - c_j) Ms_j(p) - \sum_{j \in J_f} F_j \tag{15}$$

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.

The first-order conditions for the manufacturer f's profit maximization problem are (assuming that pure-strategy Nash equilibrium in prices exists and that prices are strictly positive):[13]

$$s_j(p) + \sum_{r \in J_f} (p_r - c_r) \frac{\partial s_r(p)}{\partial p_j} = 0 \tag{16}$$

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:

$$\Delta_f = \begin{pmatrix} \frac{\partial s(J_1^f)}{\partial p(J_1^f)} & \cdots & \frac{\partial s(J_{k(f)}^f)}{\partial p(J_1^f)} \\ \vdots & \ddots & \vdots \\ \frac{\partial s(J_1^f)}{\partial p(J_{k(f)}^f)} & \cdots & \frac{\partial s(J_{k(f)}^f)}{\partial p(J_{k(f)}^f)} \end{pmatrix} \tag{17}$$

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

---

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

[13] 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.

$$\underset{s}{\begin{pmatrix} s_1 \\ \\ s_J \end{pmatrix}} + \underset{\Omega}{\begin{pmatrix} \Delta^1 & & 0 \\ & \ldots & \\ 0 & & \Delta^F \end{pmatrix}} \underset{p-c}{\begin{pmatrix} p_1 - c_1 \\ \\ p_j - c_j \end{pmatrix}} = 0 \tag{18}$$

Assume that Ω 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 markup. 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)[14]. 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). 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

[14] Step-by-step estimations are also performed by Nevo (2001).

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).

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[15]. 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

[15] This has been first suggested by Bresnahan et al. (1997) for a personal computer industry.

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 studying the simultaneous impact of a brand-name reputation and a new model on the market shares (whether they help to maintain/increase market shares).

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 subgroup (e.g., the subgroup is premium vs. volume model[16]) 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

[16] 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.

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 price differentials between new and old models, usually the question is whether the higher prices are caused by marginal costs, or by higher markups.[17]

This method will allow quantifying a reward for innovation, studying the simultaneous impact of a brand-name reputation and a new model as well as helping 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[18]). 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 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 re-compute 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 this Section approaches to answer my research questions (mainly following the approach by Bresnahan et al., 1997).

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17 The change in the producer variable profits from a new product introduction could be calculated.

18 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.

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[19], 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[20] - AutoMarxX im Dezember 2003" issued by the Center of Automotive Research, Fachhochschule Gelsenkirchen. The reputation ranking has been also taken from this publication[21].

The data on environmental and ecological statistics (e.g., fuel consumption in litres/100 km) 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-Pannenstatistik 2003". The available series is the number of technical defects per 1000 automobiles. 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

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19 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 worthwhile 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.

20 ADAC stands for the General German Automobile Club (Allgemeiner Deutscher Automobil-Club). This is one of the largest German transport clubs.

21 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.

consumers care about while purchasing a car[22] and availability of the data on technical characteristics as well as addressing the problem of multicollinearity among the technical characteristics.[23]

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

Variable	*Meaning*	*Mean/share*	*Std.err.*	*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.

22 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).

23 The estimations results in general are very sensitive to the choice and scaling of variables.

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.err.*	*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[24], 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.

[24] 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.

Table 5: German automobile market: premium vs. volume manufacturers across market segments

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-Class	15.2
	Audi A4, S4	14.4
Upper middle	Mercedes E-Class	41.8
	BMW 5er	21.3
	Audi A6, S6	17.9
Luxury	Mercedes S-Class	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.[25] The coefficients for specifications B and C appear to be quite similar in magnitudes. The price coefficient is of similar magnitude in all specifications.[26]

[25] A similar problem has been also encountered in other studies (e.g., Verboven, 1996).

[26] 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

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[27]. This may say in favour 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).

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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.

[27] 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, Porsche and Audi have enjoyed the highest rankings in 2003.

Table 7: German automobile market: pricing/marginal cost equations estimations

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***
R2	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 order 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[28] 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 is 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[29]) 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).

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28 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.

29 The top 10 brands in this ranking are Mercedes, BMW, Audi, VW, Porsche, Volvo, Renault, Toyota, Opel, and Ford.

Table 8: German automobile market: estimations results of two-level nested logit
Nests are market segment and new vs. old model

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[30].

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[31]. This large consumer 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.

[30] 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.

[31] Marketing studies show that older customers have other demand preferences towards car 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.

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 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 nested logit estimation.[32] On the other hand, these results might be true, e.g., one

[32] 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

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 market 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.

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to substitute away, say from Mercedes, to the other popular cars as measured by the market shares, and not to the other similar products.

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. err.*	*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 mark-ups 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 number 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 mark-ups 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 cannibalize 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 worthwhile. 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 heterogeneous 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 imitate/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 imitators'' 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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