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Multi-criteria and econometric evaluation of dairy products

Karmen Pažek, Jernej Turk, Sebjan Hari, Črtomir Rozman, Jernej Prišenk*

Department of Agricultural Economics and Rural Development, Faculty of Agriculture and Life Sciences Maribor, Pivola 10, 2311 Hoče, Slovenia

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Abstract

This study examined the multi-criteria assessment of four dairy products: "Pomursko mlejko" (Pomurje milk), "Lejko mleko" (light milk), "Fyto mleko" (Fyto milk) and "Posneto mleko v prahu" (dried milk). The research was executed by using a multi-criteria methodology, DEX, which was complemented by an econometric analysis for light milk to estimate the trends in production and consumption before analyzed dairy products were implemented on the market. DEXi computer program results indicated that all analyzed milk products were 'above average'. The econometric model was applied to examine changes in the demand for low-fat milk (light milk). Empirical results showed significant consumer response to the increase in the prices of low-fat milk demonstrating income elasticity (1,15 unit).

Key words: multi-attribute decision theory, DEXi, econometric analysis, milk products

Introduction

Production and marketing strategy is vital for any modern dairy enterprise. Efficient market performance enables entrepreneurs involved in milk processing to effectively pursue their business activities. Mura et al. (2012) explain that competition will force individual dairy companies to diversify their product range, maximize brand placement, and increase production with higher added value, especially in terms of future strategy. Pažek et al. (2011) used effect size and Cohen's-d index measures to analyze enterprises that introduced a new type of milk product (with phytoserol additives) to the market. Food economists and financial researchers have long been preoccupied by the issue of evaluating the performance of agri-food firms. In this aspect a new financial decision aid approach, which is based on data analysis techniques in combination with a multicriteria analysis method is presented by Kalogeras et al. (2005). In many applications it is necessary to use a simple econometric model as the basis for decision-making process (Skouras, 2001) and its evaluation of elasticity's that measure is used in economics to show the responsiveness (it gives the percentage change in quantity demanded in response to a one percent change in price). However, there has been little empirical research in the dairy industry thus far on issues concerning the application of joint multi-criteria and econometric analyses for estimating market performance. Some authors (e.g. Tiwari et al., 1999) asserted that business systems are complex and market criteria alone may be insufficient. Investments can be crucial to achieve product diversification, and hence, should be integrated in the planning process and decision-making strategies that are based in market opportunities too (Bojnec and Latruffe, 2011). It is important to note that multiple competitive criteria are likely to influence the decision-making process. A decision-making model must be able to evaluate all options when considering factors that influence on the decisions. A multi-criteria decision analysis (MCDA) approach can be used to assess different organizational and planning decisions. The application of MCDA in management, such as the DEX methodology employed in this paper, has been extensively discussed in the literature (Bohanec et al., 2007; Bohanec et al., 2008; Pavlovič et al., 2011; Prišenk et al., 2013).

*Corresponding author/Dopisni autor: Phone/Tel: +386 2 230 900; E-mail: karmen.pazek@um.si

Two modelling approaches are broadly used to estimate food-demand elasticity. The first involves a simple demand analysis by using the single equation estimation approach - Engel curve is estimated first, and then subsequently food expenditure and income elasticity are derived (Shaffer, 1993). The second approach to make econometric estimations is to first construct the demand system and then compute the compensated and uncompensated (Marshallian) price and expenditure elasticity. A demand system methodology has been widely applied in empirical research through the Almost Ideal Demand System (AIDS) model. Alston and Chalfant (1993) show that an entire body of modern literature concerning food-demand analyses is exclusively based on popular demand models such as the AIDS and Rotterdam models. The 'Linear Approximation of Almost Ideal Demand System (LA/AIDS) was employed in Slovene relations, where the demand for seven different food groups, including milk and milk products, was estimated (Erjavec et al., 1998). The authors reported that the own-price demand elasticity of most food products is inelastic (including for milk and milk products), while expenditure elasticity for milk/milk products approached 1.2, indicating milk and dairy by-products to be luxury goods.

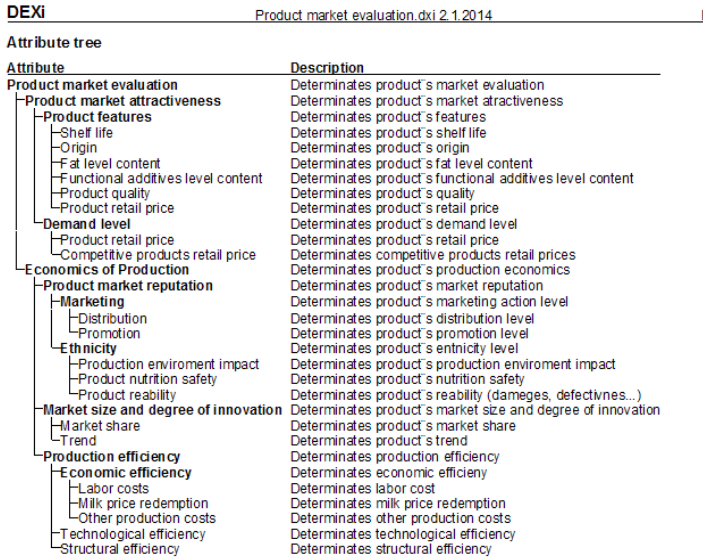
The main objective of this paper is to develop a DEXi multi-criteria decision support tool to assess four types of dairy products that are in the market implementation process in the observed agri-food business (in search of better returns, the milk industry is widening its focus to include and implement new milk products on the market). Further, an econometric analysis is provided to estimate production and consumption trends for one of the analyzed dairy product based on MCDA methodology. The paper first describes the development and application of the DEXi MCDA support tool and econometric model in the Materials and Methods section. Then the results of the multi-criteria analysis of the examined milk products using the DEX methodology and linear-logarithmic model are presented in the Results section. Finally, the last section presents the main findings and conclusions of this study.

Materials and methods

An economic crisis might have a significant impact on the food demand, including staple food products such as dairy products. These shifts in the economic system would largely affect only the higher or lower income groups of the population. An economic crisis might have a significant impact on the food demand, including staple food products such as dairy products, although consumers under rather severe deteriorating economic circumstances tend to exhibit even more drastic change of their purchasing patterns - towards basic commodities only (e.g. bread, milk, potato, etc.). One of the main aims of this research is to identify a few of these effects and evaluate their influence on market performance as well as the consumption structure of dairy products. The multi-criteria decision methodology is used to evaluate the market performance and the demand for the analyzed milk products. Hierarchical multi-criteria decision models (MCDM) are a general decision support methodology aimed at the classification or evaluation of options that occur in decision-making processes (Bouyssou et al., 2006).

DEX is a combination of traditional multi-attribute decision-making processes and specific elements of expert systems and machine learning techniques (Bohanec, 2003). The variables in this method are connected by utility functions, which are adjusted to the qualitative variables and hence represented by the "if-then" decision rules (elementary decision rules). They are usually arranged in a tabular form. The DEX method can be used for solving various decision problems in the real-world and is also supported by a software program called DEXi (Bohanec et al., 2000). A multi-attribute DEX model is characterized by the following (Bohanec, 2003):

- The model consists of variables called attributes that are structured hierarchically.
- All the attributes are qualitative rather than quantitative, with only a finite (and usually a small) number of discrete symbolic values included.
- The aggregation values of the model are defined by rules.



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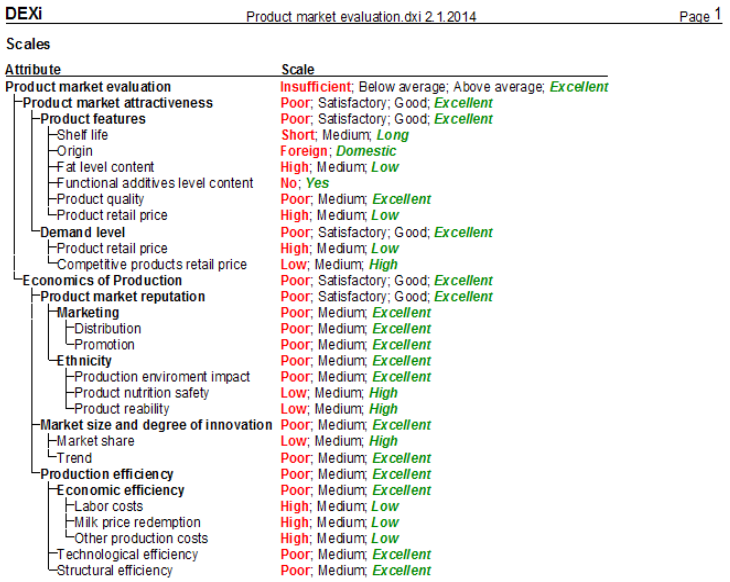
Attribute tree

Attribute	Description
Product market evaluation	Determinates product´s market evaluation
Product market attractiveness	Determinates product´s market atractiveness
Product features	Determinates product´s features
Shelf life	Determinates product´s shelf life
Origin	Determinates product´s origin
Fat level content	Determinates product´s fat level content
Functional additives level content	Determinates product´s functional additives level content
Product quality	Determinates product´s quality
Product retail price	Determinates product´s retail price
Demand level	Determinates product´s demand level
Product retail price	Determinates product´s retail price
Competitive products retail price	Determinates competitive products retail prices
Economics of Production	Determinates product´s production economics
Product market reputation	Determinates product´s market reputation
Marketing	Determinates product´s marketing action level
Distribution	Determinates product´s distribution level
Promotion	Determinates product´s promotion level
Ethnicity	Determinates product´s entnicity level
Production enviroment impact	Determinates product´s production enviroment impact
Product nutrition safety	Determinates product´s nutrition safety
Product reability	Determinates product´s reability (dameges, defectivnes...)
Market size and degree of innovation	Determinates product´s market size and degree of innovation
Market share	Determinates product´s market share
Trend	Determinates product´s trend
Production efficiency	Determinates production efficiency
Economic efficiency	Determinates economic efficieny
Labor costs	Determinates labor cost
Milk price redemption	Determinates milk price redemption
Other production costs	Determinates other production costs
Technological efficiency	Determinates technological efficiency
Structural efficiency	Determinates structural efficiency

Figure 1. Hierarchical model structure for assessment of milk product alternatives



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Scales

Attribute	Scale
Product market evaluation	Insufficient; Below average; Above average; ***Excellent***
Product market attractiveness	Poor; Satisfactory; Good; ***Excellent***
Product features	Poor; Satisfactory; Good; ***Excellent***
Shelf life	Short; Medium; ***Long***
Origin	Foreign; ***Domestic***
Fat level content	High; Medium; ***Low***
Functional additives level content	No; ***Yes***
Product quality	Poor; Medium; ***Excellent***
Product retail price	High; Medium; ***Low***
Demand level	Poor; Satisfactory; Good; ***Excellent***
Product retail price	High; Medium; ***Low***
Competitive products retail price	Low; Medium; ***High***
Economics of Production	Poor; Satisfactory; Good; ***Excellent***
Product market reputation	Poor; Satisfactory; Good; ***Excellent***
Marketing	Poor; Medium; ***Excellent***
Distribution	Poor; Medium; ***Excellent***
Promotion	Poor; Medium; ***Excellent***
Ethnicity	Poor; Medium; ***Excellent***
Production enviroment impact	Poor; Medium; ***Excellent***
Product nutrition safety	Low; Medium; ***High***
Product reability	Low; Medium; ***High***
Market size and degree of innovation	Poor; Medium; ***Excellent***
Market share	Low; Medium; ***High***
Trend	Poor; Medium; ***Excellent***
Production efficiency	Poor; Medium; ***Excellent***
Economic efficiency	Poor; Medium; ***Excellent***
Labor costs	High; Medium; ***Low***
Milk price redemption	High; Medium; ***Low***
Other production costs	High; Medium; ***Low***
Technological efficiency	Poor; Medium; ***Excellent***
Structural efficiency	Poor; Medium; ***Excellent***

Figure 2. Basic structure of the decision model with descriptions of values

The hierarchical model structure was used to examine the milk product alternatives (defined as Product Market Evaluation in the hierarchical structure) and was defined by a focus group consisting of experts involved in the decision-making process in concerned enterprises. First, two main criteria for the analysis were identified and incorporated into the model structure, namely, a) product market attractiveness and b) economics of production. Then, the two sets of criteria were divided into subgroups, and finally they were divided further in the final evaluation of the analyzed products. The hierarchical DEXi model structure is presented in Figure 1.

The attributes at the lowest level were basic descriptors of model alternatives such as shelf life, origin and fat level content (Figure 1). These basic descriptors represented model inputs, which were provided by the decision maker. Figure 2 shows discrete value sets that characterized all attributes in the model.

	Product retail price	Competitive products retail price	Demand level
	50%	50%	
1	High	<=Medium	Poor
2	<=Medium	Low	Poor
3	High	High	Good
4	Medium	Medium	Good
5	Low	Low	Good
6	>=Medium	High	Excellent
7	Low	>=Medium	Excellent

	Product market reputation	Market size and degree of innovation	Production efficiency	Economics of Production
	44%	28%	28%	
1	Poor	Poor	<=Medium	Poor
2	Poor	<=Medium	Poor	Poor
3	Poor	*	Excellent	Satisfactory
4	<=Satisfactory	Poor	Excellent	Satisfactory
5	Poor	>=Medium	>=Medium	Satisfactory
6	<=Satisfactory	Medium	Medium	Satisfactory
7	Poor	Excellent	*	Satisfactory
8	<=Satisfactory	Excellent	Poor	Satisfactory
9	Satisfactory	Poor	*	Satisfactory
10	Satisfactory	<=Medium	<=Medium	Satisfactory
11	Satisfactory	*	Poor	Satisfactory
12	Satisfactory:Good	Poor	<=Medium	Satisfactory
13	Satisfactory:Good	<=Medium	Poor	Satisfactory
14	Satisfactory:Good	>=Medium	Excellent	Good
15	Satisfactory:Good	Excellent	>=Medium	Good
16	Good	*	Excellent	Good
17	>=Good	Poor	Excellent	Good
18	Good	>=Medium	>=Medium	Good
19	>=Good	Medium	Medium	Good
20	Good	Excellent	*	Good
21	>=Good	Excellent	Poor	Good
22	Excellent	Poor	*	Good
23	Excellent	<=Medium	<=Medium	Good
24	Excellent	*	Poor	Good
25	Excellent	>=Medium	Excellent	Excellent
26	Excellent	Excellent	>=Medium	Excellent

	Marketing	Ethnicity	Product market reputation
	90%	10%	
1	Poor	*	Poor
2	Medium	Poor	Satisfactory
3	Medium	>=Medium	Good
4	Excellent	*	Excellent

Figure 3. Examples of some decision rules with utility function for presented case

Figure 3 shows the decision rules in a so-called complex form with headings displaying the approximate weights assigned to the attributes; the so-called 'weight-based strategy' of defining decision rules was used. The symbols '< =' and '> =' defined value intervals for the relevant attribute. An asterisk in the evaluation indicated any potential value. The relative importance of the attributes was expressed by weights, as seen at the top of Figure 3. These weights were estimated by DEX by using a linear regression method (Rozman et al. (2009), where DEX interpolated the values of previously undefined rules in the table. The linear coefficients responded to the required weights, and its surface was as close as possible to the subset of rules initially specified (Pavlovič et al., 2011). In practical terms, the magnitude of the weight was directly proportional to the importance of the attribute. The difference between local and global weights is due to the tree of attributes. Local weights refer to a single aggregate attribute and a single corresponding utility function, so that the sum of weights of the attribute's immediate descendants (function arguments) is 100 %. Global weights, on the other hand, take into account the structure of the tree and relative importance of its sub-trees. A global weight of an attribute is calculated as a product of the local weight and the global weight of the attribute that lies one level above. A global weight of the root attribute is 100 % (as seen in Figure 5) (DEXi, 2014).

Each attribute was first assigned a scale, and then the utility functions were defined, as shown in Figure 5. The utility functions evaluate and define an individual attribute in relation to its immediate descendants in the hierarchy. A utility function procedure was derived for each level in the hierarchy; partial utility function was derived for aggregate attributes and overall utility function for the whole model except for the lowest level. DEX uses qualitative variables, whose values are usually represented by words rather than numbers, for example "poor", "medium", "excellent", etc. Furthermore, to represent and evaluate decision alternatives, DEX uses "if-then" decision rules. For instance, a decision rule can be: "if the Distribution is "excellent" or "medium" and Promotion is "poor", then the alternative is evaluated as "Above average". Further, "if the Distribution and Promotion are "poor", the alternative is evaluated as "Below average" This is in contrast with more common quantitative MCDA, which use utility functions that employ weights, such as the expected value or weighted sum. Average weights for final Product market evaluation are presented in next figure (Figure 4).

The first part of the example illustrating the decision rules for the observed problem is presented in Figure 5. The decision rules, which are acquired from the model developer describe the mapping of the two main attributes, five sub-attributes and other sub-sub attributes as well as the final cumulative attribute assessment into the overall product market evaluation (as seen in Figure 2). Complex rules are

obtained by joining several elementary rules which have the same function value.

Further an econometric analysis of observed dairy production was provided. One objective of this empirical study was to evaluate the genuine response of low-fat milk consumers to price changes as well as yogurt prices. It also aimed to predict consumer reactions to changes in consumer income (average net salaries). The model specification was derived by including an endogenous variable (demand for low-fat milk) and three exogenous variables (price of low-fat milk, price of yogurt and average net salary in Slovenia). The data collected from the Statistical Office of Republic of Slovenia (2011) was for the period 2000-2008. The data were also deflated by the Wholesale Price Index (WPI). The applicability of the data series is a key element in conducting single equation estimation (evident in cases requiring a sophisticated system demand approach), especially if certain discrepancies in the official statistical data may have occurred. This suggests that any econometric analysis will be difficult to perform without proper data sets that is presented in Table 1.

The linear-logarithmic (lin-log) model yielded the most reliable empirical results and was supported by corresponding statistical tests and reliable econometric validation:

$$y1 = \ln\alpha + \beta\ln x1 + \gamma\ln x2 + \delta\ln x3 + u_t$$

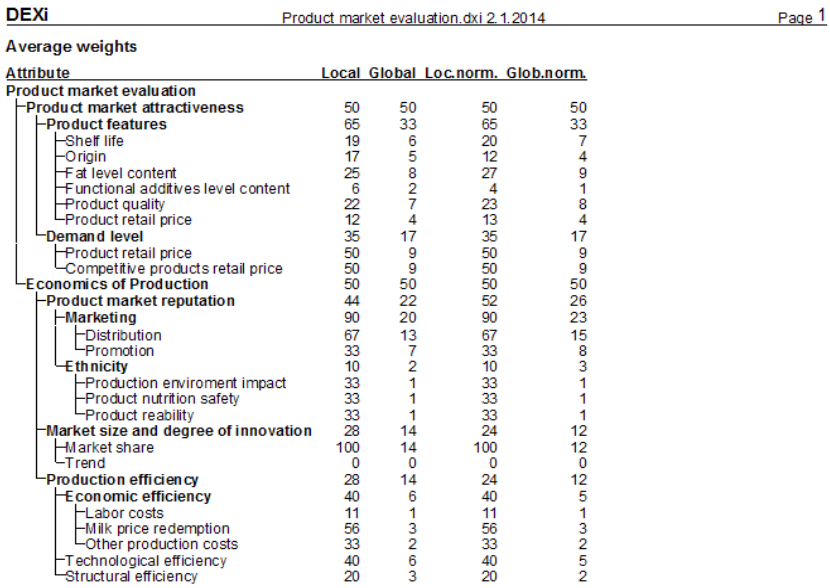
where: y1 = demand for low-fat milk, α = intercept, β,γ,δ = parameter estimates, x1 = price of low-fat milk, x2 = average net salary, x3 = price of yogurt, u_t = random residual.

Results and discussion

The milk product alternatives that were analysed by the multi-criteria decision theory were "Pomursko mlejko" (Pomurje milk), "Lejko mleko" (light milk), "Fyto mleko" (Fyto milk) and "Posneto mleko v prahu" (dried milk). The input data for the DEXi model analysis were gathered by the enterprise's focus group. The data comprised two

Table 1. Input data aid for econometric empirical analysis

Parameter/year	2000	2001	2002	2003	2004	2005	2006	2007	2008
y1 (€)	15,35	15,92	18,85	21,44	24,58	26,05	27,98	28,99	28,98
x1 (€ for 1)	0,65	0,69	0,72	0,71	0,71	0,69	0,68	0,76	0,95
x2 (€)	503,50	562,60	617,30	663,70	693,00	736,00	773,20	834,20	899,60
x3 (€ for kg)	1,65	1,69	1,83	1,88	1,86	1,83	1,92	2,14	2,58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Average weights

Attribute	Local	Global	Loc.norm.	Glob.norm.
Product market evaluation				
Product market attractiveness	50	50	50	50
Product features	65	33	65	33
Shelf life	19	6	20	7
Origin	17	5	12	4
Fat level content	25	8	27	9
Functional additives level content	6	2	4	1
Product quality	22	7	23	8
Product retail price	12	4	13	4
Demand level	35	17	35	17
Product retail price	50	9	50	9
Competitive products retail price	50	9	50	9
Economics of Production	50	50	50	50
Product market reputation	44	22	52	26
Marketing	90	20	90	23
Distribution	67	13	67	15
Promotion	33	7	33	8
Ethnicity	10	2	10	3
Production enviroment impact	33	1	33	1
Product nutrition safety	33	1	33	1
Product reability	33	1	33	1
Market size and degree of innovation	28	14	24	12
Market share	100	14	100	12
Trend	0	0	0	0
Production efficiency	28	14	24	12
Economic efficiency	40	6	40	5
Labor costs	11	1	11	1
Milk price redemption	56	3	56	3
Other production costs	33	2	33	2
Technological efficiency	40	6	40	5
Structural efficiency	20	3	20	2

Figure 4. DEXi model structure with average weights

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	Shelf life	Origin	Fat level content	Functional additives level content	Product quality	Product retail price	Product features
	19%	17%	25%	6%	22%	12%	
1	Short	Foreign	High	*	Poor	*	Poor
2	Short	Foreign	High	*	<=Medium	High	Poor
3	Short	Foreign	<=Medium	No	Poor	High	Poor
4	Short	*	High	No	Poor	<=Medium	Poor
5	Short	*	High	*	Poor	High	Poor
6	<=Medium	Foreign	High	*	Poor	High	Poor
7	Short	Foreign	High	*	>=Medium	>=Medium	Satisfactory
8	Short	Foreign	<=Medium	*	Medium	>=Medium	Satisfactory
9	Short	Foreign	<=Medium	*	>=Medium	Medium	Satisfactory
10	Short	Foreign	*	No	Medium	Medium	Satisfactory
11	Short	*	High	No	>=Medium	>=Medium	Satisfactory
12	Short	*	High	*	>=Medium	Medium	Satisfactory
13	Short	*	<=Medium	No	Medium	>=Medium	Satisfactory
14	Short	*	<=Medium	*	Medium	Medium	Satisfactory
15	<=Medium	Foreign	High	No	>=Medium	>=Medium	Satisfactory
16	<=Medium	Foreign	High	*	>=Medium	Medium	Satisfactory
17	<=Medium	Foreign	<=Medium	*	Medium	Medium	Satisfactory
18	<=Medium	*	High	*	Medium	>=Medium	Satisfactory
19	*	Foreign	High	No	Medium	>=Medium	Satisfactory
20	*	Foreign	High	*	Medium	Medium	Satisfactory
21	Short	Foreign	High	*	Excellent	*	Satisfactory
22	Short	Foreign	<=Medium	*	Excellent	<=Medium	Satisfactory
23	Short	*	High	No	Excellent	*	Satisfactory
24	Short	*	High	*	Excellent	<=Medium	Satisfactory
25	Short	*	<=Medium	No	Excellent	High	Satisfactory
26	<=Medium	Foreign	High	No	Excellent	*	Satisfactory
27	<=Medium	Foreign	High	*	Excellent	<=Medium	Satisfactory
28	<=Medium	Foreign	<=Medium	No	Excellent	High	Satisfactory
29	<=Medium	*	High	*	Excellent	High	Satisfactory
30	*	Foreign	High	*	Excellent	High	Satisfactory
31	Short	Foreign	Medium	*	<=Medium	>=Medium	Satisfactory
32	Short	Foreign	Medium	*	*	Medium	Satisfactory
33	Short	Foreign	>=Medium	No	<=Medium	Medium	Satisfactory
34	Short	Foreign	>=Medium	*	Poor	>=Medium	Satisfactory
35	Short	*	Medium	No	<=Medium	>=Medium	Satisfactory
36	Short	*	Medium	*	Poor	>=Medium	Satisfactory
37	Short	*	Medium	*	<=Medium	Medium	Satisfactory
38	Short	*	>=Medium	*	Poor	Medium	Satisfactory
39	<=Medium	Foreign	Medium	*	Poor	>=Medium	Satisfactory
40	<=Medium	Foreign	Medium	*	<=Medium	Medium	Satisfactory
41	<=Medium	Foreign	>=Medium	*	Poor	Medium	Satisfactory
42	<=Medium	*	Medium	No	Poor	>=Medium	Satisfactory
43	<=Medium	*	Medium	*	Poor	Medium	Satisfactory
44	*	Foreign	Medium	No	Poor	>=Medium	Satisfactory
45	*	Foreign	Medium	*	Poor	Medium	Satisfactory

Figure 5. Defined decision rules with utility functions for presented case

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Evaluation results

Attribute	Pomursko mlejko	Lejko mlejko	Fyto mlejko	Posneto mleko v prahu
Product market evaluation	Above average	Above average	Above average	Above average
├Product market attractiveness	Good	Good	Good	Excellent
│├Product features	Good	Good	Good	Excellent
││├Shelf life	Long	Long	Long	Long
││├Origin	Domestic	Domestic	Domestic	Domestic
││├Fat level content	High	Medium	Medium	Low
││├Functional additives level content	No	No	Yes	No
││├Product quality	Excellent	Excellent	Excellent	Excellent
││└Product retail price	Medium	Low	Medium	High
│└Demand level	Good	Excellent	Excellent	Good
│├Product retail price	Medium	Low	Medium	High
│└Competitive products retail price	Medium	Medium	High	High
└Economics of Production	Good	Good	Satisfactory	Satisfactory
├Product market reputation	Good	Good	Good	Good
│├Marketing	Medium	Medium	Medium	Medium
││├Distribution	Excellent	Excellent	Excellent	Medium
││└Promotion	Poor	Poor	Poor	Poor
│└Ethnicity	Excellent	Excellent	Excellent	Excellent
│├Production enviroment impact	Excellent	Excellent	Excellent	Excellent
│├Product nutrition safety	High	High	High	High
│└Product reability	High	High	High	High
├Market size and degree of innovation	Medium	Medium	Poor	Poor
│├Market share	Medium	Medium	Low	Low
│└Trend	Poor	Excellent	Excellent	Excellent
└Production efficiency	Medium	Medium	Medium	Medium
├Economic efficiency	Medium	Medium	Medium	Medium
│├Labor costs	Low	Low	Low	Low
│├Milk price redemption	High	High	High	High
│└Other production costs	Medium	Medium	Medium	Medium
├Technological efficiency	Medium	Medium	Medium	Medium
└Structural efficiency	Medium	Medium	Medium	Medium

Figure 6. Integrated final assessment of single milk product business alternatives

aggregate attributes by the utility function, and an integrated assessment of a particular milk product was determined, as seen in Figure 6.

We concluded from the results in Figure 6 that the main issue facing the concerned enterprise is the implementation of the product to the market and its productivity and commercial success. As seen in Figure 6, all business alternatives were ranked above average. On the one hand, "Pomursko mlejko" (Pomurje milk) and "Lejko mljeko" (Light milk) were found to be efficiently manufactured and easily marketable, while on the other, "Posneto mleko v prahu" (dried milk) was found to have excellent market attractiveness but only satisfactory production efficiency. "Fyto mlejko" (Fyto milk) was ranked slightly lower, with good market attractiveness and satisfactory economics of production. However, to improve the final evaluation of each business alternative, a detailed analysis of the decision model was conducted. As seen in Figure 7, with regard to the criterion economics of production, the enterprise showed rather uniform production.

A detailed model analysis showed that "Posneto mleko v prahu" and "Fyto mlejko" were inferior to the other two alternatives, due to a lack of size and degree of innovation and low market share. The conclusion, based on the model results, was that the enterprise has homogeneous economic efficiency in dairy production. This means that the structural, technological and economic effectiveness for all analyzed dairy products was the same, namely, "medium".

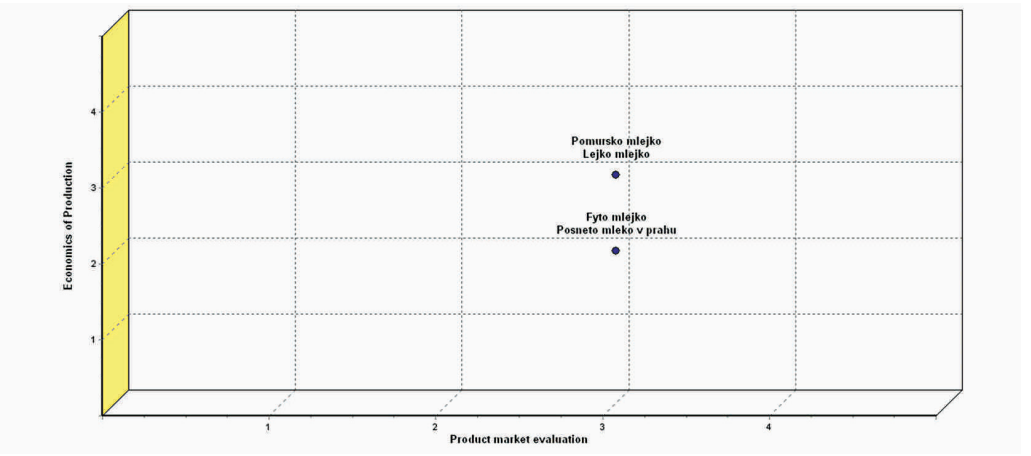
When considering the attribute of ethnicity, factors such as the environmental impact, safety and reliability of the product were considered. All these three sub-attributes received the highest rating because no allergies have been reported and the products have no additives or features that could have a negative impact on consumer health or the environment, i.e., product packaging.

In the marketing sub-attribute, we considered the effectiveness of product promotion and distribution. The enterprise jointly promotes its products instead of advertising individual or groups of products (e.g., Pomurje milk and yoghurt). Moreover, its promotional campaign performance is significantly lower than that of its competitors. Therefore, the promotional campaign of the analyzed dairy products was considered to be "bad". The distribution of the first three milk products was marked as 'excellent' as the enterprise distributes these products in three major Slovene trading enterprises. The distribution of the fourth milk product is, however, limited to the largest shopping centers in Slovenia (in the model marked as "medium").

The concept of "product market attractiveness" focuses on the factors related to customer perception (Figure 8). Consumer trends show a declining interest in the fat content of milk due to health concerns and increased use of milk protein and various functional additives (omega-3 fatty acids, coenzyme Q10, plant sterols, etc.). Therefore, following the evolution of consumer preferences, habits and competitive products, milk products 2, 3 and 4 were assessed as "trendy".

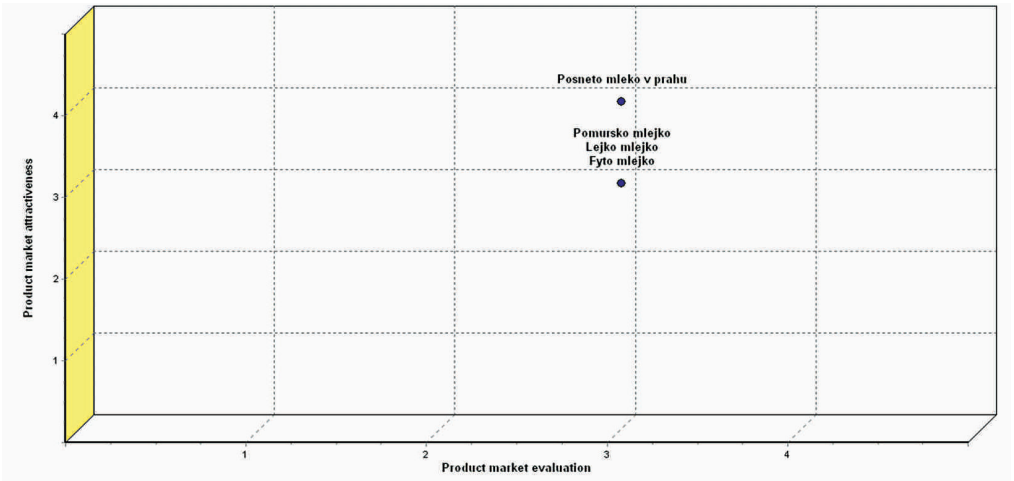
"Posneto mleko v prahu" received the highest score of 4 for product market attractiveness, while the other three analyzed milk products were assessed as "good". However, as seen in Figure 8, the analyzed milk product "Posneto mleko v prahu", with the highest level of marketing attractiveness, was deemed "satisfactory" in the attribute economics of production. Therefore, a challenge for the enterprise is that customers are attracted to a product that has higher economics of production over similar products with lower economics of production.

With regard to the demand level attribute, the products were evaluated using market research based on price comparisons between own products and mutual comparisons between own and competitor products. In the mutual comparison, the retail price was lower for "Lejko mlejko". The attribute "product features" was defined on the basis of the results of surveys on the demand for milk from the enterprise (336 surveys). According to these results, "Posneto mleko v prahu" was assessed as "excellent" because of its high quality, long shelf-life and especially its low fat content (defined as



*Economics of Production: 1 - poor, 2 - satisfactory, 3 - good, 4 - excellent; Product market evaluation: 1 - insufficient, 2 - below average, 3 - above average, 4 - excellent

Figure 7. Economics of production alternatives ranking



*Product market attractiveness: 1 - poor, 2 - satisfactory, 3 - good, 4 - excellent; Product market evaluation: 1 - insufficient, 2 - below average, 3 - above average, 4 - excellent

Figure 8. Assessment of product market attractiveness of analyzed milk products

the factor that most influences the market attractiveness of the product). The other three products were deemed "good". According to the results is the model sufficiently sensitive to generate other scenario analysis.

A compiled data set also allowed us to conduct econometric analysis on the demand for low-fat milk. Because of the existing constraints in data availability, individual equation estimation was performed instead of the complex system of the demand approach. The model evaluation referring to economic, statistical and econometric criteria suggested that the lin-log functional form estimation was the best empirically supported single-equation model. Hence, empirical application is not very challenging to execute, and the results are simple enough to be interpreted with relative ease. The econometric analysis provided a proper empirical framework to investigate the basic demand trends and enabled the computation of own price, cross price and income demand elasticities as seen in Figure 9:

The single equation was developed to demonstrate the change in demand for low-fat milk. A specified equation for low-fat milk demand was estimated by using the OLS method. Econometric estimates are well supported with statistical tests (t-test, R^2), while Durbin Watson (D.W.) shows that there is no problem of autocorrelation. Hence, the empirical results derived refer to own price, cross price and income elasticity. The demand for low-fat milk was found to be price elastic, indicating relatively high responsiveness of consumers to price alterations. The results showed that an increase in low-fat milk prices led to a decline in its demand by 1.15 %. This indicated a price elastic response on the part of consumers, which aligns with the study by Haidacher et al. (1988). It is evident that an increase in average net salaries, as well as a rise in yoghurt prices, boosts the demand for low-fat milk. While the range of income elasticity (1.24) indicated that low-fat milk could be perceived as a luxury good, the positive sign of the cross price elasticity

$$\hat{y} = -184 - 26.61\ \ln x_1 + 28.71\ \ln x_2 + 16.96\ \ln x_3 \qquad R^2 = 0.97 \qquad D.W. = 1.96$$

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-184,000	23,607		-7,794	,001	-244,683	-123,318
	lnx1	-26,606	12,995	-,539	-2,047	,096	-60,011	6,798
	lnx2	28,706	5,304	,985	5,412	,003	15,071	42,341
	lnx3	16,959	15,661	,419	1,083	,328	-23,298	57,216

a. Dependent Variable: y1

Figure 9. Model summary output for dependent variable "demand for low-fat milk"

value (0.73) denoted that low-fat milk and yogurt were considered important for subsistence.

The increase in demand for low-fat milk indicated that its consumption has become more responsive to price changes. The cross price elasticity estimate was inelastic but established a strong link between the demand for low-fat milk and yoghurt. Yoghurt and low-fat milk have become increasingly price elastic indicating that they are viewed as important for subsistence. The high value of income elasticity revealed consumer behavioral patterns suggesting that low-fat milk is considered as a luxury good in Slovene regions. The latter result corroborates the empirical derivations of Erjavec et al. (1998), who also obtained similar values of demand-expenditure elasticity for milk.

Conclusions

This research uses two approaches, namely, a) the multi-criteria approach and b) the econometric approach, in order to exploit a limited data set and analyze the price elasticity of four dairy products. The developed multi-attribute DEXi model can be regarded and applied practically to a broader sphere of dairy production enterprises. The model can be applied to similar new dairy's product evaluation, however if necessary appropriate changes in the hierarchy and decision rules should be made with respect to producers or product specifics'. This kind of model is comprehensible to a wide range of users in the evaluation process. It can be used in business planning and strategic enterprise developments. The model features such as sensitivity analysis and visualization, which contribute to the comprehensibility and justification of the assessment process, and may also give specific advice to the management and product developers on how to improve market acceptance of the new dairy product. In addition, it can be upgraded with the latest information and adapted to specific requirements. The multi-criteria methodology cannot replace or exclude the management or decision-making experts, but it can be a tool to conduct efficient analyses. Further, a simple econometric analysis was designed to provide empirically supported indices to make coherent policy recommendations. The own-price demand elasticity for low-fat milk shows that consumers would respond strongly to changes in its prices, while the cross-price elasticity value infers substitutes between low-fat milk and yoghurt. The most striking result probably comes from the relatively high value of income demand elasticity for low-fat milk. This can be explained by changes of consumption habits (diet) as well as the lower purchasing power of many domestic consumers who are seeking new 'popular' food commodities. Milk consumption is high in Slovenia and the consumers are sensitive to changes in their economic environment. These findings are compelling, especially if applied to other dairy and food products.

Višekriterijski i ekonometrijski pristup ocjenjivanja mliječnih proizvoda

Sažetak

Multikriterijski pristup ocjenjivanja mliječnih proizvoda u smislu upotrebe DEX bio je nadograđen ekonometrijskom analizom za ocjenjivanje proizvodnih i potrošačkih trendova prije negoli su analizirani proizvodi uvršteni u prodaju. Studija istražuje četiri različita mliječna proizvoda odnosno proizvodne alternative: "Pomursko mlejko", "Lejko mleko", "Fyto mleko" i "Posneto mleko v prahu". Rezultati DEXi analize ukazuju na to da se svi analizirani mliječni proizvodi svrstavaju u kategoriju "iznadprosječni". Istraživana je mogućnost poboljšanja situacije s mlijekom u prahu preko povećanja njegove distribucijske moći na tržištu, te je pri tome upotrijebljena "what-if'" ("što-ako") analiza. U zadnjoj fazi izgrađen je ekonometrijski model za ocjenjivanje promjena u strukturi potraživanja mlijeka s malim postotkom masnoće. Empirijski rezultati pokazali su veliku reakciju kupaca na promjene u cijenama te vrste mlijeka, s relativno visokim vrijednostima elastičnosti potraživanja (1,15 jedinice).

Ključne riječi: multikriterijska teorija odlučivanja, DEXi, ekonometrijska analiza, mliječni proizvodi

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