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The impact of brand equity on profit premium in an equilibrium framework

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Abstract

Recent research extends the estimation and analysis of structural demand and supply models to consider the concepts of brand equity and brand value and their role in product investment decisions. In this paper, we analyze data from the Dutch market for new cars to show that differences in brand equity may also entail significant differences in marginal costs. Next, we illustrate that ignoring the role of brand equity in marginal costs, as the existing literature has, ignores the possibility that investments in brand equity may actually reduce the marginal profits for the offering. This can change investment incentives and produce different market structures.

Keywords Brand equity · Brand value · Nash-Bertrand · Random coefficient logit · Empirical IO methods · Car market

1 Introduction

A central problem in marketing is to quantify the value of brands (Oh et al., 2020). Researchers have focused on measuring, on the one hand, the effect of brands on consumers' preferences and, on the other hand, the value of a brand to its producer.

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Following Goldfarb et al. (2009), we use the terms *brand value* and *brand equity* distinctively to mean the performance of a brand from the perspective of its producer and the contribution of a brand to consumers' utilities, respectively. The importance of these concepts is reinforced by the fact that, as has been argued recently, both concepts are closely linked to the market valuation of companies (Vitorino, 2014; Belo et al., 2014; He & Calder, 2020).

Brand value is in general measured by the difference between a factual measure (like price or revenue) and a corresponding counterfactual. We follow the recent proposal by Goldfarb et al. (2009) and Ferjani et al. (2009) and define the counterfactual as the unbranded equilibrium measure, that is, as the measure computed in a new equilibrium when the product is deprived of its brand equity. We operationalize brand equity as a brand-specific intercept in the utility that is common to all consumers (Kamakura & Russell, 1993; Sriram et al., 2007; Goldfarb et al., 2009; Borkovsky et al., 2017). This way, the counterfactual depends on the search attributes of a specific product, which are just the product attributes available to consumers from the description of the product. Consequently, brand value is measured as the extra value to the producer that can be attributed to brand equity.

The literature has conceptualized brand value measurement through different measures. For example, Aaker (1991) proposed the price premium; Kamakura and Russell (1993) used the sales premium, which is based on market share as a quantity for computing the brand value; and Ailawadi et al. (2003) proposed the revenue premium. An important discovery was that, employing the methodology from Berry et al. (1995), one can estimate marginal costs, which makes it possible to compute profit premium as the difference between the profit from the products belonging to a brand and the profit from the unbranded versions of the same products (Kartono & Rao, 2006; Goldfarb et al., 2009; Borkovsky et al., 2017). This is arguably a potentially superior brand value measure since it contains relevant information regarding the financial performance of the brand.

Goldfarb et al. (2009) propose to compute profit premiums in the ready-to-eat cereal market based on a model of demand and supply along the lines of Berry et al. (1995). This model defines demand as a random coefficient logit model whose corresponding utilities depend on search attributes and brand-specific intercepts. As mentioned above, a brand-specific intercept measures brand equity that consumers derive from experience and credence attributes; this can signal features of the brand beyond the search attributes (Nelson, 1970). The supply side of the model specifies prices as the outcome of a Nash equilibrium for profit-maximizing firms. Regarding the supply side, Goldfarb et al. (2009) assume that marginal costs do not depend on brand-specific parameters, that is, they compute unbranded marginal costs by assuming that the production technology is preserved.

This assumption, however, is not always plausible because for some product categories, variation in experience and credence attributes across products is more pronounced. For example, in the case of cars, comfortability and durability can be regarded as experience attributes, and they are expected to vary across car brands. Also, brands with better comfortability or better durability are expected to have higher marginal costs, which suggests that brand equity, which compresses all experience and credence attributes, should be included in the marginal cost specification. This rationale corresponds to the Berry et al. (1995)'s methodology, according to which marginal costs are specified by product attributes. The idea behind this is that product attributes are expected to carry information on marginal cost shifters, such as the cost of factors of production. In such a specification, it is natural that, in addition to search attributes, experience and credence attributes are also useful for explaining marginal cost variation, and hence, brand equity itself can also explain variation in marginal costs.

In this paper, we invoke comparative statics results by Choi et al. (2018) for discrete choice models and argue that when marginal costs do not contain brand-specific features, the profit premium of any brand is positively related to its equity. This implies that an increase in the equity of the brand necessarily increases its profit. Consequently, by ignoring the role of brand equity in marginal costs, one ignores the possibility that investments in brand equity may actually reduce marginal profits.

This paper contributes to the literature by proposing a brand value measure that offers a solution to the problem formulated. Specifically, we propose a modification of the profit premium concept of Goldfarb et al. (2009) that takes brand-specific features in marginal cost into account. In this regard, similar to the demand side, we capture brand-specific features in marginal cost by including brand-specific intercepts (Kartono & Rao, 2006).[1]

The profit premium we propose is *qualitatively* different from the one proposed by Goldfarb et al. (2009). This is because, based on comparative statics, when marginal costs contain brand-specific features, then whether a brand's profit premium is positively or negatively related to brand equity depends on the ratio of marginal cost and utility brand-specific intercepts. Specifically, if for a brand the corresponding ratio is sufficiently large, then the profit premium of the brand will be negatively related to its equity. Due to this property, the profit premium concept we propose is qualitatively superior to previously proposed concepts, as it signals the possible risk of unprofitable investment.

In order to demonstrate the practical importance of these findings, we conduct an empirical study of the new car market in the Netherlands. Using yearly sales and car characteristics data in the period 2003–2008, we estimate demand and brand equities as well as marginal cost specifications both without and with brand-specific intercepts. Our findings indicate that in the former case, all profit premiums are positive while in the latter case, some profit premiums are negative, which support our theoretical considerations.

The remainder of the paper is structured as follows. Section 2 describes the model while Section 3 provides the definition of profit premium and explains how it is related to brand equity. Section 4 presents the empirical results for the Dutch car market and includes a brief description of the data and the estimation method used. Section 5 provides concluding remarks.

[1] This is in fact equivalent to including brand equity in the marginal cost and allowing it to have a heterogeneous effect (as explained in Section 2.2). The relatively high correlation (i.e., 0.67; see Table 2) between the estimates of the brand intercepts in the utility and marginal cost suggests that this effect is not too heterogeneous and that the brand intercepts in the marginal cost are rather closely related to brand equities. Since the above arguments suggest that the variation in marginal costs is captured by brand features that are closely related to brand equity, our proposed profit premium computes the counterfactual equilibrium by removing brand-specific variation from both utility and marginal cost.

2 The model

We use a model that allows for measuring brand effects on both the demand and supply sides. It is based on the well-known (Berry et al., 1995) model, which features a random coefficient logit demand model combined with a Nash-Bertrand supply-side model.

2.1 Demand

Let F denote the number of firms active in the market. The utility of consumer i from buying product $j \in \mathcal{G}_f$, where $\mathcal{G}_f$ denotes the set of products produced by firm $f \in \{1, \ldots, F\}$, is given by

$$u_{ij} = \beta_f - \alpha_i p_j + \mathbf{x}_j \boldsymbol{\beta}_i + \delta_i M_j + \xi_j + \varepsilon_{ij}. \tag{1}$$

In this indirect utility function, β_f is a parameter common to all products of firm f, $\mathbf{x}_j$ is a K-dimensional row vector of search attributes of product j whose first component is 1 for the intercept, p_j is the unit price of product j, M_j is a measure of marketing expenditures, ξ_j is a product characteristic unknown to the econometrician but observed by consumers, and ε_{ij} is an iid type I extreme value distributed error term. Further, the random coefficients have distributions $\alpha_i \sim N(\alpha, \sigma_\alpha^2)$, $\boldsymbol{\beta}_i \sim N(\boldsymbol{\beta}, \Sigma)$, and $\delta_i \sim N(\delta, \sigma_\delta^2)$, where Σ is a diagonal matrix with diagonal elements $\left(\sigma_1^2, \ldots, \sigma_K^2\right)$. Consumers can choose from J products or can opt for an outside alternative, which represents the option of not purchasing any of the J products. We normalize the utility of the outside good to $u_{i0} = \varepsilon_{i0}$.

The utility specification yields that the probability that product j is purchased is

$$s_j = \int \frac{\exp\left(\beta_f - \alpha_i p_j + \mathbf{x}_j \boldsymbol{\beta}_i + \delta_i M_j + \xi_j\right)}{1 + \sum_{g=1}^{F} \sum_{r \in \mathcal{G}_g} \exp\left(\beta_g - \alpha_i p_r + \mathbf{x}_r \boldsymbol{\beta}_i + \delta_i M_r + \xi_r\right)} \varphi\left(\alpha_i, \boldsymbol{\beta}_i, \delta_i\right) d\alpha_i d\boldsymbol{\beta}_i d\delta_i, \tag{2}$$

where $\varphi\left(\alpha_i, \boldsymbol{\beta}_i, \delta_i\right)$ is the joint density function of the random coefficients α_i, $\boldsymbol{\beta}_i$, and δ_i. If the number of purchases is large, this choice probability is equal to the market share of product j. Therefore, in what follows, we use the term "market share" to refer to both quantities.

We define brand equity as the demand side effect of the brand, and, since we assume that all products of firm f have the same brand name, we measure brand equity by the firm-specific parameter β_f.[2] This approach is rather common in the literature (e.g., Jedidi et al. 1999; Chintagunta 1994; Chintagunta et al. 2005; Sriram et al. 2007; Aribarg & Arora 2008; Goldfarb et al. 2009). Since search attributes are included in the utility, we expect β_f to measure the brand-specific effect of experience attributes on utility.

[2] Bronnenberg and Dubé (2017, footnote 3) raise the concern that the brand equity measured by a brand-specific parameter captures all unobserved product-level features, including some features that should not be part of brand equity. The unobserved product characteristic ξ_j in the utility attempts to alleviate this concern.

2.2 Supply

We assume that prices are determined as a Nash equilibrium, where each firm maximizes its own profit with respect to its own prices. The profit of firm f is

$$\pi_f = \sum_{h \in \mathcal{G}_f} (p_h - c_h)\, s_h,$$

where c_h denotes the marginal cost of producing product $h \in \mathcal{G}_f$. The fixed costs of production and the number of consumers in the market are omitted because they do not depend on prices. We specify the marginal cost of product $j \in \mathcal{G}_f$ as

$$c_j = \gamma_f + \mathbf{w}_j \gamma + \omega_j, \tag{3}$$

where γ_f is a parameter that measures the brand-specific effect on the marginal cost, $\mathbf{w}_j$ is a vector of attributes that affect marginal cost, and ω_j is a marginal cost characteristic unobserved by the econometrician. Intuitively, γ_f is expected to be positively correlated with β_f across firms $f = 1, \ldots, F$ because higher experience attributes for a product are likely to increase the marginal cost of the product. Therefore, in the paper, we refer to the brand-specific intercept γ_f as the experience attribute effect on marginal cost. In order to model the dependence of γ_f on β_f, we assume that $\gamma_f = \phi_f \beta_f$. By specifying the coefficient ϕ_f of β_f as firm f-dependent, we allow marginal costs to be heterogenous with respect to experience attributes. This allows for imperfect correlation between the brand-specific parameters in the demand and supply side. We expect this correlation to be positive because, as explained in Sect. 1, several types of brand equity cost determinants affect marginal cost. Throughout the paper, we refer to ϕ_f as the ratio of marginal cost and utility brand-specific intercepts.

Following the literature, we assume that prices can be determined from the first-order conditions for profit maximization. These are equivalent to the equations (Berry et al., 1995)

$$\mathbf{p}_f - \mathbf{c}_f = \Delta_f(\mathbf{p})^{-1}\mathbf{s}_f, \quad f = 1, \ldots, F, \tag{4}$$

where $\mathbf{p}_f$, $\mathbf{c}_f$, and $\mathbf{s}_f$ are the vectors of prices, marginal costs, and market shares for the products of firm f, respectively, and $\Delta_f(\mathbf{p})$ is a conformable square matrix with the element in row j and column r equal to $-\partial s_r / \partial p_j$.

3 Profit premium and its properties

According to the widely accepted definition of Keller (1993), brand value measurement involves a comparison between a certain factual measure and a corresponding counterfactual. The literature offers various solutions for choosing the brand used for the counterfactual, including a private label brand (Ailawadi et al., 2003), a hypothetical unbranded product (Ferjani et al., 2009), or the brand with the lowest market share. Following the proposal of Goldfarb et al. (2009), we define the counterfactual for a brand to be an unbranded quantity, that is, the quantity computed by setting the brand-specific parameters equal to zero. Along these lines, we define the brand value of a specific brand as the incremental gain realized over the unbranded state of the same brand. In the unbranded state, the brand enters the computations without brand equity but it retains its search attributes. Specifically, in order to compute the counterfactual prices and market shares for the products of firm f, we take the unbranded version of these products by putting $\beta_f = \gamma_f = 0$, while keeping the parameters and variables corresponding to the other firms unchanged.

Within this framework, we define *profit premium* as the difference between the profit from the products belonging to a brand and the profit from the same unbranded products. Specifically, the profit premium for firm f is $prp_f = \sum_{j \in \mathcal{G}_f} \left[\left(p_j - c_j \right) s_j - \left(p_j^c - c_j^c \right) s_j^c \right]$, where p_j^c, s_j^c, and c_j^c are product j's counterfactual equilibrium price, market share, and marginal cost, respectively, computed by putting $\beta_f = \gamma_f = 0$ in Eqs. 2, 3, and 4.

According to the above definition, profit premium can be regarded as an explicit function of brand equity. Here, we present results on how the profit premium behaves as a function of brand equity in the simple logit version of the model (so $\alpha_i = \alpha$). For more details, we refer to the online appendix.

Proposition 1 *The following statements hold for any firm f.*

1. *If $\phi_f = \min \left\{ \phi_g : g = 1, \ldots, F \right\}$ and $1 - \alpha \phi_f > 0$, the profit premium prp_f is increasing in the brand equity β_f.*
2. *If $\phi_f = \max \left\{ \phi_g : g = 1, \ldots, F \right\}$ and $1 - \alpha \phi_f < 0$, the profit premium prp_f is decreasing in the brand equity β_f.*

An important consequence of Proposition 1 is that, if the analyst omits brand-specific effects from the marginal cost (i.e., $\phi_f = 0$ for all f in part 1), then profit premium will always increase whenever brand equity increases, so it will not be able to capture brand-specific signals from the supply side. This may imply that profit premium is measured to be positive even when in reality it is negative. According to part 2 of the proposition, when the ratio of marginal cost and utility brand-specific intercepts is sufficiently high (i.e., $\phi_f > 1/\alpha$), then the profit premium decreases when the brand equity increases, so the profit premium can also be negative. The empirical study in Section 4 presents examples of such brands.

4 Profit premium in the Dutch car market

In this section, we present profit premium estimates for new cars sold in the Netherlands in 2008[3]. We first provide a brief description of the data used, then describe the estimation of the model, and present the results. Further results obtained as robustness checks are presented in the online appendix.

4.1 Data

The data sets we use contain prices, sales, car characteristics, and advertising expenditure of cars sold in the Netherlands between 2003 and 2008. We exclude car makes

[3] All data are available at the following OSF repository: https://osf.io/m23w4

that did not have positive sales for each year of the sample. We define a market to consist of the car models that appear in a given year. A car model in a given year is included if its sales exceed 50. This leads to a total of 309 different car models that were sold during this period; this corresponds to about 226 different models on average per year. We regard each model-year combination as one observation, which results in 1355 observations in total.

We collected prices, sales, and car characteristics data from Autoweek Carbase, which is an open online database that contains data on all car models sold in the Netherlands.[4] Car characteristics include engine power, fuel consumption (as kilometers per liter), weight, size, dummy variables for whether the car's standard equipment includes cruise control, the car class the car belongs to, and other technical characteristics. All prices available are listed (post-tax) prices; although transaction prices would be more desirable, they are not available. We have normalized all prices to 2006 euros by using the Consumer Price Index in the corresponding years.

In order to create all necessary variables for the estimation of the model, we have supplemented the data set with several variables from the Dutch statistical office (i.e., Statistics Netherlands).[5] For example, we use the total number of households to construct market shares, and we use average yearly gasoline prices to construct a fuel consumption variable, where the latter is defined as kilometers per liter divided by the average price of gasoline per liter. In addition, we use data on the distribution of disposable household income.

We use information from 2007 on brand ownership structure to specify which car brands belong to the same parent car producer. There are 36 different brands in our sample over the 2003–2008 period that are owned by 16 different companies. For instance, in 2007, the Volkswagen Group owned Volkswagen, Audi, Seat, and Škoda. We use data on brand-level advertising expenditure obtained from Nielsen. We present summary statistics for the variables used in the estimation in the online appendix.

4.2 Estimation

We estimate a version of the model presented in Section 2. In the demand model, the price coefficient is defined as $\alpha_i = \alpha / y_i$, where y_i is the income of household i, and only the constant is specified as random. Following Berry et al. (1995), the supply side is specified as follows:

$$\ln c_j = \gamma_f + \mathbf{w}_j \gamma + \omega_j, \tag{5}$$

where $\mathbf{w}_j$ is a vector of supply-side characteristics of product j, where the included characteristics are listed in the lower part of Table 1.

The assumption used for identification is that the demand and supply side unobserved characteristics corresponding to a given product are mean independent of the observed characteristics of all products, which is the assumption used by Berry et al. (1995). Based on this assumption, separate identification of the demand side and the supply side follows from variation in market shares and prices, respectively, providing that there are also some observed factors that affect prices but do not affect market

[4] See https://www.autoweek.nl/carbase.

[5] See https://www.cbs.nl/

Table 1 Estimation results

Variable	(A) Coeff	(A) Std. Err	(B) Coeff	(B) Std. Err
Base coefficients				
Constant	−19.486	(7.408)***	−19.486	(7.408)***
HP/weight	2.444	(0.548)***	2.444	(0.548)***
Cruise control	0.478	(0.110)***	0.478	(0.110)***
KM per euro	0.764	(0.298)***	0.764	(0.298)***
Size	10.910	(1.494)***	10.910	(1.494)***
Advertising	0.557	(0.040)***	0.557	(0.040)***
Family car	−0.773	(0.165)***	−0.773	(0.165)***
Luxury	−0.193	(0.216)	−0.193	(0.216)
Sport	−0.775	(0.238)***	−0.775	(0.238)***
MPV	−0.240	(0.153)	−0.240	(0.153)
SUV	0.544	(0.217)**	0.544	(0.217)**
Random coefficients				
Price/income	−6.755	(2.323)***	−6.755	(2.323)***
Constant	3.352	(5.418)	3.352	(5.418)
Marginal cost parameters				
Constant	−4.553	(0.942)***	−0.462	(0.815)
Log(HP/weight)	0.160	(0.072)**	0.173	(0.064)***
Cruise control	0.019	(0.015)	0.046	(0.013)***
Log(KM per liter)	−0.665	(0.057)***	−0.599	(0.048)***
Log(size)	0.511	(0.097)***	1.075	(0.084)***
Log(CC)	0.409	(0.051)***	0.333	(0.044)***
Log(acceleration)	−0.091	(0.084)	−0.194	(0.070)***
Log(maximum speed)	0.822	(0.126)***	0.170	(0.113)
Airconditioning	−0.000	(0.016)	0.059	(0.013)***
Board computer	0.046	(0.013)***	0.032	(0.012)***
Power steering	0.114	(0.026)***	0.094	(0.021)***
Sports chairs	0.075	(0.024)***	0.068	(0.020)***
Anti-roll bar	0.249	(0.015)***	0.065	(0.014)***
Xenon lights	0.033	(0.027)	0.122	(0.023)***
Brand fixed effects supply side	No		Yes	
R^2 supply side	0.916		0.952	

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. The number of observations is 1355. The number of simulated consumers used for the aggregate moments is 2209. Standard errors are in parenthesis. The demand specification corresponding to both (A) and (B) (upper panel) contains brand-specific intercepts. The same demand side estimates are used for the marginal cost specifications (A) and (B). Kia is the base brand

shares, which can be used as excluded instruments. By using such instruments, the demand side can be identified. The supply side can be identified from Eq. 5 once we determine the demand side parameters and express the marginal costs from Eq. 4. Since

Eq. 5 is a linear model with exogenous regressors, the fixed effects are identified in the same way as the coefficients of dummies in a linear model. Identification of the fixed effects in both demand and supply is facilitated by within-brand variation, because several products belong to each brand, as well as variation in product attributes and market shares over 6 years (2003–2008).[6]

Following Nevo (2001), in a first stage, we estimate the demand parameters by GMM with moments based on the unobserved demand characteristics and instruments based on predicted prices and differentiation instruments (Gandhi & Houde, 2023) constructed from the observed characteristics.[7] The estimates are shown in the upper part of Table 1. In all demand specifications, we include brand-specific intercepts, which are reported as brand equity estimates in the first column of Table 2. In the second stage, we use the demand estimates as well as the first-order conditions for profit maximization. We do so by substituting the c_j's from Eq. 4 into Eq. 5, followed by OLS estimation of Eq. 5.

Regarding the marginal cost brand effect γ_f, we consider two specifications. In specification (A), there is no brand intercept included in the marginal cost, which corresponds to the approach followed by Goldfarb et al. (2009). Specification (B) allows for full heterogeneity of the brand effect on marginal cost, which means that γ_f is allowed to be different for each brand f, as described in Section 2.2. The estimates of the constant and slope coefficients are presented in the lower part of Table 1 while those of the brand effects on marginal cost are presented in Table 2.

4.3 Results

The upper part of Table 1 contains the demand estimates obtained in the first stage. *Base coefficients* refer to estimates of the coefficients of observed demand characteristics, and *Random coefficients* refer to the estimates of price over income as well as the random constant. We include a relatively large number of characteristics in order to exploit as much product-level variation as possible and to obtain more precise brand equity estimates. This also explains why we include a large number of characteristics and only a few random coefficients.

The base coefficient estimates have the expected signs. The constant is large and negative reflecting that only a small proportion of households buy a new car in a given year. The characteristics HP/weight, cruise control, kilometers per euro, and size affect utility positively and are statistically significant. Advertising expenditure has a positive significant effect on utility. The special car class dummy variables have effects with mixed signs on utility, which can be explained by the popularity of the respective class in comparison to a car with similar characteristics in the tiny class (the base

[6] Although identification of the brand fixed effects is not a concern, the fact that our data only consist of six markets implies that for brands for which the number of distinct products is low, there will be relatively few observations to estimate the brand fixed effects. As a consequence, these estimates may be less precise. Nevertheless, we do not believe this is a serious issue because for the vast majority of the brands, such a phenomenon does not occur.

[7] Predicted prices are obtained using the estimates of an OLS regression of price on a constant, log(HP/weight), cruise control dummy, log(KM per liter), log(size), segment dummies (i.e., family car, luxury, sport, mpv, suv), foreign brand dummy, and luxury brand dummy. The differentiation instruments are constructed using the car segment dummies only.

Table 2 Brand-specific intercepts and profit premiums

Variable	Brand-specific intercepts Brand equity (A, B) Coeff	Std. Err	Marginal cost (B) Coeff	Std. Err	Profit premiums Specification (A)	Specification (B)
BMW	3.482	(0.412)***	0.556	(0.034)***	61.650	44.083
Mini	2.728	(0.397)***	0.498	(0.067)***	10.184	8.673
Chrysler	0.378	(0.322)	0.190	(0.037)***	1.673	−2.441
Jeep	1.039	(0.440)**	0.267	(0.041)***	2.127	−0.208
Mercedes-Benz	3.577	(0.481)***	0.591	(0.032)***	44.795	31.586
Smart	1.437	(0.582)**	0.924	(0.049)***	1.810	0.782
Alfa Romeo	1.292	(0.319)***	0.304	(0.036)***	7.847	2.821
Fiat	0.660	(0.277)**	0.173	(0.032)***	27.590	18.424
Lancia	0.261	(0.326)	0.323	(0.042)***	0.542	−1.532
Ford	1.828	(0.263)***	0.162	(0.030)***	118.571	105.723
Jaguar	3.012	(0.544)***	0.537	(0.041)***	5.216	1.022
Land Rover	3.020	(0.641)***	0.493	(0.039)***	11.237	5.071
Mazda	0.930	(0.292)***	0.303	(0.031)***	16.009	2.521
Volvo	3.008	(0.369)***	0.379	(0.031)***	67.220	55.235
Subaru	0.367	(0.295)	0.308	(0.035)***	1.418	−3.142
Cadillac	0.044	(0.364)	0.216	(0.053)***	0.039	−1.342
Chevrolet	0.276	(0.262)	0.051	(0.030)	5.427	3.293
Opel	1.850	(0.313)***	0.356	(0.030)***	107.956	81.353
Saab	1.867	(0.326)***	0.314	(0.046)***	6.460	3.857
Honda	0.914	(0.283)***	0.377	(0.034)***	16.348	−2.543
Hyundai	0.478	(0.260)*	0.115	(0.029)***	18.940	10.569
Kia	0.000		0.000		0.000	0.000
Mitsubishi	0.943	(0.285)***	0.230	(0.031)***	14.383	7.753
Porsche	4.206	(0.643)***	0.682	(0.048)***	4.439	2.165
Citroen	1.243	(0.275)***	0.251	(0.030)***	55.991	34.297
Peugeot	1.240	(0.281)***	0.227	(0.031)***	88.810	64.401
Nissan	1.152	(0.309)***	0.235	(0.031)***	23.224	13.797
Renault	1.699	(0.291)***	0.260	(0.031)***	94.842	76.395
Suzuki	0.934	(0.264)***	0.174	(0.033)***	24.460	18.709
Daihatsu	0.762	(0.324)**	0.371	(0.037)***	13.413	6.824
Lexus	1.954	(0.412)***	0.344	(0.043)***	4.735	1.487
Toyota	1.865	(0.298)***	0.378	(0.030)***	103.000	71.226
Audi	3.220	(0.392)***	0.513	(0.034)***	70.038	52.312
Seat	1.111	(0.309)***	0.209	(0.033)***	28.330	19.909
Skoda	1.342	(0.367)***	0.257	(0.040)***	22.504	16.480
Volkswagen	2.283	(0.347)***	0.334	(0.029)***	139.605	116.309

Table 2 continued

Variable	Brand-specific intercepts Brand equity (A, B) Coeff	Std. Err	Marginal cost (B) Coeff	Std. Err	Profit premiums Specification (A)	Specification (B)
Correlations (*p*-values)						
with brand equity						
Pearson			0.671	(0.000)	0.295 (0.085)	0.307 (0.073)
Kendall			0.550	(0.000)	0.284 (0.016)	0.308 (0.009)

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. The number of observations is 1355. The number of simulated consumers used for the aggregate moments is 2209. Standard errors of estimates other than correlations are in parenthesis. Numbers are based on the estimates in Table 1. Profits are measured in € mln. Profit premium is calculated as profits minus counterfactual profits (setting brand to the minimum brand found)

group). Specifically, both family cars and sports cars generate lower marginal utility, and SUVs are relatively popular, while the luxury car and MPV dummies do not affect utility significantly. The coefficient of price/income is estimated to be highly negative and statistically significant, which reflects the negative marginal utility of price. The random constant (i.e., the standard deviation parameter corresponding to the constant) estimate is not significantly different from zero.

The brand-specific intercept estimates presented in Table 2 are obtained by using Kia as the base brand for both the demand and supply sides. Since the brand-specific intercepts in the demand model can only be identified relative to a comparison brand, the brand value obtained can also be computed only relative to a comparison brand.[8] We note that most estimates of brand equity are significant at a 5% level. These estimates show several patterns. First, European luxury brands tend to have higher equities: German luxury brands (Porsche, Mercedes, BMW, Audi) tend to have the highest brand equities (above 3), followed by luxury brands from the UK (Jaguar, Land Rover). Second, American brands, including American luxury brands (e.g., Cadillac) tend to have low equities. Third, highly popular brands (Ford, Opel, Volkswagen, Toyota, Renault) have equities between 1.7 and 2.3. Overall, we believe these brand equity estimates are not unrealistic.

The lower part of Table 1 contains the marginal cost estimates obtained in the second stage. In order to capture brand-specific effects as precisely as possible, we include a large number of covariates in the marginal cost specification. The estimates across the two specifications differ to some extent. However, it is remarkable that apart from the sign of log(KM per liter), all estimates have the expected signs; in both specifications, the estimates suggest that characteristics that increase utility shift marginal costs upwards.[9] Specification (B) includes brand-specific intercepts. These

[8] Borkovsky et al. (2017) use the outside alternative as the base brand. Since in our framework it is difficult to specify the marginal cost of the outside alternative, we do not use it as the base brand in the supply side.

[9] Berry et al. (1995) obtained a similar result with respect to fuel efficiency for their main specification, but by adding log(sales) in order to proxy for log(production), the sign on fuel efficiency got reversed. We also present the estimation result of a model in which we include log(production) in the marginal cost specification (see Table 3 in the online appendix). Although the coefficient of log(KM per liter) is estimated to be slightly smaller in absolute value, its sign stays negative.

estimates are statistically significant and positive, apart from that of Chevrolet. We also report the R^2's for the specifications. These are rather high for both specifications ($0.91-0.95$), the one in specification (B) being somewhat higher. These remarkably high R^2's suggest that the included variables capture most of the variation in the marginal costs.

The estimates of the brand-specific intercepts are related to brand equities. For example, luxury brands tend to have higher brand-specific marginal costs (i.e., above 0.5). The correlation coefficients between the brand equities and the marginal cost intercepts are reported at the bottom of Table 2 and confirm the strong positive relationship between these two variables. Both the Pearson and Kendall correlations are rather large and statistically significant (0.671 and 0.55, respectively, with both p-values equal to 0.000). This can also be seen in Fig. 1, which shows how the marginal cost brand effect estimates relate to the brand equity estimates. This phenomenon suggests that brand equity affects marginal cost, as we argue in the Introduction. It is important to mention that some brands with low equities have disproportionately high marginal cost brand-specific intercepts; an example of this is Cadillac. This is intuitively plausible: even though Cadillac is a luxury brand and therefore has a relatively high marginal cost brand-specific intercept due to the superior technology used, it is not very popular in the Netherlands, which manifests itself by a relatively low brand equity estimate.

The profit premium estimates based on data from 2008 are presented in Table 2. Those corresponding to specification (A) are all positive, while some of them corresponding to specification (B) are negative. The profit premiums in different specifications are highly correlated with each other (Kendall correlations range between 0.86 and 0.98; not shown in the tables), so they show strong similarities. According to both specifications, highly popular brands like Volkswagen, Toyota, Ford, Opel, and

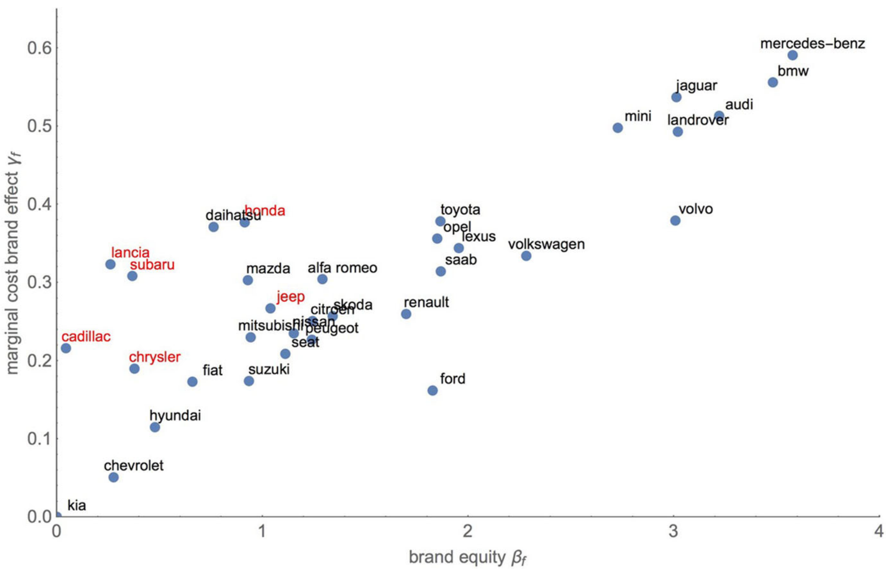

Fig. 1 Brand equity and marginal cost brand effect

Renault have the highest profit premiums, although their equities are clearly lower than those of the European luxury brands (Porsche, Mercedes, BMW, Audi, Jaguar, Land Rover). On the opposite side, we have obtained the lowest profit premiums for brands with low equities like Chrysler, Lancia, Subaru, Cadillac, and Chevrolet, but also for some brands with relatively high equities like Smart and Jeep. Below, we argue that these results can be explained by using the negative profit premiums obtained for specification (B) and by Proposition 1.

Although profit premiums corresponding to specification (B) highly correlate with those corresponding to the other specification, there are some notable differences. First, the former are systematically lower than the latter, which suggests that they are less optimistic than profit premiums corresponding to specification (A). Second, as mentioned above, some profit premiums corresponding to specification (B) are negative (brands in red in Fig. 1). Four out of these, namely, Chrysler, Lancia, Subaru, and Cadillac, are among those brands mentioned above as having the lowest equities, while Jeep and Honda have relatively high brand equities. This suggests that brand equity alone cannot explain negative (or low) profit premium. According to our conclusion in Proposition 1, the magnitudes of the ratios $\phi_f = \gamma_f/\beta_f$ of brand-specific intercepts corresponding to marginal cost and utility are expected to carry information on the sign of the profit premium. Despite their high brand equity, this ratio is rather high for Jeep and Honda, so the findings in Proposition 1 provide an explanation why their profit premiums are negative.

In order to investigate this issue statistically, we compare the Kendall correlations of profit premiums with brand equities to those with the ratios ϕ_f for specification (B). The lower part of Table 2 presents the former along with the Pearson correlations. Although none of the Pearson correlations is significant at the 5% level, the Kendall correlations are more relevant here, and they are statistically significant. The Kendall correlations between profit premiums and brand equity range between 0.281 and 0.308, where the correlation corresponding to specification (B) is higher. The correlation between profit premiums and the ratios ϕ_f for specification (B) is 0.486 (not presented in the table), which is clearly higher than the correlation 0.308 of the same profit premiums with brand equities. This suggests that the ratios ϕ_f are indeed more informative than brand equities regarding variation in profit premiums.

Among the brands with a negative profit premium, Honda deserves special attention because this case illustrates the advantages of including brand-specific intercepts in marginal cost when computing profit premiums, as done in specification (B). Indeed, we can notice that in terms of brand equity, Honda is rather similar to Mazda and Mitsubishi while it has a brand intercept in marginal cost higher than the other two brands. The profit premiums computed for specification (A) are rather similar for these three brands, so they do not capture the differences in the marginal cost brand effects. The profit premiums corresponding to specification (B), however, are quite different. For example, the profit premium of Mitsubishi drops by less than 50% compared to that in specification (A) from 14.383 to 7.753, while that of Honda goes down by more than 100% from 16.348 to −2.543.

Consequently, the specific profit premiums computed for Honda and the other two brands illustrate the theoretical properties stated in Proposition 1. Specifically, the profit premium computed based on brand-specific effects in the marginal cost (specification (B)) allows for both positive and negative profit premiums. On the other hand, the profit premiums computed without taking brand-specific effects in marginal cost into account (specification (A)) are positive for all brands, and therefore, they cannot signal potentially unprofitable investment in the brands.

5 Conclusions

This paper proposes a modification of the profit premium concept introduced by Goldfarb et al. (2009) that accounts for brand-specific features in the marginal costs of products. According to this modification, the counterfactual profit of a brand is computed by depriving the brand of its specific features both in utility and marginal cost. This profit premium will generally have values lower than the one originally proposed by Goldfarb et al. (2009) We argue in the paper that this is not just a quantitative artifact, but it is a rather important feature that allows profit premium to signal situations in which it is not profitable to invest in brand development.

Both our conceptual and empirical procedures are based on assumptions that may be restrictive in certain situations. First, we assume that brand equity is exogenous. This assumption is not realistic since brand equity is regularly monitored by firms and its value is influenced by various instruments like advertising. This implies a relationship between brand equity and advertising that is not taken into account by our model. Advertising in a market with so many brands as the car market is associated with limited consumer information that may have nontrivial implications on the brand equity estimates (Sovinsky Goeree, 2008; Draganska & Klapper, 2011). Second, we assume a static framework that presumes that brand equities and brand effects in marginal cost are constant over the sampling period. From a conceptual point of view, this is not necessary, but we needed to adopt this assumption in the estimation due to the limitations of our data set. One could potentially use additional data (e.g., consumer-level data) or a more restrictive method of estimation (e.g., maximum likelihood) to estimate brand equities. Inter-temporal variation of brand equities can be modeled by taking into account depreciation and rebuilding through advertising in a dynamic framework (Borkovsky et al., 2017). Such an approach requires detailed data on advertising and possibly on other investments in brand equity as well, since, as Borkovsky et al. (2017) admit, advertising is just one component of building brand equity. In addition to data issues, another difficulty of the dynamic approach is that car producers typically operate several different brands, and therefore, the methods by Borkovsky et al. (2017) should be extended to a setup where firms maximize profits across multiple brands. Third, unlike Goldfarb et al. (2009), we do not distinguish between retailers and wholesalers. The main reason for this is that we do not have retail and wholesale prices in our data set. On the other hand, it is more difficult to derive the comparative statics results in that case. Adapting our profit premium concept with the less restrictive model features mentioned above are tasks that we will undertake in the future.

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Declarations

Ethical approval Not applicable

Informed consent Not applicable

Conflict of interest The authors declare no competing interests.

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