

SZENT ISTVÁN UNIVERSITY  
**Doctoral School of Economics and Organisational  
Sciences**

**ANALYSIS OF DOMESTIC FOODSTUFF SUPPLY  
CHAIN, FOCUSING ON CONSUMER RISKS**

THESES OF DOCTORAL (PhD) STUDY

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# 1. INTRODUCTION

## *1.1 Actuality of the topic*

In recent decades, there were significant changes in the foodstuffs supply chain, including the supply chain of fruits and vegetables. One part of these changes is the structural reorganisation of the foodstuffs supply chain. The other is the strengthening of its internal coordination and integration. One of the reasons the chain changed is that agro-products and foodstuffs' international trade was liberalised (GATT, WTO agreements). This caused a globalisation effect: the international capital flow strengthened, multi-national corporations came forward one after the other, the international market competition radically hastened, and the market became more and more dense. One important by-product of the abovementioned processes was that the role of traditional government regulation became less pronounced, and the subsidies agro- and foodstuff products received diminished. While the international foodstuffs market globalised, a regionalisation tendency was also apparent, f. e. the expansion of the European Union, and the appearance of NAFTA and LAFTA. The globalisation and regionalisation processes of international trade impacted local foodstuffs systems a lot, diminished their roles, thereby pushing their re-organisation back to the previous decade.

The structural change in foodstuffs supply chains was fundamentally determined by the appearance of coordination points within them, and these points gaining significant ground. These are the following: biological input sectors, and foodstuffs retailing. Biological input sectors (sowings, mother spawn production, pesticides, chemical manure production and bio-technological activities) were integrated into various systems of an enterprise more and more, and their size and market share increased significantly. The other coordination point is the foodstuffs retailing, which obtained a well-defined market influence, via the concentration and integration of retailing (most notably foodstuffs wholesale trade and foreign trade). The concentration of various forms of retailing related to foodstuffs gained ground both on the global market, and on markets on the continents. This caused a significant effect on the market players in the background of our domestic foodstuffs supply chain. The most important tool of coordination was shaping the prices at first (matching consumer and retail prices). Later, this was replaced by product development (contractual production agreements, retail foodstuff brands, other technological, procurement and production requirements), changing the sales channels, and re-structuring the connection between the players in the supply chain. During the recent period, marketing-communications also gathered in the hand of retailer companies, while the communication expenses within the mart increased, causing the external expenses' share to reduce. The abovementioned

coordination points strengthened significantly, which also caused the agricultural base material production to industrialise, which resulted in a production, process and distribution systems of high intensity and resource consumption.

The processes moving within the foodstuffs supply chain (product, financial, information, control and coordination) formed a system, which had to be harmonised with utmost urgency. The global foodstuffs structure organised more and more differentiated production methods, human healthcare (labour force) requirements into a single system, which caused the quality of foodstuffs and security of foodstuffs to be highly important problems. The previous process also caused an increase in the importance of foodstuff risks, and the frequency of their related scandals. Foodstuffs quality and security management systems' harmonisation, the structuring of a process regulation system, and its improvement created completely new forms of coordination, like HACCP, the ISO systems, and the private standard systems related to these.

The creation of the previously mentioned systems was accompanied by the creation and harmonisation of information processes within the foodstuffs supply chain. Within this, the foodstuffs tracing system became the most important, which transformed into an obligatory accessory of entering some specific markets. The abovementioned processes were impacted by the increased awareness of foodstuffs consumers related to foodstuffs risks, which was further spurred by new and modern analytics tools, the fast-response systems, and the media, which overstressed foodstuffs risks. The radical increase in foodstuffs risk importance became the most notable roadblock for foodstuffs trade both internationally, and in the national market environment.

## ***1.2 Main goals of the doctoral thesis***

While writing my doctoral thesis, I determined, and focused on the following goals:

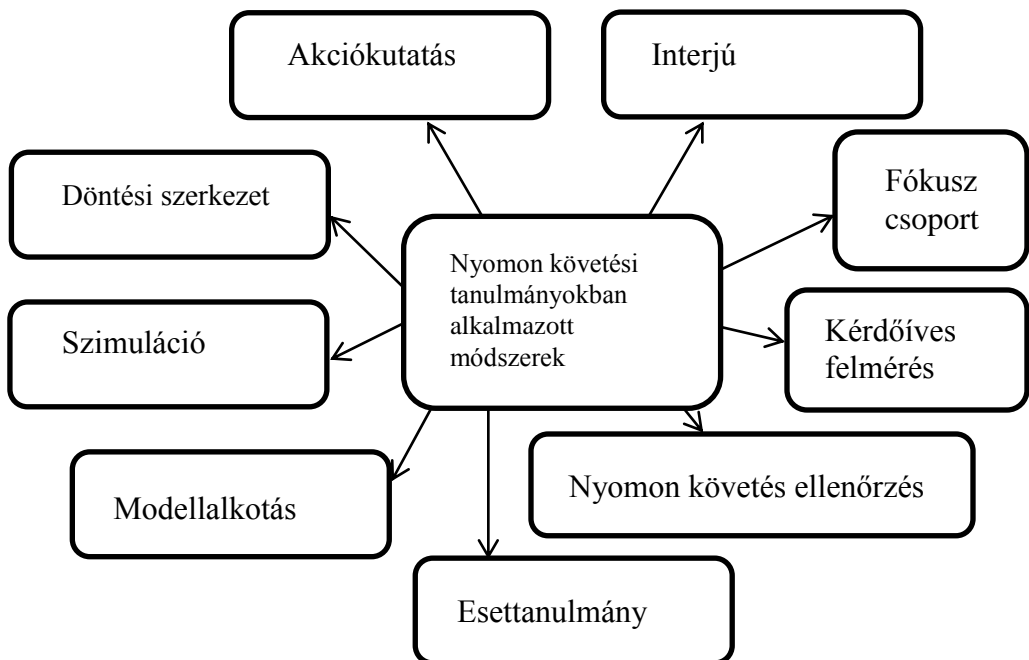
- G1: Overview of the literature related to the foodstuffs supply chain, and their evaluation, finding the main routes of the supply chain's change, and identifying what caused them.
- G2: Overview of the foodstuffs quality and security management processes, most notably the tracing system's processes of the fruit and vegetable supply chain.
- G3: In the form of secondary information gathering, I wish to analyse the forms of appearance, and tendencies of the abovementioned process, related to the international and domestic fruit and vegetable supply chain.

- G4: Overview of the analysis models related to the topic, found within international literature sources.
- C5: In the form of primary information gathering, I wish to analyse the role of foodstuffs risks consumers observed, and factors influencing them - most notably for the tracing system - and the effects these have on consumer behaviour.
- C6: Evaluation of connections between risks observed by foodstuffs consumers as the most notable decision-making inhibition factors, and the willingness to buy, furthermore, willingness to pay premium price, and finding the inconsistencies related to this.
- C7: Based on a research representing the entirety of the adult Hungarian population (15+), I wish to test model results, and clarify the connection between elements.

## 2. SOURCE AND METHOD

Tracing foodstuffs - including fruits and vegetables - is a topic that can be analysed and researched using multiple method groups.

### 1. Figure: Methods used to analyse foodstuffs tracing



Source: Karlsen et al 2013 p. 414.

An important facet of the research is the applicable, and the applied methods. The group of applied methods related to tracing was analysed by Karlsen et al. (2012) using literature source processing method. He identified and defined the following research methods: action research, choice architecture, simulation, modelling, case study creation, tracing verification mechanism, questionnaire research, focus group analysis, and deep interview technique.

Action research is used to improve systems in practical operation, which is social-based, and relies on cooperation. Action sciences and action-type learning are its basis, its main goal is to improve the system's practice and conditions step by step (Lingard et al., 2008).

The method of choice architecture according to Thaler and Shunstein (2008) is a tool for improving purchase decisions, in order to minimise errors and misconceptions, which come from decisions based on incomplete rationalism. Its main components are the following: list of possible mistakes and errors, structure of consumer decisions and its analysis, feedback, complex choice, structuring the decision itself, and forming the choice motivators. The method can be divided into two parts: one is the description of possible choices and its structure, the other is the choice options and alternatives. The choice structure contains the following: number of alternatives, decision-supporting tools, errors and mistakes, time dimension of the decision. The choice alternatives and options consist of the following: dividing the options into parts, description of attributes, drawing up new planned attributes. An important goal for consumer decision is to decrease choice overload.

The simulation method is a mathematical model applicable to the optimisation of the enterprise's tracing system, which describes the original system and its attributes well. The simulation model can be used to reproduce the analysis, and to research elements and alternatives of the model.

Modelling and model creation are also applicable to the analysis of the tracing system, and as part of marketing, they mainly constitute the creation of a logical connection model. The model most widely used for researching tracing and foodstuff consumer and buyer behaviour in the literature sources is the structure model of Pavlou et al (2007), modified by Choe et al. (2007). The Pavlou et al. (2007) model is based on the theory of representative-salesman, which concentrates on the misleading behaviour of the seller side, which stems from the asymmetry of information. The most notable elements and attributes of the model are as follows:

- The central element of the model is the uncertainty related to foodstuffs, and perceived risks.
- Variables explaining uncertainty and perceived risks:

- asymmetry in information,
- fear of the seller's opportunist behaviour.
- Factors limiting, mitigating the uncertainty and perceived risks:
  - product diagnostics (product attributes and characteristics),
  - information supply,
  - consumers' trust in the tracing system.
- Effects and consequences of uncertainty and perceived risks on foodstuffs purchase behaviour:
  - willingness to buy,
  - willingness to pay premium price.

The abovementioned model was analysed by Chen and Huang (2013), an Choe et al. (2007), in the framework of foodstuffs purchase processes.

Case study creation is a complex and all-encompassing method introducing results and activities in light of their interconnections. It concentrates on analysing a single case, and aims at the attributes of the phenomenon which can be generalised. Creating a case study encompasses two important dimensions: complexity - researching the completeness, and internal causalities of the case - and contextuality - concentrating on the mutual connections with the operational environment, and identifying its effects on processes.

The method of validating the tracing process (Tracefood, 2012) is a solution based on document analysis, which serves as a tool to validate its authenticity, and to test it.

Questionnaire research aims to unearth key indicators through a desirably large sample, and wants to determine the connections between said indicators. It primarily analyses the statistical connections between the various indicators, and wants to find conclusions from them, which can be expressed in numbers. In the case of questionnaire processes, the sample size is important, similarly to the method of sampling, the structure of the sample, and representativeness. Questionnaires are categorised among the quantitative forms of marketing research.

Focus groups are one method of qualitative marketing research, which tries to understand deeper connections affecting behaviour, as part of the given phenomenon. Usually, it's a half-controlled method, where a moderator coordinates the group's activity, where group size can vary between 8 and 12 people. Gaining information from consumers can happen via the following methods: brainstorming, card assorting, role-play, associations, finishing the sentence game, and collage techniques.



Interviews and deep interviews are important tools of qualitative marketing research, which aim to better understand consumer behaviour through identifying and understanding personal experiences, feelings and understanding.

As part of my thesis, I analysed the effect of tracing, as a key process of the supply chain system on the behaviour of foodstuff consumers. The framework of my analysis was evaluated with the aid of the structural model adapted by Choe et al. (2007). I adapted element from the structural model, and applied them to the circumstances of the Hungarian foodstuffs consumers' and purchasers' behaviour. The method of my analysis was quantitative marketing research, in the form of a questionnaire. The questionnaire research was conducted with the financial aid of two TAMOP programmes, which were the following:

- TAMOP-4.2.2/B-10/1/2010/0011: Analysing sustainable purchaser and foodstuffs consumer attitudes (value system, general attitudes, foodstuffs purchase attitudes) among the adult Hungarian population sub-programme.
- TAMOP-4.2.1/B-11/2/KMR-2011-0003: Consumer-perceived risks related to foodstuffs (foodstuff, lifestyle, technology), the alternatives of reducing consumer risks, and analysis of inclination to purchase among the adult Hungarian population sub-programme.

Of said two programmes, one was a research programme of the DSEO, which served as the framework of the data collection in 2013. The coordinator of the research was the Institute of Marketing. The consumer questionnaire was conducted by the Cognativ Co. Ltd., as an omnibus research. The questionnaire had participants country-wide, with a sample of 1038 participants (15+). Choosing members of the sample was done via random walk method, and the sample was corrected by weighting with population census data. The sample may be considered representative from the perspectives of gender, age, location and employment. The questionnaire was based on a multi-target data collection. The questionnaire contained both foodstuffs risks, foodstuffs purchase attitudes, inclination to pay premium price, and value systems, non-foodstuff risks, product categories of sustainable foodstuffs, finally, culture consumption attitudes. The main goal of the questionnaire was to create a database for the PhD course, and to use it for PhD students' research.

As part of the questionnaire, the following had to be commented on, and were linked to the various blocks of the applied structural model:

- Product diagnostics:
  - external attributes of the foodstuffs (f. e. size, shape, colour, form),

- internal attributes of the foodstuffs (f. e. nutrient, vitamin and energy content),
- taste and freshness of foodstuffs,
- if the foodstuffs abide by the requirements of healthy eating (mineral content, anti-oxidants),
- purchase of seasonal foodstuffs,
- purchase of industrial and retail brand foodstuffs,
- purchase of commercial brand foodstuffs (f. e. Tesco, Spar),
- purchase of foodstuffs marked with geographical and source location brands,
- source of foodstuffs (country, region, local origin),
- favouring low water-consumption foodstuffs,
- favouring foodstuffs causing low carbon-dioxide emission.
- Information content:
  - planning and preparing purchases better,
  - checking the attributes of the product listed on the packaging,
  - collecting more and more information about the foodstuffs (doctors, dietetics, journals, internet).
- Trust:
  - trusting the regulation of Hungarian plant- and animal health authorities,
  - trusting the product identification and tracing system of the food chain (producer, processor, seller),
  - trusting the foodstuffs risk reduction activity of authorities overseeing foodstuffs,
  - trusting the quick and effective foodstuffs recall (quick response system, recalling from the market quickly, and immediate disposal) of authorities.
- Information asymmetry:
  - decreasing the purchase of foodstuffs from foreign sources,
  - preferring Hungarian foodstuffs instead of foreign ones,
  - purchasing from the local producer and processor, instead of buying foodstuffs transported from afar,
  - purchasing in a familiar shop.
- Fear of the seller's opportunist behaviour:
  - not purchasing foodstuffs from illegal, or fishy sources,
  - favouring non-industrially produced foodstuffs,
  - favouring foodstuffs produced by traditional technological solutions,

- purchasing from local markets, the producer market, or in the local market hall,
- personally producing a part of foodstuffs consumption.
- Uncertainty, perceived foodstuffs risks:
  - health risks related to foodstuffs,
  - pesticide remnants in foodstuffs (wheat, fruit and vegetables),
  - animal drugs remnants in meat and milk products,
  - poisonous heavy metal remnants (lead, mercury, cadmium, etc.) in raw and processed foodstuffs,
  - micro-biological (viral and bacterial) infections affecting foodstuffs,
  - consumption of genetically engineered foodstuffs,
  - food additives and preservatives in processed foodstuffs,
  - illnesses spread to humans from animals (BSE, bird and swine flu, etc.),
  - harmful mould in foodstuffs (f. e. toxins of the wheat bran),
  - related to foodstuffs production technology (nano- high pressure- and high voltage rooms for conserving foodstuffs).
- Consumers' willingness to purchase:
  - purchasing eco- and bio-foodstuffs,
  - purchasing Fairtrade foodstuffs,
  - preferring seasonal foodstuffs,
  - preferring locally produced and processed foodstuffs,
  - purchasing the products made from free range husbandry animals (eggs, milk, meat),
  - following a vegetarian (vegan, ovo, lacto, ovo-lacto, semi-vegetarian) palate.
- Consumers' willingness to pay premium price:
  - premium price for tasty and fresh foodstuffs,
  - premium price for better quality foodstuffs,
  - premium price for safer foodstuffs,
  - premium price for foodstuffs that have a lower environmental load,
  - premium price for foodstuffs abiding by ethical requirements.

I measured the variables linked to the various blocks of the model - except the willingness to pay premium price - on a 1-5 Likert's scale, where 1 was the absolutely unimportant, and 5 was the very important. I measured the variables of the willingness to pay premium price block as follows: 0-5%, 6-10%, 11-15%, 16-20%, and more than 20%. In order to handle the previous intervals uniformly, I transformed them to a 1-5 scale.

Instead of measuring the phenomenon of information asymmetry directly, I employed the so-called inverted form, which I used to evaluate the attitude towards sources with better access to information. I handled the fear of the seller's opportunistic behaviour in a similar manner, which I evaluated through the measurement of purchaser behaviour towards consumer attitudes reducing them.

I checked the homogeneity of various model blocks via the factor analysis of the various variables. I analysed if these variables form different groups within the block they're contained in. Based on the indicator groups' variables, I conducted this factor analysis, which gave a single factor for the following: information supply, trust, information asymmetry, foodstuffs uncertainty and perceived risk, consumers' willingness to buy, and consumers' willingness to pay premium price. Though the factor analysis of the variables in the product diagnostics and fear of the seller's opportunistic behaviour blocks resulted in two distinct factors, their combined communality didn't exceed fifty percent, which made it necessary to consider them a single factor statistically.

I analysed the characteristics of the various model elements using the following methods: average, deviation, and relative deviation. In the case of variables with lower than 20% relative deviation, I considered the average to be applicable to defining the sample, and in the case of those of more than 20% relative deviation, I considered the usage of average values to be limited.

In the case of the model analysis, I segmented the sample using cluster analysis based on the original variables, and re-evaluated the model's relations on the level of the various segments. I employed the K-means cluster and hierarchical cluster methods simultaneously for the segmentation. Both processes resulted in very similar outputs, therefore, I chose to use the K-means cluster method in the end. I evaluated the variables allocated to model blocks by the original variables, using cluster analysis. When determining the number of output clusters, I took the following rule into consideration: the cluster number's increase will reach an upper limit, which is when the last cluster's size decreases below 10% of the original sample. Based on this principle, the following cluster number was determined for the various model blocks:

- product diagnostics: 3 clusters,
- information supply: 3 clusters,
- trust: 2 clusters (I excluded the third cluster due to having 17 elements with extreme values),
- information asymmetry: 3 clusters,
- fear of the seller's opportunistic behaviour: 2 clusters,
- consumer's willingness to buy: 3 clusters,

- consumer's willingness to pay premium price: 3 clusters.

I used variance analysis to evaluate the connections and relations between indicators, and took the significance level and F-value into consideration in order to analyse it. I used the adjusted R values for the Chi-square correlation tests. I used the SPSS16 software package to conduct the analyses.

### 3. RESEARCH RESULTS

As the first step, the various elements of the model were evaluated: product diagnostics, information supply, trust in the tracing system, information asymmetry, fear of the seller's opportunistic behaviour, uncertainty and foodstuffs risks, consumer's willingness to buy, and consumer's willingness to pay premium price. The methods of evaluation were the following: average, deviation, standard deviation, obliquity, and the ratio of 4-5 values.

**Chart 1: attributes and differences of my model's variable groups**

<b>Model elements</b>	<b>Avg : max.- min.</b>	<b>Dev: max.- min.</b>	<b>St. dev: max.- min.</b>	<b>Obl.: max.-min.</b>	<b>4-5 values, %: max.- min.</b>
<b>Product diagnostics</b>	4,54- 3,39	1,122- 0,715	32,7-20,5	-1,433 – -0,371	89,6- 47,4
<b>Information supply</b>	3,57- 2,97	1,247- 1,141	44,2-32,1	-0,460- -0,143	53,8- 38,0
<b>Trust</b>	3,92- 3,81	1,022- 0,968	26,4-24,7	-0,724- -0,587	67,0- 64,4
<b>Information asymmetry</b>	4,01- 3,31	1,203- 1,010	36,3-25,2	-0,998- -0,360	82,3- 46,6
<b>Seller's opportunistic behaviour</b>	4,31- 2,56	1,505- 0,829	58,8-19,2	-0,935- -0,331	78,1- 32,4
<b>Uncertainty, perceived risks</b>	4,45- 3,98	0,964- 0,743	24,2-16,9	-1,280- -0,752	87,6- 70,6
<b>Willingness to buy</b>	3,94- 1,61	1,279- 0,974	64,3-24,7	1,492- 0,662	68,8-7,9
<b>Willingness to pay premium price</b>	1,72- 1,33	1,136- 0,677	66,0-50,9	2,306- 1,654	10,3-2,0

Source: self-made

Foodstuffs consumers primarily check direct product attributes (taste, internal product attributes) during their decisions, however, they undervalue abstract product attributes (f. e. brand). The sample is heterogeneous, deviation and relative deviation values are relatively high. Foodstuffs consumers mainly

decide according to their own experiences, they undervalue other sources (reference groups, acquaintances, online sources). The level of trust in authorities is average-high, however, it's not product- or product attribute specific, therefore, they can't use the tracing system to reduce risks. The level of information asymmetry was rated as mid-high by the foodstuffs consumers, the homogeneity of the sample is average. The fear of the seller's opportunistic behaviour was average-high, the sample's homogeneity was average. Uncertainty's and perceived risks' level was unilaterally high, however, risks were not product- and product attribute specific, and the homogeneity of the sample was low-average. The level of consumer willingness to buy was low, the homogeneity of the sample was low-average. The consumers' willingness to pay premium price was extremely low, the homogeneity of the sample was low, deviation and relative deviation had high values.

In order to evaluate the relation between model elements, I used a correlation matrix, and used it for analysis.

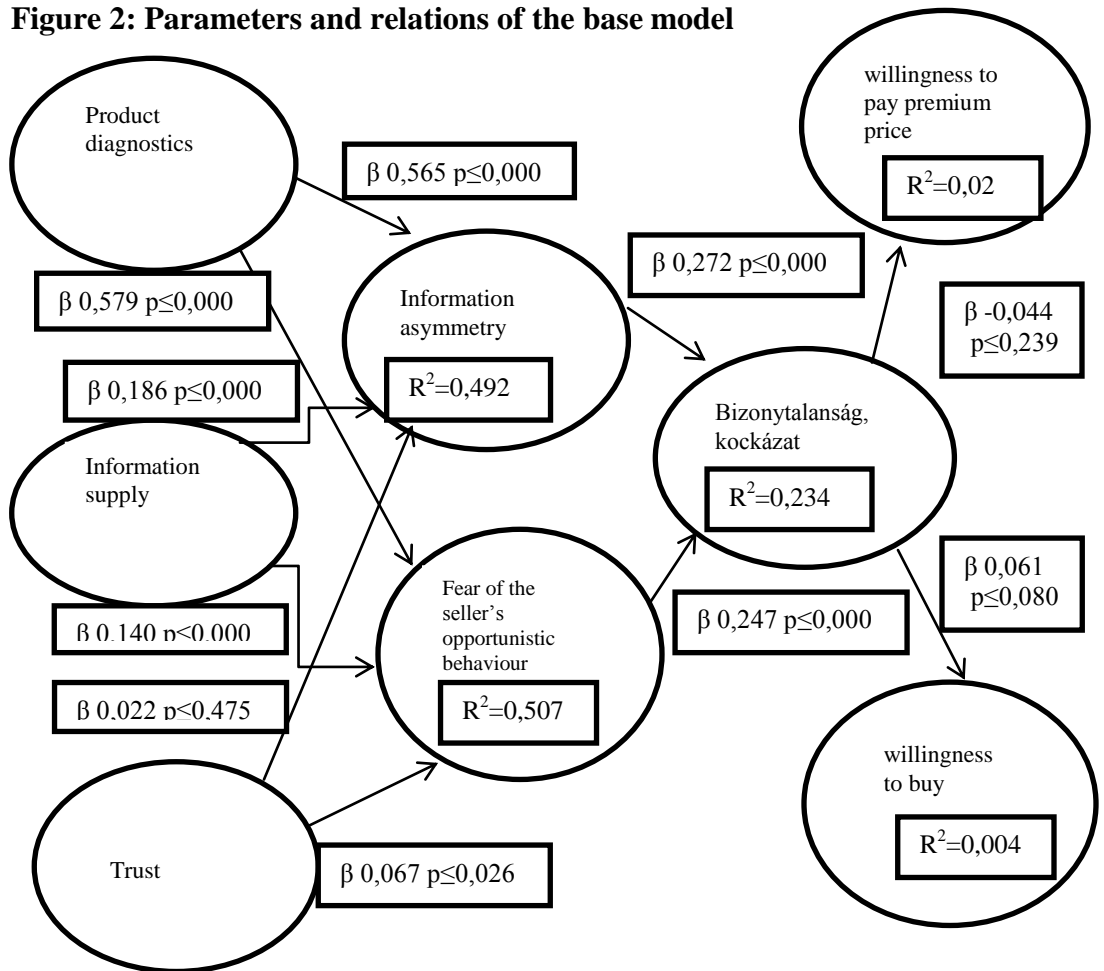
**Chart 2: Pearson's correlation and significance level of model elements**

	Product diagnostics	Information supply	Trust	Information asymmetry	Seller's opportunistic behaviour	Uncertainty, perceived risks	Willingness to buy	Willingness to pay premium price
Product diagnostics	1							
Information supply	0,577 0,003	1						
Trust	0,616 0,000	0,276 0,000	1					
Information asymmetry	0,685 0,000	0,504 0,000	0,382 0,000	1				
Seller's opportunistic behaviour	0,701 0,000	0,478 0,000	0,445 0,000	0,732 0,000	1			
Uncertainty, perceived risks	0,501 0,000	0,171 0,000	0,437 0,000	0,451 0,000	0,435 0,000	1		
Willingness to buy	0,528 0,000	0,217 0,000	0,437 0,000	0,435 0,000	0,438 0,000	0,814 0,000	1	
Willingness to pay premium price	0,194 0,000	0,263 0,000	<b>-0,016</b> <b>0,646</b>	0,125 0,000	0,088 0,010	<b>-0,044</b> <b>0,229</b>	<b>-0,02</b> <b>0,945</b>	1

Source: self-made, based on own data

The correlation between model elements usually showed average-weak relations. The relations were significant excluding three elements, which were signified by bold/italic font type. The correlation between product diagnostics and the other model elements was average-strong, except consumers' willingness to pay premium price, where the value of correlation was 0,194, showing a weak relation. The relation between product diagnostics and the information asymmetry (0,685) and the fear of the seller's opportunistic behaviour (0,701) were the strongest. The relation between information supply and some of the other model elements was average (product diagnostics, information asymmetry and fear of the seller's opportunistic behaviour), whereas the relation with the remaining elements (trust, consumer's willingness to buy, and uncertainty and risks) was weak. Trust was usually in an average relation with other model elements (product diagnostics, fear of the seller's opportunistic behaviour, uncertainty and perceived risks and consumers' willingness to buy). There's a weak correlation between trust and information asymmetry, similarly to trust and information supply. There's no significant relation between trust and willingness to pay premium price (-0,016  $p=0,646$ ). Information asymmetry shows an average relation with the fear of the seller's opportunistic behaviour, and with product diagnostics. It has weak relation with information supply, uncertainty and perceived risks, willingness to buy, and trust. Information asymmetry and willingness to pay premium price have a significant, but very weak relation. The fear of the seller's opportunistic behaviour primarily shows average-strong relation with information asymmetry and product diagnostics, shows average relation with information supply, trust, uncertainty and perceived risks and willingness to buy. The fear of the seller's opportunistic behaviour has a significant, but weak relation with the willingness to pay premium price. Uncertainty and perceived risks has the strongest relation to willingness to buy (0,814  $p=0,000$ ), it has average relation with trust, information asymmetry, and the fear of the seller's opportunistic behaviour. There's an extremely weak relation between uncertainty and perceived risks, and information supply. There's no significant relation between uncertainty and perceived risks, and willingness to pay premium price (-0,044  $p=0,229$ ). Willingness to buy has the strongest relation with uncertainty and perceived risks (0,814  $p=0,000$ ), has average relation with product diagnostics, trust, information asymmetry and the fear of the seller's opportunistic behaviour. There's a weak relation between uncertainty and perceived risks, and information supply. There's no significant relation between willingness to buy, and willingness to pay premium price (-0,002  $p=0,945$ ). The willingness to pay premium price element shows the weakest relations with the rest of the elements, in one case, it has low (information supply), in four cases, it shows extremely low, but significant relations, in two cases, extremely low (negative), and not significant relation.

**Figure 2: Parameters and relations of the base model**



Source: self-made

The level of the model's explanatory variables (information asymmetry and fear of the seller's opportunistic behaviour) are determined by the dependent variables (product diagnostics, information supply and trust) to a level that can be called average. 49,2% of information asymmetry's deviation can be explained by product diagnostics, information supply and trust variables. The strength of relation between various elements is determined by the value of the  $\beta$  variable, and the level of significance. This value is  $\beta = 0,565$  ( $p \leq 0,000$   $t = 16.147$ ) for the relation between product diagnostics and information asymmetry. Information supply and information asymmetry has the following values:  $\beta = 0,186$  ( $p \leq 0,000$   $t = 6.303$ ). There's no significant relation between trust and information asymmetry,  $\beta = 0,022$  ( $p \leq 0,475$   $t = 0,715$ ). Altogether, the level of information asymmetry is impacted by the variables of product diagnostics the most, and those of information supply the least. Trust has no effects on this explanatory variable. The level and deviation of fear of the seller's opportunistic behaviour can be explained in 50,7% by model variables. The values for the relation



between product diagnostics and fear of the seller's opportunistic behaviour are  $\beta=0,579$  ( $p\leq 0,000$   $t=16.655$ ). The relation between fear of the seller's opportunistic behaviour and information supply are as follows:  $\beta=0,140$  ( $p\leq 0,000$   $t=4.777$ ). Fear of the seller's opportunistic behaviour and trust have the weakest, but significant relation at  $\beta=0,067$  ( $p=0,026$   $t=2.234$ ). The fear of the seller's opportunistic behaviour can also be mainly determined by the variables of product diagnostics, there's a weak-average relation with information supply, a very weak, but significant relation with trust. The effects of explanatory variables on uncertainty and perceived risks is weak at  $R^2= 0,234$ , which means that the two explanatory variables - information asymmetry and fear of the seller's opportunistic behaviour - explain my model's deviation in 23,4%. The values of variables are as follows: relation between information asymmetry and uncertainty and perceived risks is  $\beta=0,272$  ( $p\leq 0,000$   $t=6.212$ ). The fear of the seller's opportunistic behaviour and uncertainty and perceived risks have the following relation:  $\beta=0,247$  ( $p\leq 0,000$   $t=5.637$ ). The relation between uncertainty and perceived risks, and consequence variables (willingness to buy, and willingness to pay premium price) is weak in all aspects. The values for uncertainty and perceived risks, and willingness to buy are  $\beta=0,061$  ( $p=0,080$   $t=3.075$ ). The deviation of willingness to buy can only be explained by uncertainty and perceived risks variables in 0,4%. A similarly weak, and not significant relation can be calculated between uncertainty and perceived risks, and willingness to pay premium price. The values are as follows:  $\beta=-0,044$  ( $p=0,229$   $t=-1.250$ ). The deviation of willingness to pay premium price can be explained by variables of uncertainty and perceived risks in merely 2%.

Summing up the relation system of the base model, we can make the following statements: information asymmetry and fear of the seller's opportunistic behaviour variables can be explained by moderating variables - information supply and trust - to a level that can be called average-strong. Of the three moderating variable, the strongest effect can be attributed to product diagnostics' variables, information supply's variables have a weak effect, and trust has an extremely weak effect. The deviation of uncertainty and perceived risks can also be explained faintly by the explanatory variables. Consequence variables and uncertainty and perceived risks have no relation from a statistical perspective.

The weak relation elements of the model can mainly be explained by the structure of the sample, the different attributes of the consumer groups, and the different consumer behaviour of consumer segments. In order to polish the model, I conducted calculations for the clusters of various model elements as well. Based on the original variables of model elements, I conducted a k-means method for forming segments, and I made the model calculations for each segment separately as well. In my thesis, I can only introduce the effects of the most notable variants, due to constraints in the length of the written thesis.

Chart 3 shows the amount of significant differences of various model element variables compared to the total amount of variables. This means that product diagnostics' and uncertainty and perceived risk's 2/9 can be interpreted as uncertainty and perceived risks has merely two variables of the nine which are significantly different, when comparing segments to each other. In the case of uncertainty and perceived risks, the lowest significantly different variables numbered 11/53, or 20,8%. The situation is a bit better for willingness to buy, as when I analysed its cluster, I found that 21 variables were significantly different of the 53%, which is 39,6%. The ratio of significant variables is high for the segments products diagnostics, information supply, information asymmetry, fear of the seller's opportunistic behaviour, and willingness to pay premium price (86,8% - 88,7%).

**Chart 3: significant differences between the model elements' variables**

Name	Product diagnostics	Information supply	Trust	Information asymmetry	Opportunistic behaviour	Uncertainty and perceived risks	Willingness to buy	Willingness to pay premium	Total
<b>Product diagnostics variables</b>	9/9	9/9	9/9	9/9	9/9	2/9	2/9	9/9	58/72 80,6%
<b>Information supply variables</b>	3/3	3/3	2/3	3/3	3/3	0/3	1/3	3/3	18/24 75%
<b>Trust variables</b>	4/4	4/4	4/4	4/4	4/4	0/4	0/4	4/4	24/32 75%
<b>Information asymmetry variables</b>	4/4	4/4	4/4	4/4	4/4	0/4	3/4	4/4	27/32 84,4%
<b>Fear of the seller's opportunistic behaviour variables</b>	7/7	7/7	6/7	7/7	7/7	1/7	4/7	7/7	46/56 82,1%
<b>Uncertainty and perceived risks variables</b>	9/9	9/9	9/9	9/9	9/9	6/9	0/9	9/9	60/72 83,3%
<b>Willingness to buy variables</b>	6/6	6/6	4/6	6/6	6/6	1/6	6/6	6/6	41/48 85,4%
<b>Willingness to pay premium price variables</b>	4/5	5/5	1/5	5/5	5/5	1/5	5/5	5/5	31/40 77,5%
<b>Total</b>	46/53 86,8 %	47/53 88,7 %	39/53 73,6 %	47/53 88,7 %	47/53 88,7 %	11/53 20,8 %	21/53 39,6/ %	47/53 88,7%	

Source: self-made calculations

The number of significant variables is high, but less than the above mentioned in the trust segment, at 39/53, which is 73,6%. The summarisation chart above also shows how the trust for the initial variables, and uncertainty and perceived risks, and willingness to buy for output variables show differences compared to the other elements. In the case of uncertainty and perceived risks, the values are completely above 4, at 4,01 - 4,87. In the case of trust, however, the values change between 3,79 - 3,90, which is below average, and 2,90 - 4,32 for within the segment. High consumer uncertainty and perceived risks can't be counterbalanced by trust, therefore, willingness to buy and willingness to pay premium price are also largely influenced by uncertainty and perceived risks. The level of uncertainty and perceived risks is very high, and doesn't show significant differences, which makes it harder to segment. Furthermore, another important attribute of uncertainty and perceived risks is that it's general, non-product specific, which means most consumers are incapable of linking products to risks properly. The average-high level of trust is behind the level of uncertainty and perceived risks on the one hand, and is also non-product specific on the other hand, which makes it have a barely recognisable effect on willingness to buy a given product. The role of trust isn't strengthened by signs and branding of product diagnostics either. Consumers evaluated the roles of both industrial and commercial brands as average (3,40 - 3,43). Signs related to geographical origin have a bit better fare, and location of origin has better evaluation too (3,98). Based on all this, consumers mainly try to decide by product attributes and their consequences, however, they have insufficient information to conclude their decisions. This process could be assisted by improving the role signs and branding play, and increasing the level of trust.

**Chart 4: summarisation chart of model variants calculated by segments**

<b>Name</b>	<b>Number of segments</b>	<b>Number of corrected coefficients</b>	<b>Number of coefficients 10% better</b>	<b>Number of corrected R<sup>2</sup> values</b>	<b>Number of R<sup>2</sup> values 10% better</b>
<b>Product diagnostics</b>	3	8	8	2	2
<b>Information supply</b>	3	9	7	4	2
<b>Trust</b>	2	4	4	0	0
<b>Information asymmetry</b>	3	8	7	2	2

<b>Fear of the seller's opportunistic behaviour</b>	2	10	<b>9</b>	2	1
<b>Uncertainty and perceived risks</b>	2	5	4	5	<b>5</b>
<b>Willingness to buy</b>	3	8	5	5	<b>5</b>
<b>Willingness to pay premium price</b>	3	5	5	7	<b>5</b>

Source: self-made

Based on Chart 4, we can state that the segmentation process improves  $R^2$  explanation percentage values, especially for variables where we got low explanation percentages, and weak coefficients. Uncertainty and perceived risks, willingness to buy, willingness to pay premium price have significantly improved  $R^2$  values, their improvement almost always went beyond 10%. In the case of explanatory variables and moderating variables, using segmentation primarily improves the relation indicators, and has a lesser effect on  $R^2$  indicators. For example, in the case of trust, the  $R^2$  indicator shows no improvement with the help of forming segments at all. There are  $R^2$  indicators clearly higher than 10% in the cases of product diagnostics, information supply and information asymmetry segments twice, and in the case of fear of the seller's opportunistic behaviour once.

**Chart 5: significant differences between the model elements' variables**

Name	Product diagnostics	Information supply	Trust	Information asymmetry	Opportunistic behaviour	Uncertainty and perceived risks	Willingness to buy	Willingness to pay premium price	Total
<b>Product diagnostics variables</b>	9/9	9/9	9/9	9/9	9/9	2/9	2/9	9/9	58/72 80,6%
<b>Information supply variables</b>	3/3	3/3	2/3	3/3	3/3	0/3	1/3	3/3	18/24 75%
<b>Trust variables</b>	4/4	4/4	4/4	4/4	4/4	0/4	0/4	4/4	24/32 75%

<b>Information asymmetry variables</b>	4/4	4/4	4/4	4/4	4/4	0/4	3/4	4/4	27/32 84,4%
<b>Fear of the seller's opportunistic behaviour variables</b>	7/7	7/7	6/7	7/7	7/7	1/7	4/7	7/7	46/56 82,1%
<b>Uncertainty and perceived risks variables</b>	9/9	9/9	9/9	9/9	9/9	6/9	0/9	9/9	60/72 83,3%
<b>Willingness to buy variables</b>	6/6	6/6	4/6	6/6	6/6	1/6	6/6	6/6	41/48 85,4%
<b>Willingness to pay premium price variables</b>	4/5	5/5	1/5	5/5	5/5	1/5	5/5	5/5	31/40 77,5%
<b>Total</b>	46/53 86,8%	47/53 88,7%	39/53 73,6%	47/53 88,7%	47/53 88,7%	11/53 20,8%	21/53 39,6%	47/53 88,7%	

Source: self-made

**Note:** In the case of mode elements, the meaning of numbers in the Chart are as follows: 5/6, of the variables, 6 are significantly different, and 5 are increasing value compared to the other segments.

Chart 5 shows the number of significant differences in model elements' variables, compared to all variables. This means that product diagnostics' and uncertainty and perceived risks' 2/9 indicates that in the uncertainty and perceived risks segment, there are only two out of nine variables which significantly differ from each other, based on the comparative analysis of segments. In the case of the uncertainty and perceived risks segment, the number of significantly different variables is the lowest at 11/53, in other words, 20,8%. The situation is a bit better for willingness to buy, as when I analysed its cluster, I found that 21 variables were significantly different of the 53%, which is 39,6%. The ratio of significant variables is high for the segments products diagnostics, information supply, information asymmetry, fear of the seller's opportunistic behaviour, and willingness to pay premium price (86,8% - 88,7%). The number of significant variables is high, but less than the above mentioned in the trust segment, at 39/53, which is 73,6%. The summarisation chart above also shows how the trust for the initial variables, and uncertainty and perceived risks, and willingness to buy for output variables show differences compared to the other elements. In the case of uncertainty and perceived risks, the values are

completely above 4, at 4,01 - 4,87. In the case of trust, however, the values change between 3,79 - 3,90, which is below average, and 2,90 - 4,32 for within the segment. High consumer uncertainty and perceived risks can't be counterbalanced by trust, therefore, willingness to buy and willingness to pay premium price are also largely influenced by uncertainty and perceived risks. The level of uncertainty and perceived risks is very high, and doesn't show significant differences, which makes it harder to segment. Furthermore, another important attribute of uncertainty and perceived risks is that it's general, non-product specific, which means most consumers are incapable of linking products to risks properly. The average-high level of trust is behind the level of uncertainty and perceived risks on the one hand, and is also non-product specific on the other hand, which makes it have a barely recognisable effect on willingness to buy a given product. The role of trust isn't strengthened by signs and branding of product diagnostics either. Consumers evaluated the roles of both industrial and commercial brands as average (3,40 - 3,43). Signs related to geographical origin have a bit better fare, and location of origin has better evaluation too (3,98). Based on all this, consumers mainly try to decide by product attributes and their consequences, however, they have insufficient information to conclude their decisions.

Segmentation significantly improved the possibility of evaluating uncertainty and perceived risks, willingness to buy, and willingness to pay premium price model elements. The smallest improvement was for the model element uncertainty and perceived risks. This once again proved that foodstuffs risks are altogether overstated, segmentation merely causes small changes. High perceived risks are mainly due to the activity of the media, which overstates risks. In the case of demographic attributes of overvaluing segments, we can list the following demographic attributes which have an impact: mainly women, mainly middle-aged and older generation, mainly high school and college / university graduates, mainly members of the middle and upper class. Differences by settlement and region don't show a consistent picture among evaluated model elements. Higher perceived foodstuffs risks has a relation to product development and purchase, and willingness to pay premium price can mainly be seen for demographic groups which increase values. This may lead to resolving the foodstuffs consumer paradox in the long-term.

## 4. EVALUATING HYPOTHESES, THEIR ANALYSIS IN LIGHT OF RESEARCH RESULTS

<p><b>H1:</b> For decisions related to foodstuffs purchase, variables related to product diagnostics play a significant role in Hungary. Among product attributes, direct foodstuffs product attributes are the ones with the most impact, indirect product attributes (like brand, seal, location of origin) have a lower impact.</p>	<p><b>Holds true</b></p>
<p><b>H2:</b> The level of information Hungarian foodstuffs consumers hold is average, based on the usage of information sources, Hungarian consumers and purchasers are less aware. The variables related to information held by consumers can be considered homogeneous.</p>	<p><b>Partially holds true.</b></p> <p><i>Note:</i> The level of consumers being informed is average: <b>holds true</b>. Said level being homogeneous: <b>does not hold true</b>.</p>
<p><b>H3:</b> The trust Hungarian foodstuffs consumers have in the tracing system can be considered low, due to the insufficient trust in the supply chain. The differences between model elements are small, they are structurally homogeneous.</p>	<p><b>Partially holds true.</b></p> <p><i>Note:</i> The trust Hungarian foodstuffs consumers have in the tracing system can be considered average-high: <b>partially holds true</b>. trust model elements are homogeneous: <b>holds true</b>.</p>
<p><b>H5:</b> Hungarian foodstuffs consumers' willingness to buy is low in the product group evaluated from the perspective of traceability. The variables related to the model are similar, and can be considered a relatively homogeneous system.</p>	<p><b>Partially holds true.</b></p> <p><i>Note:</i> Risks perceived by foodstuffs consumers are high: <b>holds true</b>. Perceived foodstuffs risks are homogeneous: <b>partially holds true</b>.</p>
<p><b>H6:</b> Hungarian foodstuffs consumers are usually price-sensitive, therefore, their willingness to pay premium price is low. The willingness to pay premium price variables are relatively similar, and form a homogeneous system.</p>	<p><b>Partially holds true.</b></p> <p><i>Note:</i> Hungarian foodstuffs consumers are price-sensitive, and their willingness to pay premium price is low: <b>holds true</b>. Their willingness to pay premium price is relatively homogeneous: <b>does not hold true</b>.</p>

<p><b>H7:</b> The effect of the model's risk reduction variables is relatively low, and the effects of attributes (product diagnostics, consumer information and trust) are significantly different. The highest effect comes from product diagnostics, the lowest from trust.</p>	<p><b>Holds true.</b></p> <p><i>Note:</i> The moderating effect on foodstuffs risk is low: <b>holds true</b>. The effects of various model elements are significantly different: <b>holds true</b>. The highest effect comes from product diagnostics, the lowest from trust: <b>holds true</b>.</p>
<p><b>H8:</b> Perceived information asymmetry and fear of the seller's opportunistic behaviour have a significant impact on perceived risk, the difference between the two groups is not significant, they have nearly the same effect.</p>	<p><b>Partially holds true.</b></p> <p><i>Note:</i> The effect is significant: <b>does not hold true</b>. The two elements have nearly the same effect: <b>holds true</b>.</p>
<p><b>H9:</b> The effects of perceived foodstuffs risks and uncertainties on consumer willingness to buy is average, and similar to their effect on willingness to pay premium price.</p>	<p><b>Does not hold true.</b></p> <p><i>Note:</i> The effects of perceived foodstuffs risks and uncertainties on consumer willingness to buy is average: <b>does not hold true</b>, as both are low.</p>
<p><b>H10:</b> The deviation of model elements' variables is high, and the number and level of significant differences is high, therefore, the efficiency of the model can be improved, by clustering and segmenting into attribute groups.</p>	<p><b>Holds true.</b></p> <p><i>Note:</i> The deviation of model elements' variables is high, and the number and level of significant differences is high: <b>holds true</b>. The efficiency of the model can be improved, by clustering: <b>holds true</b>.</p>
<p><b>H11:</b> Of the elements decreasing perceived foodstuffs risks, mainly consumer information, less notably trust elements can be grouped to have a positive effect on the strength of relations, their correlation, and relation coefficients.</p>	<p><b>Does not hold true.</b></p> <p><i>Note:</i> Of the elements decreasing perceived foodstuffs risks, mainly consumer information, less notably trust elements can be grouped to have a positive effect on the strength of relations, their correlation, and relation coefficients: <b>does not hold true</b>, as in both cases, the clusters of the model elements didn't improve either the <math>R^2</math> values, or the strength coefficients.</p>



<p><b>H12:</b> Effects of the perceived foodstuffs risks can be improved by segmenting willingness to pay premium price, segmenting willingness to pay has a lower positive effect.</p>	<p><b>Partially holds true</b>, as both willingness to buy and pay premium price can be segmented to significantly improve the relation between model elements, though with low <math>R^2</math> values. The effects of segmenting the two factor groups is nearly similar, therefore, this part of the hypothesis <b>does not hold true</b>.</p>
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## 5. NEW AND NOVEL SCIENTIFIC RESULTS OF THE THESIS

Based on the processing of literature sources, and the results of the primary research, the following new and novel scientific results can be stated:

1. The Pavlou-Gefen (2004) purchaser behaviour model based on the theory of salesman-representative was adapted to foodstuffs purchaser behaviour conditions. The base model was mainly formed for online purchase conditions, which was reformed by Choe et al. (2007). Research until now mainly didn't refer to foodstuffs consumers. The thesis has a special framework, I determined statements applied to foodstuffs consumption as part of the thesis, and adapted them. The model adapted based on the list of statements provided extra research results, but based on the current evaluation, this can be further improved.
2. I analysed the various model elements - product diagnostics, consumer information, trust, information asymmetry, fear of the seller's opportunistic behaviour, uncertainty and perceived risks, willingness to buy and to pay premium price - related to the foodstuffs consumer behaviour model. The statistical analysis methods used were: average, deviation, relative deviation, obliquity, ratio of 4 and 5 values. The various elements showed significant differences from the perspective of average values and homogeneity. The deviation of model elements was mainly above 20%, therefore, the effectiveness of the non-homogeneous sample, and the model based on it can be improved using the sample's grouping, clustering.
3. The central element of the model from the perspective of tracing is the trust in the tracing system. The variables of the trust model element (average, deviation, relative deviation, obliquity, ratio of 4 and 5 values) was analysed, and I determined that the consumer trust is average-high (3,5-4,0 averages), which can be considered good. The relative deviation of my model's variables is average (24,7%-26,4%), which is relatively

homogeneous. The clustering of trust doesn't significantly change the level of relation model elements have (in other words,  $R^2$  values), it only improves the  $\beta$  coefficients. Increasing trust in the tracing system may lower the risks perceived by consumers, and their uncertainty, but only if this is improved in a product-specific manner.

4. I used the K-means cluster analysis method to analyse the connection systems of the behaviour model based on the simplified foodstuffs consumer behaviour, and the relation between information supply and market uncertainty, and how to improve the model's efficiency. The model's relation indicators ( $R^2$ ,  $\beta$ ) for various clusters were analysed, and I determined that the efficiency of the model can be improved via clustering. However, the clustering based on various model elements yielded significantly different results. Clustering information asymmetry and product diagnostics improved the value of  $R^2$  the most, which is minimal in case of the trust model element (0). Based on the demographic attributes of the clusters, and model elements made more precise by clustering, I determined demographic groups which have significantly positive effects on the model's indicators.
5. The simplified model adapted to the foodstuffs purchaser behaviour suggests that the Hungarian foodstuffs consumer behaviour can be seen as paradox. Namely, the high foodstuffs consumer risks are not related to the trust in the foodstuffs tracing system, it's not product-specific, or source-specific, and isn't based on consumer awareness, but media information instead. The base solution of the high perceived foodstuffs risks would be the willingness to buy safer foodstuffs, and the higher premium price paid for it, which, however, is refused by the majority of consumers, therefore, product development and its related excess tracing price are things they're unwilling to pay for.

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