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Ph.D. thesis

ECONOMIC ANALYSES OF DOMESTIC MILK AND SUGAR FOOD CHAIN

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INTRODUCTION, PURPOSES

It is an effortful task to define the performance criteria related to the food sector, as it can be interpreted in various ways. According to the classical economics theses a vertical type system (with consecutive, moreover, inter-related levels) can only work out effectively in the long run, if participants at different levels refrain themselves from violating the interests of other participants (such as consumers). The relevant theoretical optimum prevails when participants of the food chain obtain a fair return compared to their expenditures during market transactions, i.e. they at least become able to cover their alternative costs (in the short term), or reach economic profits (in the long term).

The above mentioned optimum criteria have not showed up before and ever since the change of political systems to an extent that would guarantee the long term competitiveness of the Hungarian food sector. This thesis incorporates multiple aspects of cost, income and price analyses of the Hungarian milk and sugar supply chains implemented between 1998 and 2002, almost half of a decade subsequent to privatization, just before Hungary's EU accession.

The goals of the research

- The processing of domestic and international literature relevant to the different vertical food systems and chains;
- A further elaboration of relevant methodology in order to provide a complete analysis of vertical food systems and chains;
- The examination of the correlation between producer, consumer and world prices;
- The complete analyses of milk and sugar chains;
- The investigation of the important food chains and the identification of cost and profit ratios at production, processing and trade levels.

The part of this thesis containing self-prepared analyses is divided into three larger segments. **The first *encompasses a statistical analysis aimed to disclose connections***

between farm, retail and world market prices in the investigated food chains by using decompositional time series models, as well as two and multiple variable methods. **The second** ***one contains a comprehensive analysis of the selected vertically integrated chains, in order to introduce the economic position of the producing, processing and trading spheres with emphasis on their cost, income and price status.*** The rapports of the different producer levels have been evaluated by a self-constructed, descriptive-type simulation model system, whereas the investigation of the processing and trade levels has yet again been assisted by a self-constructed, factual data based model. **The third division** ***treats price conditions of some major supply chains within the vertically integrated milk- and sugar industries, including an economic analysis of the prices, with respect to the distribution of costs and incomes, or share of producers, processors and traders.***

According to one of the main characteristics of the applied methodology, the economic evaluation of chain participants concerns not only the reached profit but the economic profit calculation of the capital return as well. Furthermore, the impartial investigation of chains price conditions are supported by the calculation of price centre which guarantee the recovering of normal profit and the relevant profit levels.

THE FIELD, DATABASE AND THE METHOD OF RESEARCH

As a consequence of the investigations being broad in nature, special methodology has been evolved to satisfy all criteria applied in the framework of this study. Production, food processing or food trade spheres might one by one provide a considerable basis for separate studies, however, the vertical analysis (and all related figures) in this study touch only upon some major issues: price, cost and profit relations respectively, together with capital background evaluations. Additional investigations have been carried out both to disclose existing connections between farm and retail prices, and to estimate the impact of world market prices. Notwithstanding that research work started back in 1996 (eventuating in some results later employed in model calculations), supply chain analyses have only been carried out for the period of 1998-2002.

1. A detailed methodology of price-statistic analyses

Investigations have mainly been based on conventional statistical methods, such as ***decompositional time–series models or two and multiple variable model analyses***. Trend, correlation and regression analyses are based upon monthly figures from between 1998 and 2002. Domestic farm and retail prices are taken from the official publication of the Hungarian Central Statistical Office, while dollar exchange rates are accrued from monthly periodicals of the National Bank of Hungary. World market prices are of various origin. White sugar prices imply average monthly prices (FOB, Europe) of London's Future Exchange market. World market dairy product prices (FOB, W.Europe) are calculated as simple averages of prices published in every two weeks by the USDA appertained Agricultural Marketing Service. Monthly average prices (FOB, US-Gulf) for wheat and corn originate from the regularly published database of the International Grain Council by FAO.

Analyses in the dissertation have been prepared by MS Excel Analysis Tool Pak, according to the following methods: After a diagrammatic presentments have defined the major statistic characteristics (i.e. standard deviation, error, etc) of collected time series data through descriptive statistic methods, which, in order to maintain comparability, was followed by a calculation of the coefficient of variation. Differences between minimum and maximum values were then expressed in percentage forms. Tentative goodness–of–fit tests were then performed to trace the best–fitting trend factor (relevant R^2 value, the type of function, and the exact equation are indicated). Analysis Tool Pak's tool for handling adjunctions, which has been designed to perform parameter estimation, was incorporated to demonstrate results derived from regression statistics, analysis of variance and parameter estimation. The investigations, during which I managed to identify the coefficient of correlation and determination together with the parameters of function were performed according to the methodology discussed in relevant literature (see RAPPAI, 2001; SZŰCS, 2002). With the help of function parameters and after having the linear fitting factor identified the best–fitting regression function (relevant R^2 value, the type of function, and the exact equation are again indicated) was determined through scatten–plot–diagram representation. Elucidated by Hungarian authors (KREKÓ et al., 1958 in CSÁKI and

MÉSZÁROS, 1981) standardized regression coefficients (*β–weights*) were calculated according to the following:

$$\beta_i = b_i \frac{S_{yi}}{S^2_y} \; ; \qquad R^2 = b_i \sum_{i=1}^{n} \beta_i$$

where: β_I - standardized regression coefficient; b_i - partial regression coefficient; S_{yi} - covariance between *i*-th independent variable and the dependent variable; S^2_y - variance of the dependent variable; R^2 - coefficient of determination. This methods allows for the *β*-weights to be expressed in a percentage form (if R^2= 100%).

2. A detailed methodology of supply chain analyses

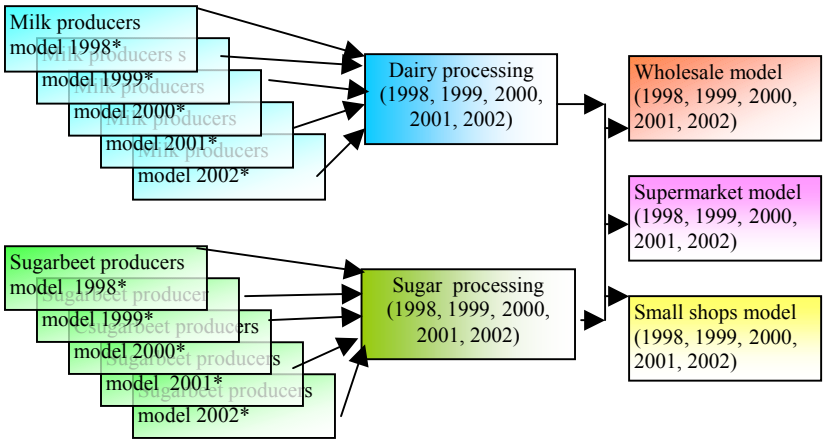
In the framework of this field of the study, I first had to make calculations relevant to the basic economic situation of chain members in the investigated supply food chains. Production (milk and sugar beat) related data, accrued largely from Hajdú–Bihar county, were categorized basically according to farm size (small and large farm), but official databases (regional offices of the Ministry of ARD, Agricultural Intervention Centre, product councils, insurance corporations, energy service companies, breeding-performance office etc.) together with figures from the relevant technical literature were also incorporated in a model designed to disclose cost and profit positions and other major economic indices. Obtained findings of the model calculations were - in the framework of an aggregated evaluation of the level of production - averaged according to the proportion of weights conformable to Hajdú-Bihar county conditions. The models applied to analyse the economic situation of production sphere are largely based on and developed from those business plan concepts, elaborated and made regular in DU-CAS Faculty of Agricultural Economics and Rural Development Department of Farm Business Management. The constructed models (by taking all the annual costs and incomes into consideration) allow for the calculation of the following figures, essential for vertical analyses: EBIT, cost and capital profitability, normal and economic profit, economical profit ratio, price center.

General economic position analyses in the study are based upon annual report figures accrued from major dairy and sugar processing firms of the region. Here, Court of Registration figures were complemented with profit calculations. The food chain analysis is mainly based on figures published by the dairy and sugar industry, costs are categorized

according to their types whereas, incomes are calculated from average farm and retail prices. The calculated indices are similar to those applied to investigate the level of production.

The analysis of the trading sector is based upon the elaboration of the economic positions of three different kinds of shops. In the case of whole–sale shops and supermarket chains, a region level database, large enough to represent circumstances authentically, is set up, while a monographic survey has been elaborated to accumulate data from small shops. All data have been harnessed and built into a model, designed to evaluate the general economic positions of the different kinds of shops, and to provide an outlook for the general economic position of the supply chain itself. The self–prepared (formerly published) methodology is based upon the calculation of direct and indirect trading costs. The shares of production, processing and trade, just like the cost and profit positions in each of the supply chains, have been identified according to the results obtained by industrial model calculations.

The structure of the food chains model



* weighted average of small and big producers modelled results

Calculation mode of Herfindahl indices (HI) indicated the market concentration:

$$HI\ (\%) = \sum_{i=1}^{N} Z_i^2 \times 100\ ;$$ where Z – means the market share of enterprises

The products and their main characteristics involved in the food-chain analyses

polypacked milk, 1 l with 2,8% fat; aseptic packed **UHT milk** 1 l, with 2,8% fat; **butter,** 100 g with 80% fat ; **Trappista cheese,** 1 kg with 45% fat; **sour cream,** 175g with 20% fat; **standard yoghurt**, 175 g with 2% fat; **granulated sugar,** 1 kg, paper packed

MAJOR ACHIEVEMENTS AND CONCLUSIONS OF THIS DISSERTATION

Results and conclusions related to methodology

The specifics of the subject analysed called for special methodology to be elaborated, partly to provide for the comparability of economic situations at different vertical levels, partly because of data accessibility difficulties. In supply chains, where market-led price conditions apply, the analysis of price determining factors (consumption, market structure, demand/supply positions) should be the task to start with, and as for these investigations, foreign literature offers a specific methodology. However, this kind of methodology claims for both a peculiar database and an information processing capacity. In supply chains, where prices are both influenced by market processes and administrative tools (or especially in those chains, where administrative tools are the main determinants), price analyses should be approached from a cost and profit dominated point of view, since, provided the base of evaluation is chosen correctly, extra information on economic situations and market positions might be gained.

Domestic farm, consumer and world market prices – results of the correlation analysis

The market price analyses showed that the market-protection barriers (customs) gave adequate protection for domestic market during the analysed period, that is demonstrated by determinant indices of low value resulting from regression analysis (*Table 1.*) However, when domestic markets are no more receptive to goods, through low imports, the indirect effect would generate such market disruptions that would restrict prices to levels with no economic profit content in both processing and production.

Table 1.

The value of indices shows the strengtheness of price connection in the case of studied products

		Y				
		Pasteuri-sed milk	**Trappista cheese**	**Butter**	**Sour cream**	**Sugar (domestic price)**
X	**The value of r^2 according to linear regression**					
	Raw milk (domestic price)	0,924	0,904	0,937	0,927	
	Milk powder world pr.	0,181				
	Cheese world price		0,342			
	Butter world price			0,135		
	Sugar world price					0,273
	The value of R^2 confirmed by the best fitted regression function					
	Raw milk (dom.price)	0,934	0,909	0,940	0,927	
	Milk powder world pr.	0,257				
	Cheese world price		0,353			
	Butter world price			0,252		
	Sugar world price					0,274

The close correlation of farm and consumer prices in the milk supply chain indicates a symmetric cost–pass trait, which means that **both processors and traders in the chain possess the market power to transmit the effect of an increase in input prices (costs) towards customers**, thus entailing an increase in retail prices. This fact needs to be taken into consideration, since dairy products are generally considered to have a positive effect on the health status of society.

Results related to the complete analyses of milk and sugar chain

Besides cost and profit positions **capital return aspects and potentials should also be taken into consideration when deciding on bases for evaluation.** Obtained figures reveal that **high asset-rated profitability does not always result in favorable capital recovery (or economic profit).** The price deficit (or gain), which we come to after deducting actual (realized) price from price center on the one hand indicates the level of profits and the degree of return for normal profits, and on the other hand, it allows for some implications in connection with the bargain power of the particular level. A positive price margin (price or profit surplus) implies that the incomes of a particular character of a level cover not only

economic costs (accountancy cost + normal profit), but also facilitate a certain level (rate) of economic profit to be realized. Such economic profit rates are detailed in *Table 2.*

Table 2.

The income (profit) exceeding the normal profit in different levels of milk and sugar vertically integrated chain members, on the basis of model calculations (averages of 1998-2002)

.	1998	1999	2000	2001	2002
Milk producers	1,58%	3,21%	5,56%	1,91%	2,11%
Sugarbeet producers	-25,48%	-7,23%	-12,58%	20,34%	18,68%
Dairy industry	-3,98%	-3,96%	0,93%	1,30%	-0,24%
Sugar industry	-20,59%	-8,74%	-4,04%	-0,23%	-0,25%
Wholesale trade	26,24%	27,73%	29,93%	27,31%	28,16%
Supermarkets	13,91%	13,40%	13,93%	14,70%	13,81%
Small shops	0,89%	0,11%	0,45%	-0,41%	-1,30%
Annual inflation rate*	14,30%	10,0%	9,90%	9,20%	5,30%

*Source: Hungarian National Bank

Result figures of the investigated period revealed that positive price margins (referring to the realized price above the level of price center covering a particular profit level) are hardly ever experienced at lower levels of the food chain. **This fact**, at least partly, **supports the assumption that claims producing and (with some products) processing spheres as being weak in their bargain status, when trying to carry off price expectations sufficient enough to obtain results equaling to or exceeding normal profit levels.** However, unfavorable figures of the milk and sugar industries are to be handled with care, as here, peculiar interests of investors might pull the string.

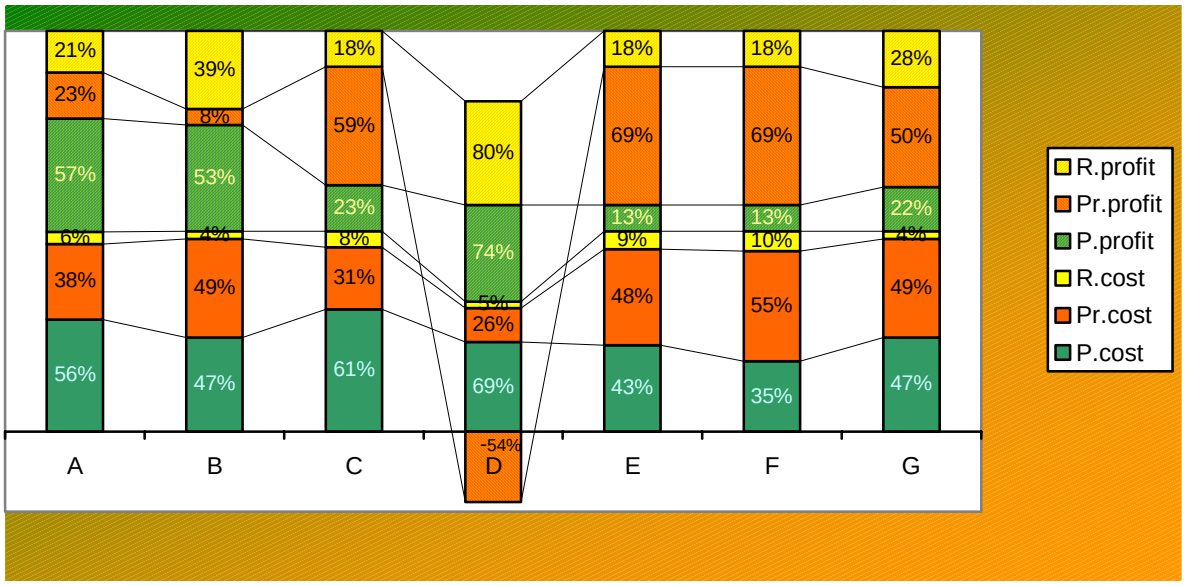
Results relevant to analyses of major chains within milk and sugar vertical systems

Both accomplished research work and all obtained findings underpin the assumption that a **detached evaluation of economic situation in different food chains can only be provided, if investigations cover the general economic status of the different supply chain members.** One can and must not draw a general conclusion regarding the actors of a

supply chain by simply analyzing one particular product's cost and profit situation, as their general economic position and realized outcomes at different levels of food chains associated with the investigated supply chain might differ considerably. At producer levels, differences are due mainly to different income transfers (for example quality subsidies) or other subsidies: at producer level they are due to export subsidies, while at trade level, differences are owing to non-price incomes (such as shelf fee, listing fee, etc.)

Food chain analyses are based on the research of cost and profit situation of seven products, each of which provide for a major share in total incomes at processing and trade levels of the particular supply chain. It requires much attention to select the food chains to be investigated, for packaging might considerably affect the cost and profit status of the particular product.

Figure 1.: ***Relative distribution of cost and profit-ratio on the basis of cumulative data of the studied food-chains (total cost of chain=100%, total profit=100%)***



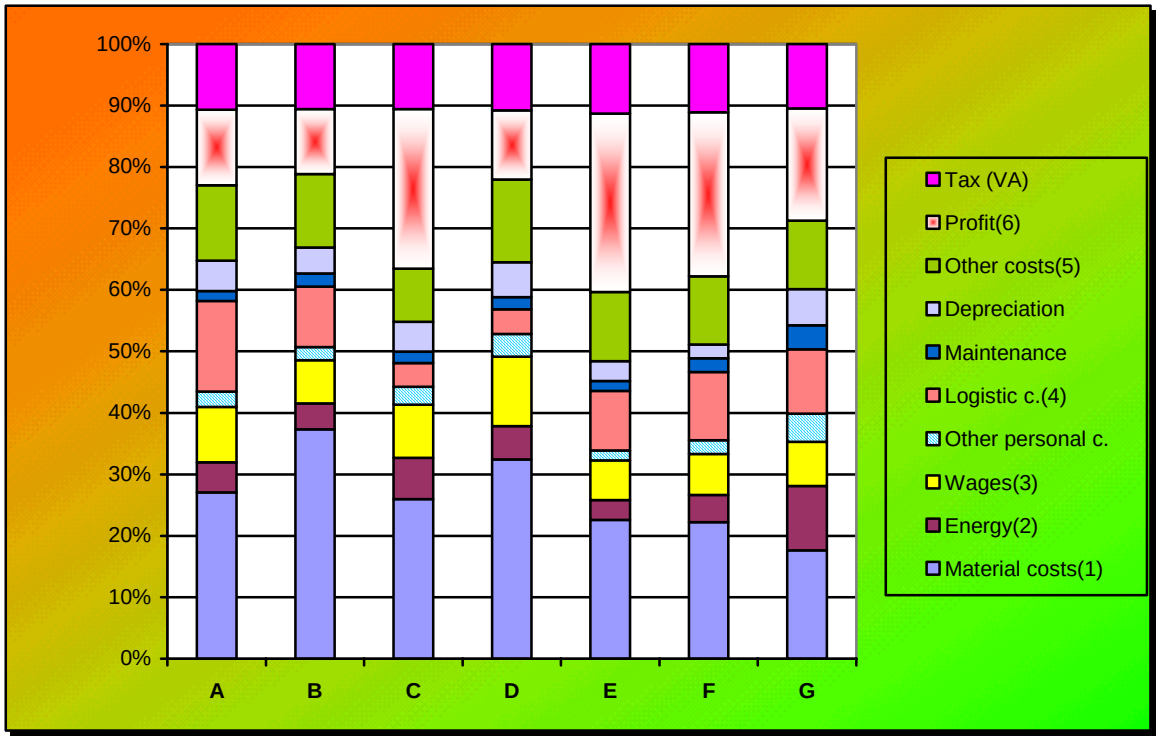
Note: **P**-agricultural producer; **Pr**-processing industry; **R**-retail trade; **A**- poly-packed milk (2,8%, 1 l); **B**- UHT milk (2,8%, 1 l); **C**-butter (100g); **D**-trappista cheese (1 kg); **E**- sour cream (12%, 200g); **F**-standard yoghurt (175g); **G**-crystal sugar (1 kg).

As far as the investigated food chains are concerned (*Figure 1.*) it can be concluded that much of the costs are realized at lower levels, in contrast to profits, which are realized

mainly at upper levels of the chain. These disproportions however have not yet caused problems, or broken Competition Law.

Another approach to analyze cost and profit positions in different food chains intended to reveal cost and profit components within the consumer (or retail) price. This technique is expected to reflect cumulated expenditures and returns at different levels of the food chain. (*Figure 2.*)

Figure 2.: ***Cumulated cost and profit ratio of the studied food-chains (the average of 1998-2002)***

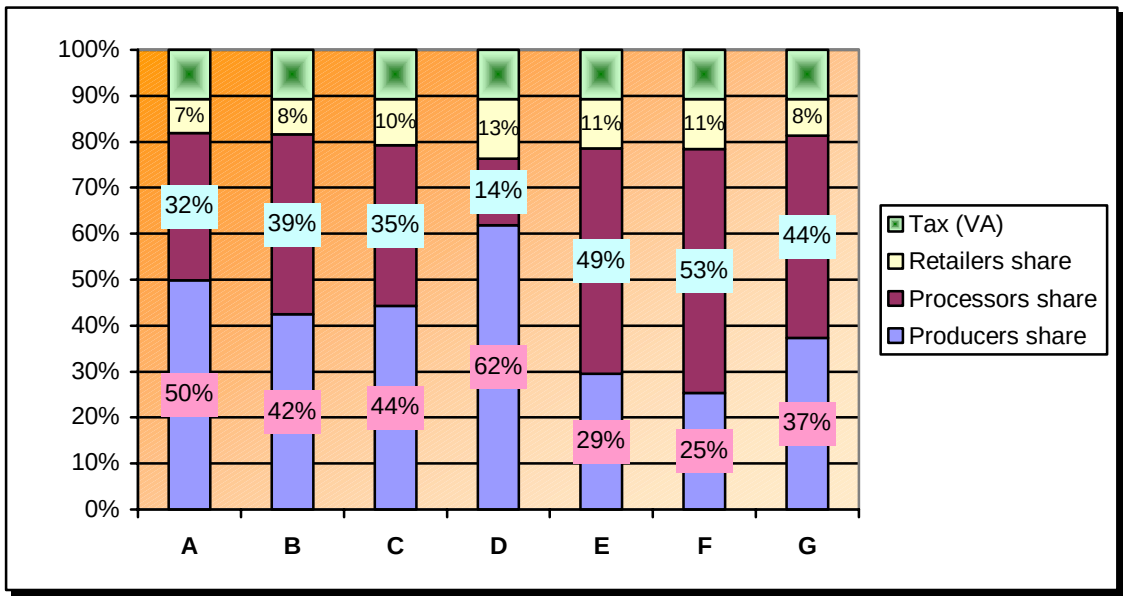


Note: (1)-Feed, fertilise, seed, chemicals; (2)-Electricity, fuel, gas; (3)- Wages and other personnel costs; (4)-Transport, storage, cooling; (5)-Services (advertising, veterinary cost , insurance etc.); (6)-profit before tax. **A**- poly-packed milk (1 l); **B**- UHT milk (1 l); **C**-butter (100g); **D**-Trappista cheese (1 kg); **E**- sour cream (200g); **F**- standard yoghurt (175g); **G**- granulated sugar (1 kg).

These facts and calculations could serve important information in such conditions when there is social-medical consensus, according to which some food (eg. dairy) products are considered to have a positive effect on the health status of society.

The obtained results have revealed considerable, and prospectively permanent income disproportion at different levels of the investigated supply chains, which are especially due to iniquitous price relations. These price relations are, of course, affected by multiple factors, but administrative factors (especially those, expected to last long) are considered to be the key determinants. Shortly after the change of political systems, considerable changes took place at different levels of all food chains, resulting in the formulation of price ratios similar to those now experienced. In the case of each product, the shares of production, processing and trading spheres within the retail price structure were altered significantly (*Figure 3.*). These changes on the one hand can be linked to the differences in bargaining power between the different levels, and on the other hand to the differences of products in nature, packaging and relevant consumer preferences.

Figure 3.: ***The share of producers, processors and the retailers in consumer price (cumulative data of 1998-2002)***



Note: **A**- poly-packed milk (1 l); **B**- UHT milk (1 l); **C**-butter (100g); **D**-Trappista cheese (1 kg); **E**- sour cream (200g); **F**- standard yoghurt (175g); **G**- granulated sugar (1 kg).

Within retail price structures, high shares are attributed to production in products with less added value (see milk), while in products with much added value, processing provides for the greatest share. Research findings indicate, that there is very close correlation between

the decreasing share of production and the increasing share of processing costs in product price structures (*Table 3.*). Figures from the 5 inspected years indicate a moderate rise in the share of trade levels. This tendency is homologous with those discussed in relevant literature, and linked up with the extension of distribution processes.

Table 3.

Determination indices related to values of producers, processors and retailers (regression-analyses of modell calculations - five year average data)

.	**Poly-packed milk**	**UHT milk**	**Butter**	**Trap-pista cheese**	**Sour cream**	**Stan-dard yoghurt**	**Granu-lated sugar**
Producers share (X)							
Processors share (Y1)	0,976	0,993	0,991	0,995	0,972	0,966	0,946
Retailers share (Y2)	0,094	0,844	0,095	0,422	0,877	0,606	0,152
Processors share (X)							
Retailers share (Y)	0,202	0,901	0,217	0,490	0,964	0,776	0,027

Conclusions and proposals relevant to production, processing and trade relationships

The Consumer is the main beneficiary of the competition between processors and traders. As far as the investigated supply chains are concerned, we can not point out an absolute disadvantaged participant in this respect, despite the fact that bargain powers are generally stable, although great differences occurred regarding the types of shops. Similarly to the agricultural sector, the partnerships of small shops should be encouraged either in a co-operative type of way, or in other ways. Consumer interests are often offended (cheaper, but less quality products, fals advertising etc.) when major market chains compete, that is why consumer protection organizations have to be strengthened if market concentration increases.

The accomplished investigations of this study have confirmed considerable cost and profit disproportions induced by: administrative regulations, the market and pricing strategies of the different levels of food chains and the changes in consumer's scale of values and

preferences. Considering the fact that there is very little possibility to affect the pricing behaviour of participants at the processing and trade levels, investigations should be confined to interventions applied at producing level. This applies to subsidies aimed to improve natural effectiveness, moreover to the development of a technical advisory and professional qualification system. The bargain power of producers should be strengthened, which claims from subsidies to create horizontal marketing systems. Inevitable is the need for changing the milk pricing system that would alleviate the position of smaller producers. Processors and traders should be made concerned about mitigating cost and income disproportions. A possible chance for that would be increasing consumption by common marketing tools, which requires encouraging such promotion activities, keeping and furthermore the effectiveness of such advertising campaigns under control.

THE NEW OR NOVEL RESULTS OF THE THESIS

As a first step, I managed to provide a systematic overview of relevant foreign and domestic literature. Within this framework, it was important to find points of connection, with which the chosen issue could be adequately approached. It soon became clear for me, that an investigation, based on foreign methodological patterns was unaccomplishable, especially due to the deficiency of relevant statistic databases and the lack of adequate informational background, however, when preparing the overview of literature section, I desired to arrange methodologically non–relevant literature so as to be able fit it into my own argument.

At the same time, domestic literature, as far as certain sections (for example: cost and profit positions of agricultural production), turned out to be quite well elaborated and thus easy to process, but there proved to be very few complex analyses relative to food and supply chains, and none of them investigated the trading sphere. **Taking this fact into consideration the processing of the relevant literature could be considered new in this case.**

The economic analysis of the domestic dairy and sugar sectors has been approached from a multitude of viewpoints and at a multitude of levels. Looking at methodology, special emphasis has to be laid on the method enabling the research to be detached in nature through calculating costs, incomes, profits, cost and capital profitability, normal and economic profits. The methodology is based on factual data, together with model calculation based on these.

Analyses, based on model calculations incorporate disquisitions of capital, cost and return positions in agricultural production, sugar and milk processing and also (through analyses in 3 different types of shops) marketing activity between 1998–2002. The figures of the investigated database originate from two main sources: 1.) A self–accomplished representative survey (economic circumstances in milk and sugar beet production in 1997, average scale of milk and sugar beet production in Hajdú–Bihar county, economic characteristics of dairy and sugar industries, figures of large shops), 2.) A monographic survey (conditions of capital, cost and profit in small farms and small shops).

Statistic price analyses were aimed to supplement self–prepared calculations by quantifying correlation between farm and retail prices, besides they provided for a better demonstration of price levels determining profits. The analysis of world market and domestic prices underpinned the assumption that foreign prices do not affect domestic prices because of high custom levels. With the introduction of market reforms this situation might change considerably in the future. The reasoning of correlation analyses was aimed to elucidate reason–result connections empirically.

Unlike in conventional economic analyses the economic position of participants in the investigated supply chains are evaluated in this study according to a new manner, which, besides cost and profit conditions, also incorporates the research of returns compared to interest need. This approach is especially important because conventional profitability indices only the level of realized (above interest need) profits, they do not provide information on economic profits, however, long–term sustainability is dependent upon profit levels exceeding normal profit. **According to my calculations, the lack of such profit levels is especially detrimental to agricultural producers.**

One speciality about the applied methodology is that the evaluation of economic positions in the food chains is not limited to investigation at realized profits, but instead, incorporated is the investigation of economic profits implying capital return calculation feature. **Moreover, investigation of price conditions of product chains is assisted by a calculation of price centre which provides for reaching profit rates equal to or exceeding normal profit.**

While the analysis of the investigated supply chains is in many ways different from those, elaborated in relevant literature, the obtained results are quite similar, and even appropriate for a comparison. For example, with **some products – in line with foreign tendencies – the share of production within retail prices decline, meanwhile the shares of processing and trade arise. For some other products, reverse processes apply. Result figures relevant to regression analyses of changes in shares show that there is strong correlation between the changes of shares regarding production and processing levels, consequently shares are basically determined at these two levels.** Decreasing trade share is due to the decline of the market position of the investigated shop type, since only shops with the largest market share have been involved in the investigation.

In the framework of food chain analyses, there turned out to be significant cost and profit disproportions. In this regard, the trade sphere seems to be in a favorable position. On the basis of a calculation including seven investigated products and five investigated years we can propose that the trade sphere shares 3–10 percent of costs and 18–80 percent of profits within the different product lines (results are valid only for shops with the highest price levels, and may show lower values with other types of shops). On the contrary, the sphere of production shares 13–57 percent of profits alongside a 35–69 percent share out of all costs. The processing sphere shares 25–55 percent of costs and 8–69 percent of profits. These figures are generally in line with those published in relevant literature.

In connection with the practical applicability of gained results we can claim that the elaborated methodology of this dissertation, together with the model system drawn up, is eligible to analyzing food chains and different levels of supply chains. The models – if adequate data are available –give us the opportunity to analyze the general economic position of different levels of supply chains through a multitude of index figure systems. At the same time, the models also enable us to work out a complex analysis of cost and profit positions in different product lines, to make an objective comparison of returns realized at different levels of supply chains, and, if there is any, to detect disproportions. Vertical price structure analyses allow for a comparison of obtained results to reference figures, and furthermore the level of contribution of the different levels to retail prices can be pointed out.

Special emphasis has to be laid on the detailed investigations relevant to the trading sphere. The related research could be considered "pioneering" at this field. Investigations in technical literature are limited to the analysis of the position of production and processing, without touching upon the positions of trade. By laying as much emphasis on the trading sphere as to other spheres, this dissertation provides totally new information for a correct and detailed evaluation of supply chains and food chains.

There is a multitude of possibilities to apply the results of the investigations in actual practice. The elaborated model system allows for the analysis of the general economic positions of production, processing and trade spheres either vertically (by comparing the different levels) or horizontally (by comparing identical levels). If basic data are selected carefully and some conditions are fixed, the models allow for both the investigation of past connections and the composition of future projections (a great possibility for a dynamic investigation of the position of agricultural producers).

Modeled results can be taken into consideration both in the process of controlling the efficiency of market regulations, and in the demonstration of cost and profit disproportions. It would surprise me if my results constituted a reference point with

regard to some decisions of agricultural politics, such as the ones creating the basis of the different branches of agriculture.

The obtained result are also relevant for investigations in the field of competition policy, for the estimation of bargaining powers and for decisions concerning dominating firms. Last, but not least my model calculations might, both supplement consumer safeguard and welfare analyses with extra information that would facilitate an objective analysis of price–value relations, and be taken into consideration in decisions affecting social welfare (such a decision might be one affecting average dairy product consumption).

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