DOCTORAL (PhD) THESIS ABSTRACT

HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

MEASURABILITY OF FACTORS INFLUENCING THE PROFITABILITY OF FOOD INDUSTRY ENTERPRISES

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1. The background of the study, objectives

1.1. The background of the research

One of the primary determinants of a country's functioning is its economic condition. The economy, particularly the food industry, serves as one of society's main pillars, as it fulfills people's physiological needs. The share of Hungary's food industry holds significant importance. In 2020, approximately 3.2% of domestic employees worked in the food industry, and investments affecting the national economy accounted for about 2.7% in food industry developments. The sector contributed to exports with an 8.8% share (KSH, 2020). Food industry production has been continuously increasing since 2014, with a growth rate of 6.6% observed in 2022.

Hungary possesses outstanding potential in both agricultural and food production, as highlighted by Boldog et al. (2020). However, it's important to note that these industries are significant not only from an economic and societal perspective but also in a traditional sense. This is particularly evident in the fruit and meat sectors, which remain flagship industries in the Hungarian food sector (Nagy et al., 2021). Competitiveness in Hungary requires utilizing subsidies and development, especially during unfavorable periods, as emphasized by Keszthelyi (2020). The level of subsidies depends on the European Union quota, which determines the growth of specific sectors, whether agriculture or complementary food processing, as noted by Bareith and Csonka (2019). The stability of businesses significantly impacts not only economic processes but also the domestic satisfaction of basic needs (Madari, 2021). The greater the significance of companies in a particular sector, the more important it is to understand the reasons that make these companies successful and profitable. In terms of research focusing on the food sector, it's important to highlight that there are significant differences in the corporate structure of the Hungarian food industry compared to companies operating in other EU member states (Nagyné, 2004). Therefore, examining this is crucial for determining how corporate profits can be improved.

Alongside tradition and stability, modernization level is essential for food industry companies. Hungary's food industry holds a prominent position internationally in terms of digitalization, with significant integration of information technology within the sector (over 50%). However, the adoption of more advanced cutting-edge technological solutions remains relatively low (Hungary's Digital Food Industry Strategy, 2022). Typical examples include enterprise resource planning systems, as well as the use of artificial intelligence-based services and cloud services (Debrenti & Herdon, 2021).

Given the challenges faced today, it is crucial to build on strong historical traditions, possess a stable vision and innovation potential, and identify future development directions and opportunities. In this regard, the Arellano and Bond (1991) Generalized Method of Moments (GMM) estimation, relying on dynamic panel data, helps understand the circumstances affecting the sector and the most important factors (Jaisinghani, 2015; Bareith, 2019; Hirsch et al., 2021).

In addition to sectoral characteristics, corporate characteristics are increasingly valued, involving various components (Ali, 2016; Brannon & Wiklund, 2016). Without aiming for completeness, examples include the necessity of adapting to rapidly changing, volatile markets, the continuous shortening of the deadline for adapting to consumer preferences, and various support policy systems (Harmsen & Jensen, 2004; Saebi et al., 2017; Humphrey, 2006; Potts et al., 2008; Varadarajan, 2020; Barney-McNamara et al., 2020).

Food sufficiency and security remain critical issues now and in the future. In addition to the challenges posed by a growing population, economic aspects play an increasingly significant role with the continuous evolution and change of the modern market economy. The food market, connecting agriculture with end consumers, can be integrated into the national economy in various ways. Likewise, businesses can play numerous functions in regional food supply (Espolov et al., 2020; Dung et al., 2021).

Following accession to the European Union, the expanding support system gradually improved the profitability of food industry enterprises. However, it is important to mention that profitability strongly depends on the available support as well (Lászlók, 2019). Further underscoring the importance of this research is the post-paradigm shift data from the pandemic, which shows that the profitability of food processing industry not only lags behind that of agriculture in general but also other industrial sectors, and generally within the manufacturing sector as well (Vörös-Illés & Lámfalusi, 2021).

The profit-generating capacity of businesses in the sector is subject to many external influences. Therefore, it is necessary to conduct economic studies that cannot be measured from the perspective of balance sheets and income statements or transformable into measurable forms (Angyal-Vajai, 2021).

In examining profitability, it is important to note that the number of food industry businesses in Hungary is exceptionally high compared to other sectors (KSH, 2022). The aforementioned factor's substantive constancy since the turn of the new millennium, as well as the significant and weighty export rate of the food industry, further increases its national economic significance (Tóth et al., 2019). Therefore, it is justified to subject the food industry to analysis to gain a more precise understanding of its significance, which is essential to identify factors that significantly determine or influence profit content.

1.2. Objectives

During my research, I examined domestic food industry enterprises within the time interval from 2010 to 2021. The primary objectives of my study are to investigate how various internal and external factors influence the profitability of food industry enterprises. Throughout the research, profitability is examined using multiple models.

O1.

Objective: Identification of internal and external factors influencing the operations of food industry enterprises between 2010 and 2021.

O2.

Assessment of the competitive dynamics in the food industry.

O3.

Assessment of the success of food industry enterprises in both domestic and international markets.

O4.

Examination of the prevalence of the utilization of own and foreign capital ratios among food industry enterprises.

2. Materials and Methods

The data used in the doctoral dissertation research are derived from the CREFOPORT corporate database, to which the doctoral school of MATE has a subscription.

***Table 1*: Characteristics of the variables under investigation**

	Proxy	Symbol	Description	Unit
Dependent variables	Profitability	ROE	$\frac{Profit\ after\ tax}{Equity}$	%
		ROA	$\frac{Profit\ after\ tax}{Assets}$	%
Control variables	Business size	revenue	-	thousand HUF
	Risk	short risk	$\frac{\text{current assets}}{\text{Short} - \text{term liabilities}}$	%
		long risk	$\frac{\text{long} - \text{term liabilities}}{\text{Total assets}}$	%
		ROA_sd3	Three-year rolling standard deviation of profitability of enterprises	%
	Tender	tender_dummy	Its value is 1 if the company has drawn at least 1 HUF of grant funds.	dummy
	Market share	MS	$\frac{Net\ sales\ revenue}{total\ industry\ revenue\ for\ the\ give}$	%
	Export	export_dummy	Its value is 1 if the company had export revenue in the given year.	dummy
	Top 10 share	top10_share	Industry revenue and the market share of the 10 largest revenue-generating companies.	%
Independent variables	Number of firms	number of firms	How many companies operated in the given industry and year.	db
	Industrial revenue	ln_arbev	Natural logarithm of revenue.	thousand HUF

Source: Own research

Observations in the bottom and top one percentile were removed per variable to avoid sample distortion caused by extremes. The final sample includes 6,894 enterprises, whose data are examined within the time interval from 2010 to 2021.

***Table 2*: Descriptive statistics for food businesses from 2010 to 2021**

Variable	N	Mean	p50	SD	Min	Max
ROA	23823	0,060	0,043	0,221	-0,946	0,710
ROE	23823	0,037	0,104	0,900	-5,955	2,218
ln_revenue	23823	18,349	18,370	2,393	11,798	24,011
short risk	23823	5,919	1,683	17,097	0,094	137,837
long risk	23823	0,086	0	0,154	0	0,739
tender_dummy	23823	0,928	1	0,259	0	1
number of firms	23823	2206,660	2276	167,113	1756	2358
MS	23823	0	0	0,002	0	0,080
ln_industry	23823	28,757	28,722	0,153	28,472	29,035

Source: Author's own calculations based on CREFOPORT

During the analysis, the models used excluded observations that did not contain values for any variable. The descriptive statistics in Table 2 refer to the final sample.

The industry categorization system most commonly used in scholarly work is the 4-digit SIC (Standard Industrial Classification). (Schumacher and Boland, 2005; Chaddad and Mondelli, 2013). Less literature employs the 3-digit SIC (Hawawini et al, 2004), and the 3-digit NACE (Nomenclature of Economic Activities). (Szymanski et al, 2007). CREFOPORT provides data at the 3-digit NACE level, so I define industry participation along this aggregation, which lies between the three and four-digit SIC. The sample was built from companies operating in the food processing sector with headquarters in Hungary, in any range of values registered in the three to four-digit NACE categories (25 categories, ranging from NACE-1011 to NACE-1092).

For the analysis of food industry enterprises, I followed the research methodology suggested by Hirsch et al. (2014). The Hierarchical Linear Model (HLM) allows for effect estimation by modeling appropriate relationships between corporate and industry covariates at every level of analysis.

First, I estimated a four-level model without structural covariates, which divides the total variance of ROA by temporal, corporate, and industry influences. Thus, I obtained the iteratively estimated mean of embedded regressions. At the first level, ROA is modeled for each period, with average ROA over time, adding a random error term.

$$r_{tki} = \pi_{0ki} + e_{tki} \qquad (1)$$

Where t, k, and i index time, firms, and industries, respectively.

π0ki represents the average time-varying ROA of firm k in industry i, and etki represents the time-varying random error, normally distributed with a mean of 0 and variance, which signifies the within-firm temporal variation. I assumed this variance to be unique for each observed firm k.

At the second level, I model the average ROA trajectory of each firm, π0ki, as a probabilistic variable around the industry average:

$$\pi_{0ki} = \beta_{00i} + \alpha_{0ki} \qquad (2)$$

Where β00i represents the average ROA of companies operating in industry i. α0ki represents the random firm-level error, assuming it follows a normal distribution with a mean of 0 and variance τ_π. Hence, τ_π signifies the variation among companies operating in different industries. It can be assumed that this variance is equal only among firms operating within the same industry.

At the third level, I model the average ROA of companies belonging to industry i (β_00i) as random variation around the population mean:

$$\beta_{00i} = \gamma_{000} + \mu_{00i} \qquad (3)$$

Where γ_000 is the grand mean of all ROA observations. The random industry-level effect is a normally distributed error (μ_00i) with a mean of 0 and variance τ_π, measuring the differences among industries.

Since the model defined by equations (1) – (3) does not include explanatory variables, I refer to it as completely unconditional (Raudenbush and Bryk, 2002). In an unconditional model, the percentage of variance attributable to each effect can be $\frac{\sigma^2}{(\sigma^2+\tau_\pi+\tau_\beta)}$ for the time difference, $\frac{\tau_\pi}{(\sigma^2+\tau_\pi+\tau_\beta)}$ for the difference among industries, and $\frac{\tau_\beta}{(\sigma^2+\tau_\pi+\tau_\beta)}$ for the differences among firms.

I estimated the magnitude of the yearly effects by incorporating appropriate dummy variables, which were time-period variables. Therefore, equation (1) takes the following form:

$$r_{tki} = \pi_{0ki} + \pi_{1ki(1.\acute{e}v)_{tki}} + \pi_{2ki(2.\acute{e}v)_{tki}} + \cdots + \pi_{11ki(11.\acute{e}v)_{tki}} + e_{tki} \quad (4)$$

r_{tki} represents the dummy variables for each of the 11 analysis years included in the present study (2011-2021).

Thus, the $\pi_{1ki}, \pi_{2ki}, \ldots, \pi_{11ki},$ and π_{0ki} yearly effects can now be interpreted as the average ROA of firm k operating in industry i, adjusted for the effects of the years. The magnitude of the yearly effects can be calculated as a decrease in time-specific variance (σ^2) compared to the unconditional model. The effect of the county can be generated using dummy variables, which should be incorporated at the firm level. In this case, equation (2) takes the following form:

$$\pi_{0ki} = \beta_{00i} + \beta_{01i(megye1)ki} + \beta_{02i(megye2)ki} + \cdots + \beta_{011i(megye11)ki} + \alpha_{0ki} \quad (5)$$

Among them, county 1, county 2, ..., county 11 are the dummy variables for counties, while β_{01i}, β_{02i},…., β_{011i} represent the county-country effects. Therefore, β_{00i} can now be interpreted as the average ROA of companies operating in industry i, adjusted for county effects. The measures of county effects are the reductions in firm-level variances observed when considering counties, introduced relative to the total variance of the model, which only includes years.

Finally, I examined the corporate and industry effects with corporate and industry-level corrections to determine the variance estimated based on the year and county effects in the unconditional model. To estimate the impact of specific structural factors on ROA in the unconditional model, I incorporated corporate and industry characteristics. It is also important to determine whether these variables should be considered transient (at the firm level at a given point in time) or stable (at the firm or industry level).

A variable will be transient if it considers all available observations within the analysis interval and estimates its impact on ROA as time progresses. On the other hand, I incorporated a stable variable based on time averages, explaining the cross-sectional differences in ROA between firms or industries (Misangyi et al., 2006).

To determine whether certain variables should be considered transient or stable, Misangyi et al. (2006) used within-category correlation analysis to estimate the temporal and corporate variance components for each variable. Variables with the most variation are considered transient, thus integrating over time. Cross-sectionally generated variables, which account for the largest part of the variance, are considered stable and are therefore added to the model at the appropriate higher level..

A similar analysis was conducted for the explanatory variables used in this study, and it was found that most variables exhibited significant differences over time. [1]

Furthermore, treating the variables as stable by aggregating averages would result in significant loss of information, which appears undesirable. Therefore, treating all explanatory variables as temporal seemed the most logical solution, adding them to the model at the time level. Equation (1) takes the following form:

$$r_{tki} = \pi_{0ki} + \pi_{1ki(X1)_{tki}} + \pi_{2ki(X2)_{tki}} + \pi_{3ki(X3)_{tki}} + \cdots + \pi_{nki(Xn)_{tki}} + e_{tki} \quad (6)$$

Where X1 and l = 1, 2, ..., n are intended to denote n corporate and industry characteristics, such as firm size or industry concentration. I assume that these characteristics remain constant, meaning their impact on ROA should be the same for every company.

$$\pi_{1ki} = y_{100,}\ \pi_{2ki} = y_{200,}\ \dots,\ \pi_{nki} = y_{n00} \quad (7)$$

In the following model, I estimate the profit persistence of the Hungarian food industry alongside industry and firm control variables. Beyond theoretical

[1] For each explanatory variable, determine the transient and stable components in the COV analysis, which decomposes the variance into a yearly and a corporate (industrial) effect. Results are available upon request.

considerations, the selection of explanatory variables was significantly influenced by the available data.

During the observation period, the database comprises 23,823 entries, with a total of 3,268 food industry companies in the sample. When selecting companies, it was important to ensure that the chosen enterprises cover the entire spectrum of Hungarian SMEs, and any conclusions and recommendations drawn can be applied to the industry's development. The focus of my investigation is on the Return on Assets (ROA) indicator, which represents the ratio of net income to total assets. A detailed explanation of the variables included in the analysis is provided in Table 1 and above it.

For profit persistence analysis, dynamic panel models are considered the standard method, as they currently provide the most accurate estimation (Hirsch, 2018). The dynamic model applies the GMM estimator system defined by Arellano and Bond (1991).

The outlined model used in my analysis can be expressed as follows:

$$\pi_{i,t} = \sum_{j} \alpha_j (X_{j,i,t}) + \lambda \pi'_{i,t-1} + \varepsilon_{i,t}$$

Where ε_(i,t)= η_i+ν_(i,t). The Arellano-Bond GMM estimation relies on the first difference of the equation, which eliminates time-invariant firm-specific (η_i) effects (Hirsch and Gschwandtner, 2013). The model can include firm- and industry-specific variables (X_j) that may explain firms' profit persistence. The GMM estimation is considered consistent if there is no second-order autocorrelation in the error terms and if the instruments are appropriate. The lagged dependent variable is endogenous, while all other exogenous variables in the model (Hirsch and Gschwandtner, 2013).

Blundell-Bond estimation assumes no autocorrelation among the individual error terms, and for proper functioning, panel effects must be independent of the first difference of the dependent variable's first observation. Similar to the Arellano-Bond estimation, Blundell-Bond works well with a large number of observations but finite time parameters (large N, small T type of sample).

I handled the lower and upper one percentile of the variable distribution through trimming to address outliers. The database may contain human error, as data is filled through multiple steps and issues may arise during queries. Therefore, trimming of one percentile of the data is justified as needed.

The model contains a total of 9 dependent variables, including 6 firm-specific effects and 3 industry-specific effects. Let's identify them now. The variable related to export sales is a binary variable, taking a value of 1 if the company had export revenues in the given year. This may not be common among SMEs, as this sales form is more characteristic of large enterprises (descriptive statistics Table 2).

Table 3: The descriptive statistics of additional variables included in the analysis between 2010 and 2021

Variable	N	Mean	p50	SD	Min	Max
export_dummy	23823	0.130	0.000	0.337	0	1
top10_share	23823	0.280	0.276	0.013	0.262	0.305
ROA_sd3	19473	0.108	0.054	0.151	0.001	0.917

Source: own editing based on STATA calculations

The control variable related to grant activity, similar to export sales, is a dummy variable taking a value of 1 if the economic entity has drawn at least 1 Ft of grant funds. Grant activity can be critical for a company. If a company has access to grant funds, it is assumed that there are investments and plans for the future (Kis-Tóth – Vígh, 2013). It is important not to confuse the utilization of grant funds with grant activity since not all grant applications will be successful; the model only considers the variables related to awarded grants.

The variable representing the number of companies indicates how many companies operated in the food industry in a given year. For this variable, only the number of SMEs included in my database was considered. One of the assumptions for perfect competition is an infinite number of sellers and buyers in the market. From this assumption, it follows that an increase in supply will reduce profitability, while profitability will improve due to exiting companies as a result of market competition easing.

Revenue growth is influenced by various factors, such as the company's sales policy. In my analysis, revenue represents the company's size. Due to economies of scale considerations, larger companies can operate more cost-effectively, hence being more profitable ex ante.

Risk measurement involves three variables in total. The reason for this is the basic economic principle that higher returns can be achieved with greater risk-taking. Short risk represents the ratio of current assets to short-term liabilities, indicating the company's liquidity position. In contrast, long risk can be interpreted as leverage (Szücs, 2018), calculated as long-term liabilities divided by total assets. My third risk indicator shows the 3-year rolling standard deviation of profitability (ROA). By including the standard deviation of profitability in the model, I introduce a risk indicator that does not directly use financial statement data.

Industry revenue and the market share of the top 10 largest companies (top10_share) are exogenous, industry variables in the model. The mechanism of action for industry revenue is similar to the number of companies variable. However, in this case, I release the assumption that all companies are equal, and revenue size determines market power. My assumption is that higher industry revenue reduces competition. However, this effect can only occur if market shares do not show significant jumps. The top10_share aims to measure this phenomenon. If the top 10 largest companies can increase their market share, it is expected to decrease the average industry profitability. I anticipate that major players will dominate the market, as observed in Bareith's (2020) doctoral dissertation.

3. Results and Discussion

3.1. Results of the Effects According to HLM

The properties of the HLM model were presented in the Materials and Methods section; therefore, in this chapter, the results related to my research will be presented.

The results of the unconditional model are included in Table 4, illustrating that the effects of both firm and time are statistically significant, with the firm accounting for 27.95% and the industry for 25.57% of the variance in ROA, respectively.

***Table 4*: HLM estimates on the effects of company, industry, country, and year**

Level	*Variance components*	*%*
Unconditional model		
Firm effect	0,1263	27,95
Year effect	0,1154	25,52
Activity effect	0,1156	25,57
Regional effect	0,0948	20,96

Source: Author's own calculations based on CREFOPORT

First, I will explain what each factor means. I'll start with the firm effect, which is the part of the profit that depended on the company, the managerial decisions. Secondly, the year effect, which indicates how much depends on which year we are in; there might be economic booms, crises, good agricultural years, etc. The activity effect represents the part of the profit that depended on the activity, essentially the NACE code. Finally, the regional effect indicates what is attributable to the location of the company within a certain region.

The regional effect is calculated in the usual way. During the dissertation, the regional effect represents the geographical location of the companies included in the study at the county level. If the variance component of the regional effect is high, then the profitability of food industry companies is determined by their geographical location. The model containing year and regional variables should be compared with the model containing only year variables, which accounts for 25.52% of the variance in ROA.

Comparing the results with previous studies, it is evident that the examination of firm profitability (see Table 4) also confirms the dominance of the company itself, with these effects contributing 27.95% to the total ROA variance. This is consistent with more recent HLM-based studies as well (e.g., Misangyi et al., 2006; Chaddad & Mondelli, 2013).

The weaker nature of the regional effect, as seen also in Goddard et al. (2009), reinforces the idea that resources tend to flow where their return is most likely. Regarding our focus on companies engaged in food production, our findings are largely consistent with Schiefer and Hartmann's (2013) study on the EU food industry and Schumacher and Boland's (2005) findings on the US food and agriculture sector. The difference in results could be due to the broader industrial classification system used in the doctoral thesis (4-digit NACE) compared to what Schumacher and Boland used (4-digit SIC), leading to more heterogeneous observations within industries.

The results achieved may suggest that the regional effect plays a less relevant role in my dissertation. Similar conclusions were drawn by Chaddad and Mondelli (2013) in their HLM study of the US food industry, where they did not consider the industry effect negligible, accounting for 7% of the ROA variance in their case.

In my analysis, I examined the breakdown by NACE 3 and NACE 4 categories. While further breakdowns of activity sectors may impact profitability in the variables studied, I did not observe any changes in my case. Therefore, it can be concluded that it does not matter whether I examine the changes at the NACE 3 or NACE 4 level for Hungarian food manufacturing companies.

3.2. Impact of Endogenous and Exogenous Factors on Firm Profitability

The results of the model presenting explanatory corporate and industry characteristics (with equation (1) substituted by (6)) are shown in Table 3. These variables were selected based on data availability and were constructed using the CREFOPORT database.

Revenue growth is associated with an increase in ROA (see Table 5). Revenue represents the net sales revenue of Hungarian food-producing companies. This relationship is quite straightforward, considering that increasing revenue generates higher profitability.

Two measures of corporate risk are derived from expressions extracted from CREFOPORT data. Short-term risk (1/Curr) is measured by the ratio of short-term liabilities to current assets, while long-term risk is represented by the company's leverage ratio (Gear), which is the ratio of long-term liabilities and borrowings to equity. While according to risk theory, higher-risk companies should achieve higher profits, Bowman's (1980) "risk-return paradox" suggests a negative correlation. Bowman indicates significant negative effects for both risk metrics. Chaddad and Mondelli (2013) also found that growth had a negative impact on the profits of American food processors.

To calculate market share (MS), I divide the company's revenue by the total revenue of the 4-digit NACE industry in which the company operates. According to my dissertation, market share had a negative effect on ROA. This result is surprising considering empirical evidence indicating a positive relationship between market share and profitability (e.g., Szymanski et al., 1993). In this case, an increase in market share reduces profitability for other companies within the industry.

The investigation into grant activity indicates that companies capable of applying for and winning grants cause long-term ROA growth.

The results show that industry size has no significant effect. However, an increase in the number of companies leads to a decrease in profits, as found by Hirsch et al. (2014) in their study.

There was no clear answer regarding industry revenue growth and its long-term impact on profitability. This is interesting because one would assume that increasing revenue leads to higher profitability. From a financial perspective, a similar parallel can be drawn for the cost of capital. If a company finances 70% of its investments with equity and 30% with debt, in this case, the return on equity is higher than if we increase the equity ratio to 80% and reduce the borrowing ratio to 20%. In this case, increasing the equity ratio leads to decreasing returns on equity, which applies to industry revenue as well.

***Table 5:* The hierarchical linear model (HLM) estimates of structural variables**

	Coefficient	*Corrected Std. error*	*p-value*
ln_revenue	0,0303	0,0014	0,0330
short_risk	0,0005	0,0001	0,0006
long_risk	-0,1298	0,0105	-0,1092
market_share	-10,1643	2,3003	-5,6559
number of firms	-0,0000	0,0000	2,6100
ln_industry revenue	-0,9861	0,0121	-0,0259

Source: Author's own calculations based on CREFOPORT

In Table 5, I illustrate the effects of various factors on ROA in the control variable model. When comparing it with the unconditional model (Table 4), I noticed the following differences. The corporate effect increased by nearly 2 percentage points, and a similar trend can be observed for the year effect. Regarding the impact of activity, there is a minimal decrease of 0.86%, while for the regional effect, it is 3.25%. Interestingly, when it comes to the effect on profitability, it's not the location of the enterprise that influences it, but rather the type of activity it engages in, the year in question, and the various impacts affecting the enterprise.

Table 6: Examination of the ROA variable in relation to structural variables

Level	*Variance components*	*%*
ROA control variable model		
Firm effect	0,1323	29,74
Year effect	0,1238	27,84
Activity effect	0,1099	24,71
Regional effect	0,0788	17,71

Source: Author's own calculations based on CREFOPORT

In presenting further results, I will first discuss the findings from the Markov chain, followed by the presentation of the results from the dynamic panel estimations.

3.3. Markov Chain Analysis

The Markov chain is a mathematical model that describes a finite-state system, which is in a certain state at a given point in time and transitions to another state in the next time period. The Markov chain is characterized by the "Markov property," which means that the probability of transitioning between states depends only on the current state and is independent of past states.

Profit persistence studies are often conducted using econometric estimations, typically with AR1, OLS, or GMM methods. However, Markov chains offer a different perspective on measuring profit. Markov chains can be used to analyze the likelihood of a particular company moving to a more or less profitable group.

However, interpreting the results relies more heavily on the researcher, as there is no single value to highlight. Econometric estimations usually measure profit with continuous variables (typically ROA), while Markov chains work with discrete values.

I divided the ROA values into five and then ten equally sized groups based on profitability rankings. The groups were labeled from 1 to 5(10), where 1 represents the least profitable group, and 5(10) includes the most profitable companies. The output of Markov chains is a transitional probability matrix, showing the probabilities of companies transitioning between groups (either upwards or downwards). For profit persistence, the main focus is on the diagonal of the matrix, and the closer its value is to 1, the higher the profit persistence, meaning that the profit ratio does not change significantly from year to year, and everyone stays in their own group, resulting in "sticky" profits.

I model the transition probabilities of corporate profit rates between two time points. These transition probabilities are calculated relative to the proportion of companies in the current profitability group. Then, using the obtained transitional probability matrix, I estimate the probabilities of transitions between profitability groups.

It is important to note that the estimated probabilities will be unbiased only if the data-generating process is stationary and if the sample size is sufficiently large. The estimations presented in the doctoral dissertation apply to the food manufacturing sector, and the results are contained in Tables 7 and 8.

Table 7: Transition probability matrices (food industry)

ROA	(1)	(2)	(3)	(4)	(5)	P_j
(1)	**45,56**	19,29	11,86	10,58	12,71	100
(2)	19,23	**44,78**	20,9	9,96	5,14	100
(3)	10,99	20,87	**39,12**	20,68	8,34	100
(4)	9,20	10,64	21,55	**40,40**	18,21	100
(5)	10,92	6,00	9,08	23,18	**50,82**	100
P_j	18,5	20,5	20,93	21,24	18,84	100

Source: own editing based on STATA calculations

Table 8: Transition probability matrices (food industry)

ROA	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	P_j
(1)	**31,69**	14,05	6,69	6,87	4,93	5,60	5,78	6,02	7,12	11,25	100
(2)	14,09	**31,31**	14,67	9,62	6,86	6,17	5,21	4,31	3,56	4,20	100
(3)	8,48	13,09	**31,70**	17,45	9,50	6,79	4,80	3,39	2,57	2,23	100
(4)	6,82	10,03	16,01	**24,31**	15,61	9,98	7,21	4,55	3,46	2,03	100
(5)	4,94	7,05	8,82	15,92	**23,88**	15,2	9,45	7,00	4,41	3,31	100
(6)	4,67	5,31	7,11	9,83	15,53	**23,61**	15,14	9,83	5,65	3,31	100
(7)	3,96	5,14	5,87	6,51	9,89	17,03	**22,32**	15,37	9,45	4,45	100
(8)	4,58	4,72	4,33	4,58	6,28	9,93	18,11	**24,98**	15,34	7,16	100
(9)	6,30	4,50	3,05	3,45	4,40	6,55	9,70	18,64	**28,29**	15,14	100
(10)	6,87	4,18	2,15	3,33	3,38	3,70	6,44	11,21	23,34	**35,41**	100
P_j	8,76	9,73	10,17	10,34	10,25	10,67	10,59	10,65	10,27	8,57	100

Source: own editing based on STATA calculations

Table 7 contains the transition probability matrix for 5 groups, while Table 8 presents the results for 10 groups. In both tables, the diagonal values are above 0.2 and 0.1, respectively. In Table 7, all diagonal values are above 0.4 (40%), and in Table 8, all diagonal values are above 0.2 (20%). This suggests profit persistence in the food industry, indicating a departure from perfect competition. The highest probabilities are found in the lower and upper parts of the profitability groups, indicating greater profit persistence among poorly and well-performing companies. Poorly performing companies find it difficult to break out of this state, while well-performing companies are more likely to remain in the more profitable group. Although Markov chain analysis does not provide a complete picture of market competition, it shows signs that the market is not perfect.

3.4. Dynamic panel models

In order to evaluate the model describing the profitability of businesses, I applied the Generalized Method of Moments (GMM) method with the Arellano-Bond approach. The first step of estimation was to test the validity of instruments, which was done using the Sargan test. The p-value of the Sargan test should be higher than 0.05. The diagnostic test results of the first-difference regression model are shown in Table 7. Both first-order and second-order autocorrelation tests did not show significant results, indicating no autocorrelation between the differentiated residual variables. For the Blundell-Bond model, I was able to test second-order autocorrelation, and no issues were detected with the model. These results suggest that the models meet the requirements of diagnostic tests and are likely to provide accurate estimates of business profitability.

The purpose of implementing the Blundell-Bond estimation procedure is to verify the robustness of the Arellano-Bond model's results. When interpreting the results, I rely on the Arellano-Bond model, and any discrepancies between the Blundell-Bond model results and the main model are noted separately.

It is important for every business to assess its income generation capacity. In relation to this, I conducted various examinations focusing on the income-generating ability of businesses. The examination of business efficiency involves the assessment of profit persistence, which is indicated by the coefficient of the first lag of the ROA indicator, with a significant coefficient of 0.267. The results confirm the findings of the Markov chain analysis, suggesting that the Hungarian SME sector is not characterized by perfect competition. In the literature, profit persistence in the food industry is generally lower than in the manufacturing industry, but near-zero persistence is rare. Studies by Hirsch and Gschwandtner (2013) found abnormal profit persistence ranging from 0.1 to 0.3 for five European countries, and over 0.3 for the entire economy. Molnár et al. (2021) found values between 0.11 and 0.34 in their research. However, when examining three European countries, Hirsch et al. (2020) found values between 0.4 and 0.65.

The results indicate that higher revenue increases company profitability. Regarding risk, an increase in short-term risk enhances profitability. In my case, this means that an improvement in liquidity positively affects ROA. The coefficient of long-term risk is negative, indicating that an increase in the proportion of long-term liabilities reduces profitability. Thus, it can be inferred that the profitability of financed investments and projects is lower than the interest paid on debt. The variable measuring the variance of the profit rate (ROA_sd3) is inversely related to profitability, meaning that profitability decreases as volatility increases. This contradicts expectations and confirms the yield-risk paradox theory, which states that the relationship between yield and risk is not positive. Similar results regarding the relationship between profit and risk were found by Lőrincz (2007), Miskolczi (2017), and Bélyácz-Daubner (2021).

Table 9: Results of the dynamic panel estimation

	Arellano-Bond	Blundell-Bond
	ROA	ROA
L.ROA	0.267***	0.271***
	(0.021)	(0.020)
tender_dummy	0,005	0,015
	(0.006)	(0.015)
export_dummy	-0.074***	-0.017*
	(0.005)	(0.010)
number of firms	-0.000**	-0.000***
	(0.000)	(0.000)
ln_revenue	0.017***	0.048***
	(0.001)	(0.005)
short risk	0.000***	0.001***
	(0.000)	(0.000)
long risk	-0.130***	-0.119***
	(0.009)	(0.018)
ln_industry revenue	0.002	-0.107***
	(0.011)	(0.015)
top10_share	-0.274	-0.290*
	(0.197)	(0.163)
ROA_sd3	-0.245***	-0.225***
	(0.026)	(0.044)
Constant	-0,124	2.476***
	(0.292)	(0.414)
Observations	19069	19069

Number of id	3268	3268
ar2p	0.679	0.737
hansenp	0.34	-

*** p < 0.01; ** p < 0.05; * p < 0.1

(In the case of Arellano-Bond model there are standard faults, in the case of Blundell-Bond there are WC robustness standard errors).

Source: Own editing

In the life of a business, profitability can be influenced by several factors. There is no statistically significant relationship between the utilization of grant funding and profitability. However, surprisingly, according to the model, export activities negatively impact profitability during the examined period. A possible reason for this could be that production costs increased to a greater extent than revenue from exports. Additionally, higher shipping costs alongside rising production costs could also contribute to the decrease in income. Exchange rates may also affect export sales.

There are differences between the Arellano-Bond and Blundell-Bond models regarding industry-specific variables. Regarding the variable representing the number of companies, both models are consistent, indicating that an increase in the number of firms reduces profitability, reinforcing the idea that profitability decreases with supply-side expansion. However, when considering industry revenue instead of the number of companies, this effect is only supported by the Blundell-Bond model; there is no relationship in the Arellano-Bond estimation. Similarly, for the top 10 market share variable, the expectation is that an increase would reduce profitability. This is confirmed by the Blundell-Bond model, but according to the Arellano-Bond estimation procedure, it has no effect on profitability.

4. Conclusions and Recommendations

My results strongly support the dominance of firm effects in the Hungarian food industry, as these effects account for 27.95% of the variance in firm profitability. Activity, years, and regional effects contribute 25.57%, 25.52%, and 20.96%, respectively, to the variance in ROA. Therefore, it can be concluded that firm effects have a greater influence on the profitability of food industry enterprises than the other variables included in the analysis.

Regardless of the method used, the dominance of firm effects and the relatively weaker presence of year and regional effects in my analysis reinforce previous findings (e.g., McGahan & Porter, 1997; Schumacher & Boland, 2005; Chaddad & Mondelli, 2013; Hirsch et al., 2014; Makino et al., 2004; Goddard et al., 2009). However, there is less agreement regarding the relevance of industry effects. In my analysis, industry effects account for 25.57% of the profitability of food industry enterprises. Interestingly, some studies have found industry effects to contribute less than 5% to ROA changes (e.g., Ruefli & Wiggins, 2003; Hawawini et al., 2004; Szymanski et al., 2007; Hirsch et al., 2014), while others have suggested that these effects may exceed 18% (e.g., McGahan & Porter, 1997; Schumacher & Boland, 2005). However, there is no clear consensus on the extent to which industry affects profitability. Each industry has its own risks, as does the food industry.

Furthermore, industry effects appear weaker when estimated at the broader industry classification and firm level rather than at the business unit level, as done by Chaddad and Mondelli (2013) in their study of the U.S. food industry. Therefore, a limitation of my analysis could be that I limited my data to the 4-digit NACE and firm levels. However, in the case of Hungary, there is no significant difference in results between the NACE 3 or 4 breakdowns.

This limitation prevents me from assessing the impact of related or unrelated diversification on profitability, which would be an interesting topic in the food industry. Dorsey and Boland (2009) point out that diversification of food processors into unrelated activities outside the food sector is ineffective, while the opposite is true for related activities. Chaddad and Mondelli (2013) also found that related diversification had a positive effect on the ROA of U.S. food processors.

The results of hierarchical linear modeling (HLM) have revealed several corporate and industry-specific characteristics related to profitability. In line with the findings for the U.S. food industry by Chaddad and Mondelli (2013), my results suggest that the size of a Hungarian and European food processing enterprise has a significant positive impact on performance, while risk is generally negative. Risk is understood as the uncertainty that can be mitigated but never reduced to zero. This is very simple because risk is influenced by many factors, whether it be relevant price changes in the industry, government decisions, or European Union regulations, which significantly affect investor sentiment positively or negatively. Thus, the size of the Hungarian food industry is likely to contribute to future performance based on previous and current analyses.

This suggestion is also supported by the fact that estimates of characteristics such as firm size or risk have a significant impact on ROA for some companies. However, it would be misleading not to acknowledge the impact of industry on business dynamics and competitive environments, as industry concentration and industry growth can have significant effects on profitability.

My research has shown that firms engaged in export sales are less profitable in this industry, which is consistent with the findings of other studies (Grazzi, 2012;

Ju & Yu, 2015; Gaigné et al., 2017). Unfortunately, what can promote this is the drastic increase in production and transportation costs. So, the industry is currently facing this problem, and it is uncertain when the situation in the industry will stabilize, which is not helped by inflation or the current situation. Similar to agriculture, support is needed here too for the situation to normalize in the long term, which contributes to satisfying the basic needs of everyone.

Support for small and medium-sized enterprises (SMEs) in the food industry is necessary because these businesses contribute to economic development by making investments in investments, developments, and research and development. As a result, they increase their competitiveness, innovation capability, and contribute to the development of the industry. Such support helps food industry SMEs keep up with market demands and new technologies, which promotes sustainable growth and job creation in the long run.

According to the Arenallo-Bond and Blundell-Bond models, long-term risk is negative, meaning that long-term debt reduces profits, so food companies will not take out investment loans, there will be no investments, no development, and the sector will not be competitive. The decision to take out long-term loans leads companies into loss-making directions, so food industry enterprises will not take out long-term loans, so the role of support is important in the system (Bakucs et al., 2014; Singh et al., 2021; Mokgomo et al., 2022). On the other hand, according to another viewpoint, only companies that export can be competitive, which increases profitability (Fischer & Schonberg, 2007). In contrast, I found that exports reduce profitability in the Hungarian food industry (Molnár et al., 2023). According to Herczeg et al. (2020), the higher the ROA value, the higher the average export revenue for the company. According to Kazainé (2016), export performance does not depend on ownership structure; a Hungarian-owned company is just as likely to be successful as a majority-owned foreign company.

If a company does not have the opportunity to take out long-term loans, there will be no investments, and without innovation in the medium to long term, the Hungarian food industry will fall behind. This area must be developed in the case of food industry enterprises. In this case, support is a possible alternative that is more favorable than taking out long-term loans in this case. When taking out long-term loans, companies must consider the risk, while if they choose to use support, they only need to have successful use of it. There are somewhat tougher conditions for applying for grants, but in the long run, the company may have more income from it.

Regarding short-term risk, I found that companies with better liquidity positions are more profitable, so those without liquidity problems are stable and more profitable.

For every industry, it is important for companies to achieve the same profit as before. Therefore, the analysis of profit persistence was included in the dissertation. Based on my research, there is profit persistence, which can be considered average for the processing industry, higher than for agriculture.

Regarding industry revenue, I found that the more companies operate, the lower the profit, as increasing competition results in decreasing profitability. Significant values were obtained only in the Bundell-Bond model.

In the case of top10_share, significant values were also obtained only in the Bundell-Bond model. If the top10 takes out as much of the industry's revenue as possible, profitability decreases in the sector. As a result, market-dominant players regulate prices and not the market

4.1. Limitations of the research

The limitations of HLM (Hierarchical Linear Models) research can be highlighted as follows. Firstly, linear models are only capable of modeling linear relationships, thus they cannot accurately describe more complex, nonlinear relationships. Additionally, assumptions such as normal distribution and homoscedasticity of variables are often necessary but may not hold true in reality. Like all models, linear models are susceptible to overfitting and underfitting, which can lead to decreased predictive power. In the case of hierarchical models, complexity arises, especially when multiple levels need to be considered. Finding the appropriate hierarchy and relationships, as well as parameter estimation, is a complex task that can easily result in suboptimal outcomes. Linear models, including hierarchical models, require a significant amount of data for reliable results. When the quantity of available data is low, the accuracy and stability of the models may decrease, complicating correct inferences. These limitations collectively show that while HLMs can be useful tools, various factors and challenges must be considered in their application to achieve reliable results.

Among the limitations of dynamic panel data models, the role of endogenous regressors is emphasized. These are explanatory variables that depend on the outcome variable, complicating the determination of causal relationships. Correlation typical of time series data can also pose a problem, as this correlation can affect the estimation of model parameters. In cases of missing data, dynamic panel data models may suffer from selection bias, especially if the missing data does not occur randomly but exhibits a pattern. The quantity of data is also a determining factor. Adequate time series data points are necessary for reliable estimations, and insufficient data may result in model instability and decreased estimation accuracy. High multicollinearity among explanatory variables is also a limiting factor, as it can lead to unstable estimations and make interpretation of variables difficult. All of these limitations highlight the need for careful approach and model building in the application of dynamic panel data models. Data handling, addressing endogeneity issues, and ensuring an adequate quantity of data all play important roles in achieving reliable results.

The limitations of GMM (Generalized Method of Moments) model estimation are influenced by several factors. In GMM, the method is based on "moments," which are the differences between expected values and empirical averages. It is important to select and determine the correct moments, as incorrectly chosen moments can lead to biased results. Ensuring identifiability is also crucial in GMM. If the model parameters are not uniquely identifiable based on the moments, then estimations and statistical tests may be incorrect. However, it may be the case that the problems with GMM are unsolvable or difficult to solve. For example, models may not converge, or estimations may show numerical instability. Sensitivity to outliers and other data issues is also characteristic of GMM. As a result, more robust versions or correction procedures may be necessary to prevent outliers from distorting results. Increasing the number of parameters in GMM can lead to problems known as excessive parameterization, resulting in biased estimations and statistical tests. Selecting optimal parameters and handling data appropriately are both important for achieving reliable GMM estimations.

5. New scientific findings

I. Based on my analysis, it can be stated that perfect competition does not prevail in the food industry, as supported by the Markov chain analysis and dynamic panel GMM estimations.

II. I have demonstrated that export sales have a profit-distorting effect on food industry businesses. The reason behind this is the increasing costs of raw materials and transportation.

III. The risk of long-term indebtedness has a detrimental effect on food industry businesses. This is due to the lack of support, forcing them to resort to external sources for capital replenishment. As a result, their ability to further source funding and implement developments is limited.

IV. I have demonstrated that the territorial location of food industry enterprises has a lesser impact on their income-generating capacity compared to other examined factors (year effect, activity effect, company effect), supported by the ROA control variable model.

V. Using the Hierarchical Linear Model (HLM), I have found that the increase in market share of food industry businesses diminishes their income-generating capacity.

6. Scientific Papers Written on the Topic of the Dissertation:

1. Földi, P., Bareith, T., Parádi-Dolgos, A. Mikor – Hol – Hogyan? Külső tényezők hatása az élelmiszeripari vállalatok jövedelmezőségre GAZDÁLKODÁS 67 : 6 pp. 517-531. , 15 p. (2023)

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