STATISTICS IN TRANSITION new series, March 2017
Vol. 18, No. 1, pp. 75–90

THE APPLICATION OF MULTIVARIATE STATISTICAL ANALYSIS TO THE VALUATION OF DURABLE GOODS BRANDS

Marta Dziechciarz-Duda [1], **Anna Król** [2]

ABSTRACT

Nowadays, due to changes in the market and new trends in consumer behaviours, intangible assets, such as brand, have gained fundamental importance. The more frequent conviction that a product with a well-known name is better than other products contributes to the case of replacing the price of a product by its brand name as the predominant factor in the purchase decision process. Thus, for many companies the strengthening of brand equity has become one of the key elements of marketing strategy.

The main aim of this study is an attempt to improve the process of analysing the position and value of brands using selected multivariate statistical analysis methods (hedonic regression, multidimensional scaling, classification and linear ordination methods). In the conducted research the direct approach to the evaluation of the position of the brands for a selected ICT good – smartphones – have been applied. The measurement was performed on two levels: the product level, in which the prices of branded products were compared, and the consumer level, where the perception and attitudes of consumers towards the brands were studied. The analyses have been carried out on two sets of data, which enabled fuller and more comprehensible understanding of decision rules that guide consumers in choosing the brand.

Key words: brand valuation, multivariate statistical analysis, durable goods.

1. Brand and its value

In an era of fast technological development, when durable consumer goods are endowed in number of complex features, become more and more advanced and undergo rapid improvements, the consumers more frequently face the problem of a difficult choice between many variants of complicated commodities. This issue is particularly severe on the highly advanced durable goods markets (such as, for example, ICT goods), which on the one hand are violently expanding thus posing promising prospects for the future, and on the other hand are extremely changeable

[1] Wrocław University of Economics. E-mail: marta.dziechciarz@ue.wroc.pl
[2] Wrocław University of Economics. E-mail: anna.krol@ue.wroc.pl

and, furthermore, constantly experience shortening of the life cycles of products. In such unstable conditions one of the ways to win over the confused customers, induce their purchase decision and gain their trust and future loyalty is to create and strengthen the product brand. Increasing the brand value is particularly important on the markets where it is extremely difficult to fully assess the quality of the product before the purchase, and moreover the frequency of the purchases is low in comparison to the rapid pace of technological development, so that it is very hard for the consumers to build on their own experience of the past. Therefore, the well build brand might become a kind of safety buffer for the customers. It is known that brand names can convey information about various aspects of the product, such as reputation, reliability, quality, and also are synonyms of certain prestige and even social status and identity. Thus, they might provide the means for the customers to reduce risk level involved in the buying process and increase information efficiency of the purchase (see Keller and Lehmann (2006)).

The contemporary notion of brand name is understood as a much broader concept than originally comprehended. According to the classic definition formulated by the American Marketing Association (1960) brand name is „(...) a name, term, symbol, or design, or logo or a combination of them used to identify and differentiate a product or service from the competitor in the marketplace". Thus, the main role of brand name in this early approach was to inform the potential customers about the product existence and discriminate it from other similar commodities. Nowadays the brand name notion encompasses much more. The brand represents broadly understood trust, as well as certain connection between the company and the consumer, and is extended to include representing certain quality level, introducing the image of prestige and social status, as well as building customers identity, among other things. Detailed discussion on modern brand definitions may be found, among others, in papers by de Chernatony and Dall'Olmo Riley (1998) and Maurya and Mishra (2012). Maurya and Mishra list 12 different aspects in which the brand have been regarded in the literature: brand as a logo, brand as a legal instrument, brand as a company, brand as a shorthand, brand as a risk reducer, brand as an identity system, brand as an image in consumer's mind, brand as a value system, brand as a personality, brand as relationship, brand as adding value and brand as an evolving entity. This multitude of various approaches and issues accounted for in brand name analyses shows the complexity of the brand name evaluation problem.

The presented approaches to brand definition can be related to the question of the brand equity assessment by assigning them to two major trends present in the literature: cognitive psychology and informational economics (cf. Aaker (1991), Erdem and Swait (1998), Erdem et al. (1999), Baltas and Saridakis (2010)).

The authors of the cognitive psychology concept define brand equity as the effect that the knowledge of the brand and its features has on the response and revealed preferences of the consumer (Aaker (1991); Keller (1993)). Crucial elements in the process of brand valuation include brand awareness (the degree to which consumer precisely recognizes the brand and associates it with the specific product), brand associations (the extent to which a particular brand calls to mind the attributes of a general product category), brand loyalty (the extent of the faithfulness of consumer to a particular brand), brand perceived quality (consumer's opinion of a brand's ability to fulfill expectations) and other proprietary brand assets (patents, trademarks, and channel relationships that prevent the competitors from eroding a customer base). The stronger and more positive those factors, the higher brand price premium. Informational economics approach somewhat differently presents the issue of brand equity (Erdem and Swait (1998)). This concept emphasizes the incompleteness of signals coming from the market, which forces the consumer to make decisions in a situation of partial misinformation. In this context, the brand is understood as a source of information on the quality of goods, as well as a way to reduce purchase risks and costs of searching for the right product on the market. Brand price premium reflect the return on the investment in creating and strengthening the brand made by the company.

The value of the brand name and its strength affect the mechanisms that occur during the process of purchasing goods by the consumer. Cobb-Walgren et al. (1995) showed a significant positive correlation between brand equity and consumer's brand preference. Moreover, an increase in brand value translates into higher purchase intentions and significantly influences the final purchase decision made by the customer. The more frequent conviction that a product with a well-known name is better than other products contributes to the case of replacing the price of a product by its brand name as the predominant factor in the purchase decision process. Thus, for many companies the strengthening of brand equity has become one of the key elements of marketing strategy. The relationship and interactions between the brand and the actual purchase is schematically shown in Figure 1.

Brand is especially important on durable goods market, because of the specificity of the market and durable goods features. Durables typically cost substantially more than nondurable products and thus entail greater financial risk for consumers. Even though consumers are in the market for a short period and after purchase stay away for a long time, they undoubtedly spend a substantial amount of money in that period. The individual consumer is present on the market intermittently so it is difficult to evaluate the quality of the product before the purchase. Thus, customers

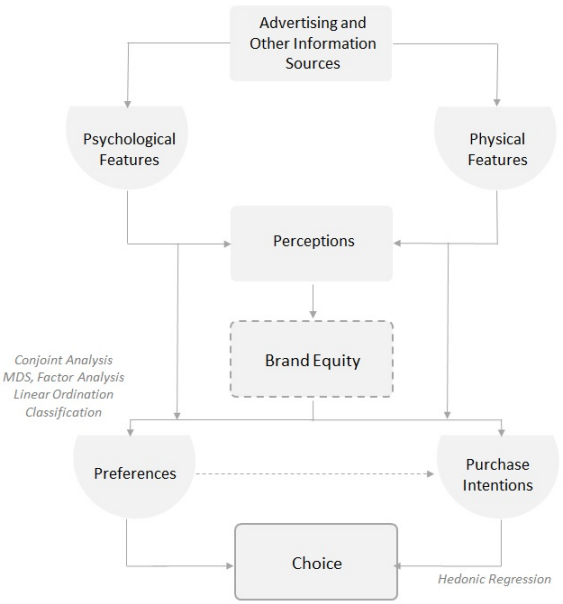

Figure 1: Brand equity in the purchase process (Source: based on Cobb-Walgren et al. (1995))

often rely on the brand name reputation in order to reduce the perceived risk and search costs.

Since in many cases brand is one of the most valuable intangible assets of the company, there is a necessity of developing accurate measures of brand equity. Brand equity measurement approaches include three main areas - one financial, and two more closely related to the marketing concepts (Keller and Lehmann (2006)):

- financial-based approach, which focuses on the monetary or financial value of the brand in the marketplace;
- consumer-based brand equity, which involves the value added to a product or service by consumers' associations and perceptions of a brand name;
- product-market-based approach.

It is worth noticing that brand in financial terms, as an asset of the company, is dependent on such factors as brand loyalty, brand awareness, perception of brand quality, brand associations (cf. Aaker (1991), which in fact are closely linked to the area of marketing in the company. Thus, financial and marketing approaches to

brand valuation are closely related and the measurement of brand value is a complex multi-level issue. This paper focuses mainly on methods of brand valuation and brand equity measurement from marketing perspectives, and thus consumer-based and product-market-based measurement approaches are analysed. Measuring brand as a financial resource - analyses of the company's assets and all related aspects in the accounting areas of the company's operations are not the subject of this study. Further aspects of the presented research concerning consumer preferences may be found in a paper by Dziechciarz-Duda and Król (2016).

2. Marketing approaches to brand equity measurement

From the marketing point of view both the product-market-based and consumer-based approaches are applied to brand valuation. In the product-market-based approach a strong brand is one that increases the effectiveness of advertising, differentiates the product from the competition and facilitates prospective expansion into new market segments. In this context, the brand value can be understood as an additional bonus due to the ownership of a particular brand, which is absent in the case of an equivalent, comparable product that does not have a strong brand. A common tool for brand valuation from the product-market perspective is the analysis of the price premium as an indicator of brand equity (Erdem et al. (1999); Netemeyer et al. (2004)). The price premium is defined as the amount of money the consumer is willing to pay for the product of preferred brand in comparison with other products having similar characteristics but different brand names (Kamakura and Russell (1993)). The price premium is considered as a valuable and comprehensive tool for brand equity measurement, which is in addition relatively easy to calculate and straightforward in interpretation. However, there are some critical views in the literature (Ailawadi et al. (2002)) indicating that the models used to calculate the price premium (e.g. hedonic models) do not directly capture the essential elements of the marketing mix (e.g. advertising). Nevertheless, it is assumed that the forces of supply and demand, as well as other market mechanisms take into account all these aspects indirectly. From that point of view hedonic modeling is a useful statistical tool in the analysis of brand value at the product level.

Numerous studies devoted to issues of brand valuation focus on the consumer-based brand equity. This approach to brand value analysis is considered especially valuable because it directly examines the consumer behavior, which provides the basis for formulating marketing strategies (Keller (1993)). According to this approach the subject of analysis is the type of associations with the brand that comes to the mind of the customer. Moreover, it is assumed that the unique, positive and strong associations influence purchasing decisions of potential customers. Brand

value at the consumer level is connected with the knowledge of the brand and types of reactions toward the brand, which can be expressed in five areas (Keller and Lehmann (2006)): awareness (ranging from recognition to recall), associations (encompassing tangible and intangible product considerations), attitude (ranging from acceptability to attraction), attachment (ranging from loyalty to addiction) and activity (including purchase and consumption frequency).

As mentioned before, the purchase process is a complex and multi-faceted operation (Figure 1), and the preferences of consumers (including the preference towards the brand), purchase intentions and the actual purchasing decision form composite relations. This raises the question whether declarative behaviours of the consumers always translate directly into actual purchasing decisions. As numerous research on the process of buying suggests, the declared preference towards the brand is highly correlated with customers' choices, but there are markets where this relationship is weaker. Undoubtedly, consumer durables market falls into that category. On durable goods markets, only few percent of the declared intention of buying is actually implemented (cf. Dziechciarz (2008), Cobb-Walgren et al. (1995), Morwitz and Schmittlein (1992)), which pose a particular challenge for analyses of consumer future reactions to the elements of marketing mix.

Given the above concerns, it seems reasonable to confront the results of studies assessing the brand at the consumer level with the objective study of the current market offer (product level approach). The combined application of these approaches to brand valuation and juxtaposition of the results of the brand analyses from the consumer and the market perspectives provides added value in the form of additional information and areas open to interpretation. On the basis of the consumer preferences research one can obtain information about subjective associations with the brand. Such a study is extremely valuable because it provides insights into individual attitudes of potential customers. The obvious disadvantage of this approach lies in its subjectivity. In addition, there are many signs saying that declarative behaviours do not always translate into actual purchasing decisions. Therefore, the authors believe that there is a need to confront the subjective brand valuations provided by the consumers with the information from the market (i.e. the calculated price premium based on existing market offer).

In the following part of the paper an empirical example illustrating the possible applications of multivariate statistical methods for the brand equity measurement for selected durable good - smartphone - will be presented. The estimated parameters from an econometric model based on the data showing the market offer will be compared with assessments of brands from a study of consumer preferences towards brands. Thus, on the product-market level of brand valuation, hedonic regression

model will be used. In turn, on the consumer-base level multidimensional scaling, linear ordering and hierarchical classification methods will be applied.

3. Data sets

The presented analyses have been carried out on two separate sets of data. On the product level the prices and significant characteristics of smartphones (including brands) were collected from price lists available on an Internet website of one of the biggest in Poland price comparison service provider, whereas on the consumer level the perception and attitudes of consumers towards the smartphone brands were measured using a specifically designed on-line survey. This two-sided approach enabled fuller and more comprehensible understanding of decision rules that guide consumers in choosing the brand of a smartphone.

3.1. Data set for hedonic analysis

Database used in this part of the study have been created using a tool for data collection from web pages created by the authors. The data originate from Polish price comparison service providers. The data set comprises 910 smartphones of 27 different brands offered in Internet shops in Poland in February 2015. Each offer is described by price (PRICE [PLN]) and the following smartphones' characteristics: SCREEN – screen size [inch], STORAGE – internal storage [GB] and CAMERA – camera resolution [Mpix]. Moreover, the following dummy variables (take value 1 if the feature is present and 0 otherwise) were used: LTE, GPS, ANDROID, as well as dummies representing the brands.

3.2. On–line survey data set

The data from on-line survey was gathered in February 2015 among the students of Wrocław University of Economics. The questionnaire was focused on measuring consumers' preferences towards smartphone characteristics and possible applications of the device. The sample consisted of 451 respondents selected based on their accessibility and proximity (convenience sampling).

The respondents were expected to asses popular brands of a smartphone, its important characteristics, as well as the common usage patterns of the device. Thus, in order to evaluate the analyzed criteria, each respondent have created his individual rankings of the brand names, the criteria, that would be taken into account while purchasing a smartphone and the common usage patterns of a smartphone. Moreover, the respondents have assessed the brand names of smartphones by assigning

the rate (on 5-point scale: 5 - highest rate, 1 - lowest rate) to five brand attributes: prestige, design, modernity, support and reliability.

4. Product level approach

4.1. Hedonic modelling

The foundations of hedonic methods are formed by the so-called hedonic hypothesis, which states that heterogeneous commodities are characterized by a set of relatively homogeneous attributes (characteristics) relevant both from the point of view of the customer and the producer (Brachinger (2002); Dziechciarz (2004)). The relationship between the price of commodity (*PRICE*) and the set of its characteristics (X) described by certain function f is called hedonic regression and may be described in the following general notation:

$$PRICE = f(X;\beta;\varepsilon), \tag{1}$$

where ε is the error term of the model. The estimate of the vector of parameters, obtained by estimation of the correctly specified hedonic regression model using data set, allows to calculate the prices of individual characteristics of the given good (so-called hedonic prices or implicit prices). It is assumed that the consumers derive utility from goods attributes, and therefore the hedonic prices reflect the willingness to pay for certain levels of attributes. In that context the hedonic model may be used to measure the brand price premium.

4.2. Estimation results

The results of estimation of the hedonic model for smartphone prices are presented in Table 1. The best functional form turned out to be the model with dependent variable transformed to logarithm (lnPRICE), and some of the independent variables in logarithmic transformation (SCREEN, CAMERA), and quadratic transformation (STORAGE). Due to heteroskedasticity of the error term weighted least squares method proposed by White (1980) was applied for model estimation.

Out of 27 brand names present in the dataset 18 were statistically significant (in the parentheses number of models representing given brand is given): ACER (11), ALCATEL (24), ALIGATOR (6), APPLE (40), ARCHOS (7), ASUS (6), BLACKBERRY (16), GIGABYTE (22), HTC (62), HUAWEI (37), LG (91), MOTOROLA (17), NOKIA (94), PRESTIGIO (41), SAMSUNG (217), SONY (87), ZOPO (15), ZTE (7). The remaining 9 brands formed the reference group: BE (9), GOCLEVER (25), KRUGER&MATZ (15), MANTA (6), MEDIA-TECH (10), MYPHONE (14),

OVERMAX (16), TELEFUNKEN (6), WIKO (9). Almost all variables in the model are highly statistically significant (on the significance level lower than 0.01). Variables ARCHOS and PRESTIGIO are significant on the level 0.05. The signs of obtained parameters estimates are in accordance with expectations. The goodness-of-fit of the model measured by adjusted R^2 statistic is on the satisfactory level 90.85%.

Table 1. Hedonic model estimation results

	Coefficient	*p*-value		Coefficient	*p*-value
constant	3.789830	0.0000	ASSUS	0.528194	0.0027
lnSCREEN	1.071200	0.0000	BLACKBERRY	0.806932	0.0000
lnCAMERA	0.340625	0.0000	GIGABYTE	0.347101	0.0000
STORAGE	0.031558	0.0000	HTC	0.707189	0.0000
STORAGE^2	−0.000348	0.0000	HUAWEI	0.383858	0.0000
ANDROID	−0.129963	0.0020	LG	0.354884	0.0000
GPS	0.120036	0.0015	MOTOROLA	0.422555	0.0000
LTE	0.149875	0.0000	NOKIA	0.288791	0.0000
ACER	0.407796	0.0000	PRESTIGIO	0.087313	0.0194
ALCATEL	0.281955	0.0000	SAMSUNG	0.512381	0.0000
ALIGATOR	0.419322	0.0017	SONY	0.500371	0.0000
APPLE	1.145070	0.0000	ZOPO	0.170541	0.0024
ARCHOS	0.136089	0.0408	ZTE	0.431813	0.0000

The estimated parameters for various brands in the hedonic model can be interpreted as brand premiums - the surplus amounts the consumers are willing to pay just because the smartphone is of a certain brand. Table 2 presents the brand premiums for the brand names which were assessed by the respondents in the second part of the study. For example, the most valued brand is Apple. The smartphones from this producer are on average about 215% more expensive in comparison to the smartphones with brands from reference group, ceteris paribus.

Table 2. Smartphone brand premiums

Brand name	Brand premium	Brand name	Brand premium
APPLE	214.27%	MOTOROLA	52.59%
BLACKBERRY	124.10%	HUAWEI	46.79%
HTC	102.83%	LG	42.60%
SAMSUNG	69.59%	NOKIA	33.48%
SONY	64.93%	GOCLEVER	-

5. Consumer level approach

For the analysis of the position of the brand at the consumer level three methods of multivariate statistical analysis have been applied. The first method, unfolding

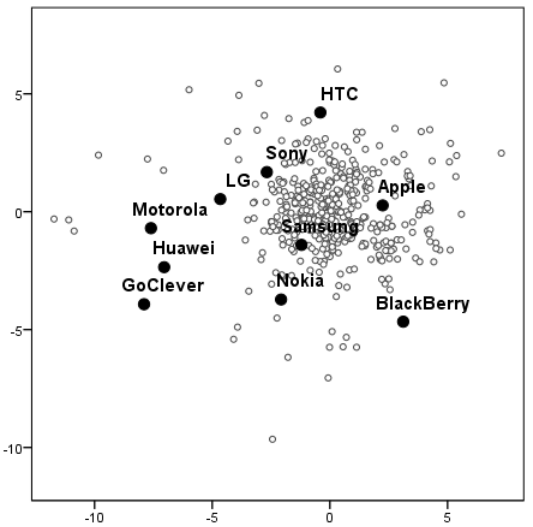

Figure 2: Preference map for smartphone brand names

analysis, belongs to a large group of multidimensional scaling methods, all of which result in the preference map creation. Multidimensional scaling is widely used in marketing research because it allows for intuitive interpretation of the results, including for example the evaluation of preference for brands (cf. Walesiak and Gatnar (2004)). The analysis was supplemented by the classification in which relatively homogeneous groups of brands were created. The similarity criterion in the clusters was the rating of selected brands of smartphones provided by the respondents. Both the perception map and the dendrogram obtained by the classification allows one to determine the groups of competing brands and provide guidance as to which brands are perceived by consumers as substitutes and which are considered exceptional. Additional analysis of consumers' preference towards brands included brands attributes such as: reliability, modernity, design, support, prestige and general brand image. On the basis of the respondents' evaluation of those criteria of brand quality, linear ordination was used, resulting in arrangement of brands from the most to the least preferred in view of the respondents.

5.1. Multidimensional scaling

In the presented empirical example, the PREFSCAL procedure of unfolding analysis was applied. The method allows for the presentation of objects and respondents in a joint two-dimensional space, which provides information on their co-existence.

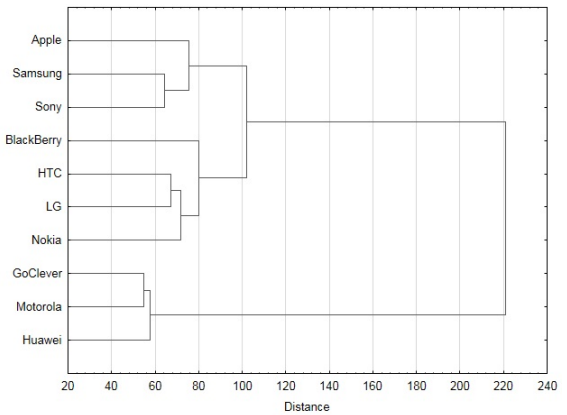

Figure 3: Dendrogram for smartphone brand names

The map of preferences (Figure 2) shows three groups of brands that are perceived by consumers in a similar manner. This observed result will be verified in the following example using hierarchical classification. By far the most preferred are the two leading brands in the market, Samsung and Apple, and slightly lower ranked is the Sony brand. Clearly, the Motorola, Huawei and GoClever brands are the least preferred by the respondents. In addition, it can be said that these brands (Motorola, Huawei and GoClever) are seen as substitutes, due to the small distance between these brands on the perception map. All other brands (Nokia, HTC, LG and BlackBerry) are valued by respondents with specific expectations and preferences.

5.2. Classification of brands

In the classification procedure the evaluations of respondents' preferences towards brands were again used. The clusters were created using Ward method, which assures high homogeneity of obtained groups (cf. Walesiak and Gatnar (2004)). As a result of the procedure, three classes of brands were created, which on the one hand led to the creation of brands groups perceived in a similar manner, and on the other hand provided the initial ranking of brand preference.

The analysis of dendrogram confirmed previous findings regarding smartphone brands preferences (Figure 3). As before, the most valued brands are Apple, Samsung and Sony. Similarly, the least valued brands (Motorola, Huawei and GoClever) are arranged in a clearly separate group. In addition, obtained classification gives the possibility to create a preliminary ranking of brand preferences according to the characteristics of established groups. Top rated are Apple, Samsung, and Sony, fol-

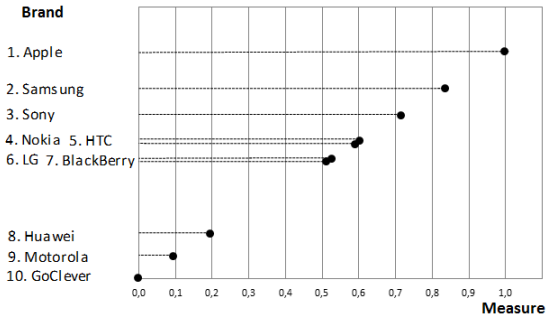

Figure 4: Measures of development for smartphone brands

lowed by another group, namely the brands BlackBerry, HTC, LG and Nokia. The brands GoClever, Motorola and Huawei are at the end of the ranking. This initial ranking is later verified using the classical method used to order objects according to multiple criteria at the same time - linear ordination.

5.3. Linear ordination

In the final step of customer-based brands analysis the ranking of smartphones' brands from the most to least preferred was created. The applied tool was one of the commonly used method of linear ordination - the index of the development method first introduced by Hellwig (1968). The method has been repeatedly discussed in the literature, detailed procedure is described in Dziechciarz et al. (1986). The principal idea is based on the concept that the best possible brand should have the shortest taxonomic distance from the pattern of development, and the longest distance from the anti-pattern of development. The pattern of development represents the abstract object for which all characteristic have the most desirable values, in the respondents' opinions. The anti-pattern of development is the reverse - the abstract brand with the worst possible attributes. The multi-attribute ranking was created using six criteria describing the brands (reliability, modernity, design, support, prestige and general brand image), all of which were stimulants. In the study weights were not applied because of the assumption of equal participation of each variable in the creation of the synthetic measure. The higher the values of development measure, the better the place of brand preferences in the ranking. Thus, the procedure of linear ordination method allowed to order smartphones' brands from the most to least preferred taking into account all mentioned criteria.

The illustration of the obtained result is presented in Figure 4. The undisputed

leader in the ranking of the most preferred brands is Apple. The following positions are occupied by Samsung and Sony, respectively. On subsequent places Nokia and HTC, as well as LG and BlackBerry brands are located. Among the least appreciated brands are Huawei, Motorola and GoClever.

6. Summary and conclusions

The juxtaposition of the results from two approaches - product level and customer level - provides additional information on consumer preferences for brands. The main idea is to compare and interpret the results obtained from the estimated hedonic model and summarized in Table 2 with the results from multivariate methods presented in Figures 2, 3 and 4. In the case of some brands (e.g. Apple, Samsung, Sony, GoClever) both approaches give similar results suggesting compatibility of respondents' preferences with market brand valuation from hedonic analysis. It is worth noticing that the strongest convergence of consumer preferences occurs for the most preferred brand (Apple) and the least respected brand - GoClever. In the case of other brands (e.g. BlackBerry, Motorola) the respondents tend to appreciate the brands less regardless of their higher valuation on the product level. Finally, some brands (e.g. Nokia) are highly preferred despite significantly lower influence of the brand on the product price.

The presented empirical example confirmed that the selected multivariate statistical methods used to analyze consumer preferences are especially valuable because of the possible applications in the field of brand valuation and brand equity measurement. Both the multidimensional scaling and hierarchical classification allowed us to determine the groups of brands most and least preferred. In addition, it was possible to determine the position of each brand against the competition, and an indication of complementary brands. In order to confirm the pre-developed linear ranking linear ordination was used, which ultimately helped to identify the most and least preferred brands. It should be emphasized that the results of analyzes carried out by various methods of multivariate statistical analysis presented in the section on consumer lever approach were very consistent. However, as previously mentioned, the results are burdened with the subjectivity of respondents, and also with the possibility that not all statements will be reflected in future activities of the consumers. For this reason it is advisable to supplement the analysis of consumers brand evaluation with objective analysis of the price premiums. The confrontation of the results of consumer-based research with product-market based hedonic modelling allowed us to identify similar as well as divergent areas in the conducted empirical example. Such approach allows one, for example, to indicate those brands which are overvalued by the market and those that could be priced higher. Moreover, the analysis

facilitates the distinction of segments within the market, and identification of brands that might be appreciated by the consumer with specific preferences.

Acknowledgements

The study was partly conducted in the framework of the research project entitled *The Application of Hedonic Methods in Quality-Adjusted Price Indices* (*Zastosowanie metod hedonicznych do uwzględniania różnic jakości dóbr we wskaźnikach dynamiki cen*). The project has been financed by the National Science Centre on the basis of decision no. DEC-2013/09/N/HS4/03645.

REFERENCES

AAKER, D. A., (1991). *Managing Brand Equity*, New York: The Free Press.

AILAWADI, K. L., LEHMANN, D. R., NESLIN, S., (2002). A Product-Market-Based Measure of Brand Equity. *Marketing Science Institute Working Paper*, 02-102.

AMERICAN MARKETING ASSOCIATION, (1960). *Marketing Definitions: A Glossary of Marketing Terms*, Chicago: American Marketing Association.

BALTAS, G., SARIDAKIS, C., (2010). Measuring Brand Equity in the Car Market: a Hedonic Price Analysis. *Journal of the Operational Research Society*, 61(2), 284–293.

BRACHIGNER, H. W., (2002). Statistical Theory of Hedonic Price Indices. *DQE Working Papers*, 1, Switzerland: Department of Quantitative Economics, University of Freiburg/Fribourg.

COBB-WALGREN, C. J., RUBLE C., DONTHU, N., (1995). Brand Equity, Brand Preference, and Purchase Intent. *Journal of Advertising*, 24(3), 25–40

DE CHERNATONY, L., DALL'OLMO RILEY, F., (1998). Defining a „Brand": Beyond the Literature with Experts' Interpretations. *Journal of Marketing Management*, 14(5), 417–443.

DZIECHCIARZ, J., et al., (1986). *Ekonometria z elementami programowania matematycznego i analizy porównawczej*, Bartosiewicz S. (ed.); Wrocław: Wyd. AE.

DZIECHCIARZ, J., (2004). Regresja hedoniczna. Próba wskazania obszarów stosowalności. In *Przestrzenno-czasowe modelowanie i prognozowanie zjawisk gospodarczych*. A. Zeliaś (ed.), Kraków: Wyd. AE, 163–175.

DZIECHCIARZ, M., (2008). Deklaracje intencji zakupu w analizie wyposażenia gospodarstw domowych w innowacyjne dobra trwałego użytku. In *Zastosowania badań marketingowych w procesie tworzenia nowych produktów (cena, opakowanie, znak towarowy)*, S. Kaczmarczyk, M. Schulz (eds.), Toruń: TNOIK, 157–166.

DZIECHCIARZ-DUDA, M., KRÓL, A., (2016). The Analysis of Consumers' Preferences with the Application of Multivariate Models: Hedonic Regression and Multidimensional Scaling. *Archives of Data Science*, under review.

ERDEM, T., SWAIT, J., (1998). Brand Equity as a Signalling Phenomenon. *Journal of Consumer Psychology*, 7(2), 131–157.

ERDEM, T., SWAIT, J., BRONIARCZYK, S., CHAKRAVARTI, D., KAPFERER, J. N., KEANE, M., ROBERTS, J., STEENKAMP, J-B. E. M., ZETTELMEYER, F., (1999). Brand Equity, Consumer Learning and Choice. *Marketing Letters*, 10(3), 301–318.

HELLWIG, Z., (1968), Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju oraz zasoby i strukturę wykwalifikowanych kadr, *Przegląd Statystyczny*, 4, 307–326.

KAMAKURA, W. A., Russell, G. J., (1993). Measuring Brand Value with Scanner Data. *International Journal of Research in Marketing*, 10(1), 9–22.

KELLER, K. L., (1993). Conceptualizing, Measuring, and Managing Customer-based Brand Equity. *Journal of Marketing*, 57(1); 1–22.

KELLER, K. L., LEHMANN, D. R., (2006). Brands and Branding: Research Findings and Future Priorities. *Marketing Science*, 25(6), 740–759.

MAURYA, U. K., MISHRA, P., (2012). What Is a Brand? A Perspective on Brand Meaning. *European Journal of Business and Management*, 4(3), 122–134.

MORWITZ, V., SCHMITTLEIN, D., (1992). Using segmentation to improve sales forecasts based on purchase intent: which „intenders" actually buy? *Journal of Marketing Research*, 29(4), 391–405.

NETEMEYER, R. G., KRISHNAN, B., PULLING, C., WANG, G., YAGCI, M., DEAN, D., RICKS, J., WIRTH, F., (2004). Developing and Validating Measures of Facets of Customer-based Brand Equity. *Journal of Business Research*, 57 (2), 209–224.

WALESIAK, M., GATNAR, E. (2004). *Metody statystycznej analizy wielowymiarowej w badaniach marketingowych*, Wrocław: Wyd. AE.

WHITE, H., (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48(4), 817–838.