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MARKET EFFICIENCY AND PROFITABILITY IN THE HUNGARIAN MANUFACTURING SECTOR

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1. BACKGROUND AND OBJECTIVES OF THE RESEARCH

1.1. Theoretical Approach

The analysis of market functioning is one of the most important areas of economics, addressing questions of optimal allocation of resources and the sustainability of economic growth. Theoretical models, such as the principle of perfect competition, depict an idealized world in which market participants are homogeneous, there are no barriers to entry or exit, and information is perfectly transparent. In this environment, prices are determined solely by the rules of supply and demand, thereby ensuring market equilibrium and maximum efficiency. Although this theoretical construct provides a fundamental compass for economic analyses, the functioning of real economic systems often deviates from this ideal, as differences between companies and market distortions significantly impact performance.

In reality, the structure and functioning of markets depend on numerous factors that may prevent the attainment of theoretical equilibrium. Information asymmetries among market participants, significant entry barriers, and heterogeneous company resources and strategies are all common. These factors lead to dynamic changes in competitiveness, complicating the maintenance of market equilibrium. However, theoretical models help identify the fundamental processes that influence market efficiency, especially in revealing distortions in competition. These insights are of key importance to the Hungarian Competition Authority (GVH), whose primary mission is to establish the institutional conditions for fair and efficient market competition, while promoting sustainability and equitable resource distribution.

Over the past decades, market mechanisms in Hungary and internationally have been significantly affected by events such as accession to the European Union, the 2008 global financial crisis, and the shock caused by the Covid-19 pandemic. The gradual integration of the Hungarian economy into European and global markets has represented both opportunities and challenges for the domestic manufacturing sector. Barriers to entry and exit have often been re-evaluated due to the impact of foreign direct investment, while companies have had to formulate new growth strategies to remain competitive. Additionally, globalization and the international expansion of supply chains have accelerated the transformation of production processes, forcing even traditional industries to adopt technological innovations and efficiency-enhancing investments.

These deviations are particularly striking when examining corporate performance and the distribution of economic profit. While the perfect competition model posits that economic profit tends toward zero in the long-run equilibrium, in reality, certain companies can consistently realize above-average profits. This phenomenon is known as profit persistence (PP), clearly indicating imperfections in market competition. Such deviations may distort the competitive environment and have long-term negative effects on economic innovation and optimal resource utilization. Abnormal profit therefore reflects not only issues with competition dynamics but also raises concerns regarding the sustainability of market equilibrium. International examples show that in countries with higher market distortions, the levels of innovation, technological renewal, and development of knowledge-intensive activities tend to stagnate (Gordon, 2016).

Profitability dispersion among enterprises shows considerable variation even within the same sector and time horizon, as highlighted by industry analysts (Wade & Hulland, 2004). Earlier research attributed these extreme differences in profitability to industry-specific factors rooted in classical industrial organization theory (Hatch, 2018). However, the accelerating pace of modernization has led researchers to reassess causality and begin analyzing the role of firm-level characteristics in performance dispersion (Van Reenen, 2018). Today, factors such as environmental impacts and national and corporate culture play a crucial role in enterprise operations and performance. These influences have grown even stronger in recent years, especially with the emergence of global trends related to sustainability, green technologies, and the circular economy, increasingly affecting the manufacturing sector (Singh et al., 2014). Such trends must not be overlooked in the evaluation of results.

As a result of my research, I reveal previously unknown correlations regarding the profitability of manufacturing companies, which contribute roughly 20% of Hungary's GDP. I quantitatively identify the factors influencing profitability, thereby providing a more accurate picture of the current state of the Hungarian manufacturing sector. The findings offer a comprehensive overview for manufacturing firms and policymakers, delivering crucial insights for shaping economic, regional, and sectoral development programs. In this context, promoting sustainable and innovative production structures may play a key role in enhancing competitiveness at both national and international levels, especially as emerging megatrends (digitalization, climate awareness, global trade network expansion) are expected to continue transforming traditional market dynamics.

Accordingly, the dissertation defines three main objectives:

(1) to highlight the relationship between firm-level factors and market structural characteristics in shaping profitability;

(2) to map the extent of PP in the Hungarian manufacturing sector as an indicator of imperfect competition;

(3) to examine how technological advancement and productivity improvement affect firm competitiveness and long-term profitability.

Based on this threefold objective, the structure of the dissertation is built to first review the relevant theoretical foundations and related literature, then present the databases and methodologies used, and finally interpret the results from both economic policy and corporate perspectives. The insights gained may help sector-level policymakers identify areas requiring intervention, whether in stimulating R&D and innovation, lowering entry barriers, or assessing the quality of foreign investments.

This chapter thus provides the analytical framework for examining market functioning, competitive distortions, and persistent profitability deviations. It also outlines the core economic theories and practical aspects that form the foundation of the subsequent empirical analysis. The novelty of the approach lies in examining the Hungarian manufacturing sector using multiple methodological frameworks—hierarchical models, dynamic panel models, and stochastic frontier analysis (SFA)—allowing for detailed exploration of firm-, industry-, and region-level effects. Due to this synthetic approach, the dissertation not only evaluates market characteristics in Hungary with scientific rigor but also strives for practical applicability in economic policymaking and corporate strategy development.

From the perspective of modern economic thought, market analysis is no longer limited to neoclassical rationality- and equilibrium-based models. Behavioral economics highlights that distortions such as overconfidence or simplifying heuristics influence strategic corporate decisions, affecting market adaptability and innovation dynamism (Spiegler, 2011). Armstrong and Huck (2010) empirically demonstrate how irrational pricing or overly cautious decisions may distort competition, especially under information asymmetries. According to Heidhues and Kőszegi (2018), company decisions are often influenced not just by pure profit maximization but also by psychological factors and distorted information, which can lead to systemic market inefficiencies. From an institutional economics perspective, Buitrago and Camargo (2021) emphasize how legal certainty, institutional stability, and the regulatory environment significantly affect competition quality. Donohue et al. (2020) reinforce these insights, stating that behavioral patterns in production and operational decisions—such as risk aversion—may substantially influence competition mechanisms. Accounting for these patterns may provide a new foundation for analyzing market efficiency, particularly in industries characterized by decentralized decision-making and high risk sensitivity. Overall, these complementary perspectives show that competition is not merely an economic optimization process, but a complex system shaped by institutions and psychological motives. A deeper understanding of this system is essential for interpreting imperfect markets and manufacturing sector profitability. These insights are not only vital for theoretical modeling but also for designing economic policy interventions, particularly in developing adaptive regulatory tools.

The analytical framework presented here relies on a multi-level approach, where firm-, industry-, and national-level processes collectively influence manufacturing sector profitability and competitiveness. This is confirmed by theoretical and empirical studies indicating that performance differences among firms result partly from the legal and market environment and partly from firm-specific resources and strategies. The following studies reveal important connections that help clarify how external (e.g., industry or national-level) and internal (e.g., corporate governance or resource allocation) factors intertwine, and how these contribute to the emergence and persistence of profitability disparities.

A fundamental principle of economics is that under perfect competition, no firm can realize above-average profit in the long run. If, however, a significant number of firms consistently achieve above-average (abnormal) profit, this suggests a failure in market competition, leading to reduced consumer surplus and overall social welfare. While in the short run abnormal profit may occur even in perfect markets, in the long run, competition should force prices to align with market norms. The "perfection" or efficiency of market competition can be measured by profit persistence, which indicates how quickly the profits of firms realizing abnormal returns converge to equilibrium levels—in other words, the speed of correction. Since the 1970s, economists and strategic management scholars have conducted extensive research on profit persistence (Mueller, 1977; Roquebert et al., 1996; McGahan & Porter, 2003; Gschwandtner, 2005, 2012; Gschwandtner & Hirsch, 2018; Sanderson et al., 2018; Hirsch et al., 2020), forming the theoretical backbone of my research.

Productivity is one of the most important indicators of economic growth and development, measuring the efficiency of input utilization. Productivity growth refers to producing more output with the same amount of input, contributing to overall economic welfare and competitiveness (Syverson, 2011). It plays a particularly crucial role in the long-term sustainable growth of national economies, directly influencing real income growth and job creation (Hulten, 2017). Numerous empirical studies confirm the importance of productivity. Countries with high productivity growth achieve faster economic expansion and higher living standards (Baumol, 2016). For instance, in the United States and other developed economies, productivity growth has directly contributed to GDP growth and real wage increases (Fernald, 2015). Additionally, productivity growth enables companies to become more competitive in global markets, which is especially important in the age of globalization and intensifying international competition (Baily & Montalbano, 2016).

To promote productivity growth, governments and companies can implement various measures, including support for technological innovation, incentives for research and development (R&D) investment, workforce training and retraining, and organizational reforms at both corporate and industry levels (Gordon, 2016). Technological advancement and innovation are particularly important for productivity growth, enabling the adoption of new production methods and procedures that improve resource efficiency and reduce costs (Brynjolfsson & McAfee, 2014). Efforts to boost productivity are thus essential for long-term economic development and can significantly enhance competitiveness across various sectors. The effectiveness of these efforts can be further examined using the SFA (Structure-Function Analysis) method, which provides in-depth analysis of economic systems and production processes. The SFA method facilitates a better understanding of complex economic models, helping to identify optimal production factors and their interactions, which are crucial for successful productivity enhancement measures. These steps not only offer theoretical advantages but also yield measurable benefits in practical applications.

While productivity growth is a central factor in economic development, sectoral differences and global economic trends also play a decisive role in its success. To fully comprehend the economic effects of productivity growth, it is essential to closely examine the role of individual sectors, particularly manufacturing, in sustainable development and global competitiveness.

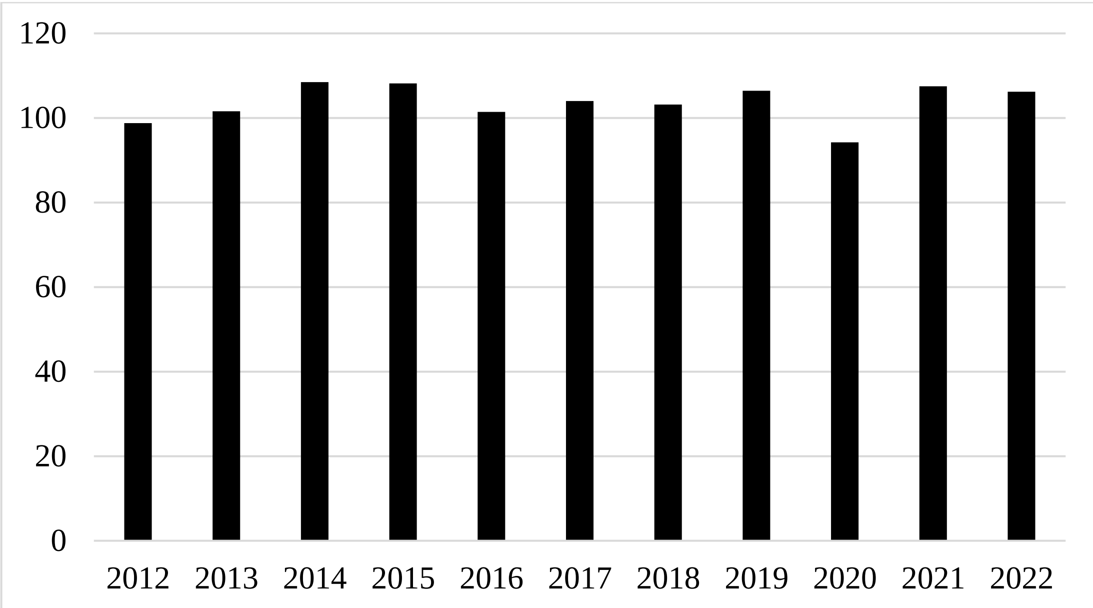
1.2. Industry Overview

The manufacturing sector is a key pillar of many national economies, contributing significantly to the achievement of sustainable economic growth (UNIDO, 2018). Sustainable production refers to the creation of products that use minimal resources, have minimal environmental impact, and are produced at an acceptable cost to society (Singh et al., 2014). The technological development and processes of globalization have generated new types of goods and services, as well as new business models on a global scale (Povolná and Svarcová, 2017). The international manufacturing industry plays a crucial role in the global economy, influencing various aspects of economic productivity and employment. Globally, China is the largest manufacturing country, accounting for 28.7% of total global manufacturing output—more than 10 percentage points ahead of the United States, which was previously the world's largest manufacturing economy. With a manufacturing value added of nearly USD 4 trillion in 2019, the sector accounted for almost 30% of China's total economic output. In contrast, the U.S. economy today is significantly less dependent on manufacturing: in 2019, the manufacturing sector contributed just over 11% of GDP. Most European countries also place a strong focus on industrial production, much of which is driven by manufacturing. This sector contributes substantially to sustainable economic growth. Within Europe, Germany plays a leading role in manufacturing, with data from 2019 showing that USD 806 billion came from this sector, accounting for 24.2% of German GDP (Statista, 2021; KSH, 2019a). In terms of added value and employment, countries such as the Czech Republic, Bulgaria, Estonia, Italy, Hungary, Slovenia, and Slovakia are also of significant importance (Behun et al., 2018).

The importance of Hungarian manufacturing has been analyzed by Nagy and Lengyel (2016) and Koppány (2017), focusing on the sectoral structure, export performance, drivers of reindustrialization and restructuring, as well as the role of medium-sized enterprises. The Hungarian manufacturing industry has been one of the key drivers of the country's economic growth, contributing an average of 19% to the national GDP over the past two decades—a figure that reflects the sector's importance in the Hungarian economy (KSH, 2022). The industry has undergone significant transformation during this period. Following Hungary's accession to the European Union, manufacturing performance grew dynamically until 2007, resulting in improvements in gross value added, export sales, and labor productivity (Nagy and Lengyel, 2016). However, the 2008 global economic crisis disrupted this growth trend and led to a drastic downturn in manufacturing output. Export sales regained momentum from 2010, but the previous growth trajectory was only restored by 2014. According to Nagy and Lengyel (2016), this rebound was not necessarily the result of reindustrialization, but rather reflected restructuring and reorganization within the sector. Since then, manufacturing performance has followed a year-over-year upward trend (KSH, 2022). Between 2010 and 2019, the growth in industrial output, exports, and industrial employment contributed significantly to Hungary's development (ÁSZ, 2021). The share of industry in Hungary's GDP showed a steadily increasing trend until 2015, after which it began to decline significantly due to the rapid expansion of the services sector. International comparisons reveal that industrial output as a share of GDP in the Visegrád countries and the 27 EU member states followed a similar trend—increasing until 2015–2016, then declining significantly thereafter. To reverse this trend and increase the share of industrial output in GDP, targeted government policies are necessary—ones that support the production of export-oriented goods and simultaneously prioritize increasing both the volume and skill level of labor input (ÁSZ, 2021).

Based on average sales volume indices in domestic manufacturing, it can be stated that overall sales dynamics grew by 10% compared to the 2012 base level. In 2020, the growth rate declined, largely due to the underperformance of nearly all sub-sectors—except for the chemical industry—compared to the previous year. This downturn can be attributed to the negative macroeconomic impacts of the COVID-19 pandemic. However, the situation later stabilized, and a 14% increase was observed compared to the low point (KSH STADAT 13.1.1.7).

Figure 1: Volume Indices of Manufacturing Sales (previous year = 100.0%)

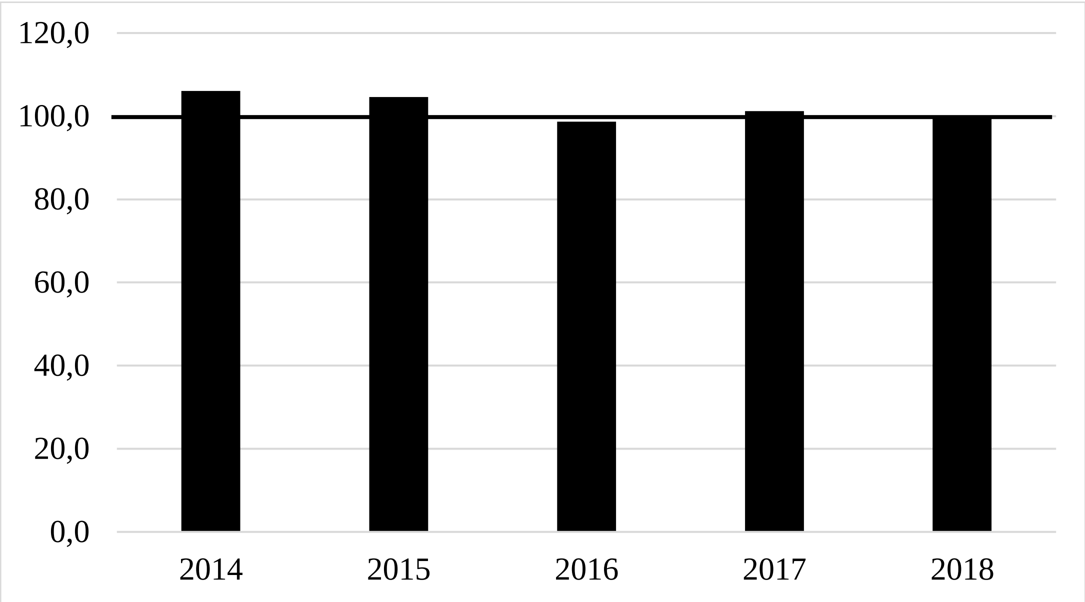


Source: Edited by author based on KSH STADAT 13.1.1.7

Manufacturing production continues to rely primarily on export markets, with 72% of sales originating from foreign markets in 2019. Excluding the manufacture of food, beverages, tobacco products, and the manufacture of coke and refined petroleum products, at least half of all products were exported. In the majority of the machinery industry, as well as in the pharmaceutical industry and the manufacture of textiles, apparel, leather, and leather products, the share of foreign sales exceeded 80%. The highest export share, at 96%, was observed in the manufacture of computer, electronic, and optical products (KSH, 2019a). The depreciation of the forint also contributed to maintaining export market competitiveness, as without this, the forint-denominated export prices would not have been able to keep up with the rapid increase in world market prices that began in 2016 (ÁSZ, 2021).

According to Eurostat data, in 2021 Hungary's manufacturing sector achieved one of the highest labor productivity rates adjusted for wages in the EU, reflecting outstanding competitiveness (Eurostat, 2021). The role of the manufacturing sector in economic growth is multidimensional. First, it significantly contributes to GDP; second, through its export orientation, it supports a positive trade balance; and third, it creates numerous jobs, especially in higher value-added industries such as automotive and electronics (Wan et al., 2022). The rapid technological advancement of recent years, the adoption of Industry 4.0 solutions, and the spread of digitalization have had a significant impact on productivity indicators (MNB, 2022). Productivity indices in manufacturing have shown a growing trend year after year, with the exception of 2016, when productivity declined by 1.3% compared to the previous year (KSH STADAT 13.2.1.29). In the same year, industrial production volume decreased by 0.5% compared to the same period of the previous year. Industrial export volume fell by 4.2% compared to the previous year, particularly in the automotive sector, where a 6.0% decline was recorded, while exports of computer, electronic, and optical products increased by 4.0% (KSH, 2016).

Figure 2: Productivity Indices in the Manufacturing Sector (previous year = 100.0%)



Source: own compilation based on KSH STADAT 13.2.1.29

In 2023, approximately 72% of Hungary's manufacturing output was directed toward export markets. This high export ratio highlights the crucial role of global markets in sustaining and expanding the Hungarian manufacturing sector. The segment with the highest domestic export sales was the manufacture of electrical machinery and equipment, accounting for 26.4% of total exports. Notably, the automotive industry and the production of electrical equipment demonstrated significant growth in their export volumes, further strengthening the international competitiveness of the sector (World's Top Exports, 2024).

2. MATERIALS AND METHODS

During the research, I used the Crefoport Scholar corporate database provided by Céginformáció.hu Kft., which contains comprehensive financial data for Hungarian companies for the period between 2013 and 2022. In terms of sampling, I worked with the entire population of firms. This database is an ideal source for analyzing the Hungarian manufacturing industry in several respects: it is representative at the industry, regional, and size levels, and it offers reliable, well-structured data on companies' financial status and operational characteristics. The final sample was filtered according to the following criteria: it includes corporate entities that apply double-entry bookkeeping. I excluded companies where either the balance sheet total or the equity was zero or negative, and I also excluded enterprises with negative net sales revenue. During the examined period, the sample covered on average 5,323 enterprises annually, including small-, medium-, and large-sized firms. Therefore, the final sample provides a well-reflected representation of the diversity and heterogeneity of the Hungarian manufacturing sector. The database covers key areas such as business profitability, balance sheet data, profitability ratios, and financial risk indicators, providing a comprehensive picture of both internal operations and external market conditions.

Based on the available data, I was able not only to analyze the key financial indicators of individual companies (e.g., revenue, profit, structure of assets and liabilities) but also to assess more detailed attributes such as firm size, activity type, export orientation, and regional and industry classifications. This allowed me to go beyond traditional financial metrics and examine how companies differ in terms of structural and operational characteristics. Therefore, the research covered not only standard financial indicators (e.g., ROA or return on equity), but also a comparative analysis of production profiles, regional attributes, and strategic decisions (e.g., export activity, financing structure).

To conduct the research, it was necessary to clean the dataset. During the filtering of missing values, I ensured that all relevant companies in the final sample had data available for the most important indicators (e.g., revenue, assets, profits). I also paid close attention to removing duplicate records, since multiple entries of the same firm could interfere with statistical estimates. I further checked for inconsistencies in the balance sheet or income statement (e.g., negative equity or missing total assets), as such inconsistencies could significantly distort profitability and efficiency indicators.

The database offers a unique analytical framework for examining Hungarian manufacturing firms, as it captures the spatial, temporal, and activity-related impacts on the industry's performance. This enabled the combined application of HLM, dynamic panel models, and SFA, which each examine profitability and efficiency from different perspectives. The integration of these three approaches provides a comprehensive understanding of the operational dynamics and competitiveness of Hungarian manufacturing firms.

In my research, I estimated a four-level model without structural covariates, which decomposes the total variance in ROA into temporal, firm-level, geographic, and sectoral components. At the first level, the model captures the variation of ROA over time, incorporating a random error component. This analysis is further justified by the fact that, to my knowledge, no profitability studies using HLM have been conducted on the Hungarian manufacturing sector.

HLM is an effective statistical method for analyzing hierarchically structured or nested data. It allows simultaneous examination of variable effects at different levels of analysis, thereby offering a more comprehensive understanding of the data. The essence of HLM lies in the use of random effects at each hierarchical level to model variability. This is implemented through a series of linear equations that capture relationships between variables at different levels. The HLM model I applied is largely based on the steps outlined by Hirsch et al. (2014):

$$r_{tki} = \pi_{0ki} + e_{tki}$$

where t, k, and i represent time, firms, and industry sectors, respectively. In this model, π_0_ki denotes the average time-varying ROA of firm k in industry i, and e_tki stands for the time-varying random error component.

HLM enables the estimation of both fixed effects (such as the average relationships between variables across all groups) and random effects (such as the variability in relationships between groups). This dual capacity facilitates a more nuanced understanding of the data and can uncover patterns that traditional linear models might overlook. Overall, HLM is a valuable tool for analyzing hierarchical data and understanding complex relationships between variables at multiple levels. Due to its ability to incorporate random effects and support multilevel analysis, HLM is particularly well-suited to studying real-world phenomena that exhibit hierarchical structures.

Table 4: Variables Included in the Analysis

Reference	Proxy	Notation	Description	Unit of measurement
Dependent variables	Profitablity	ROA	Net profit / Total assets	%
Firm-level/ Firm-specific explanatory variables	Output	output	Net sales revenue	million HUF
	Liquidity position	short_risk	Short-term liabilities / Total liabilities	%
	Long-term indebtedness	long_risk	Long-term liabilities / Total liabilities	%
	Market share	market_share	Net sales revenue / Industry revenue by activity	%
	Export activity	export	= 1 if the company has export revenue in the given year	binary variable
	Operational risk	rolling_risk	3-year rolling ROA	-
Industry/Industry-level explanatory variables	Market size	market_output	Annual aggregated revenue (by activity)	million HUF
	Share of top 10 companies	top10_share	Market share of the top 10 companies by revenue (by activity)	%

Source: own compilation

In my research, I examined four effects both without and with control variables:

1. Firm Effect: Elements of profitability that depend on the decisions and strategic moves of company management (e.g., investment decisions, pricing, organizational structure)
2. Year Effect: The influence of the given year's macroeconomic environment (economic growth, demand, exchange rates, etc.) on company performance.
3. Activity Effect: Industry-specific characteristics based on the company's NACE (main activity) code, which may affect the operational environment of the enterprise.
4. Regional Effect: Advantages or disadvantages arising from geographical location (county), such as infrastructure, local taxes, and labor availability.

In addition to independent effect assessments, I also incorporated control variables into the model I applied (see Table 4). The focus of my analysis is the ROA (Return on Assets), which is defined as the ratio of net income to total assets. As a control variable for firm size, I used the natural logarithm of revenue. I also included variables related to short-term risk (current assets divided by short-term liabilities) and long-term risk (the proportion of long-term liabilities within total liabilities). Further relevant variables in my model include export activity (equal to 1 if the firm has export revenue in a given year, and 0 otherwise), the logarithm of the annually aggregated revenue of the sector (based on the first two digits of the NACE code), and market share based on revenue, all of which are assumed to influence profitability. Descriptive statistics of the variables are provided in the appendix.

Understanding how markets operate requires examining not only the supply side—such as industry concentration or economies of scale—but also incorporating demand-side factors into the analysis. Consumer behavior, demand elasticity, and product differentiation fundamentally shape the intensity and structure of competition. Classical economic models—such as those by Hotelling (2024) and Lancaster (1979)—already highlighted that consumer taste heterogeneity and product differentiation determine the scope of action available to firms. Experimental and empirical studies—such as Draganska and Jain (2006), and Davcik and Sharma (2015)—confirm that consumers' price sensitivity, differentiated products, and brand loyalty have a direct impact on pricing strategies and the long-term profitability of firms. Demand elasticity becomes particularly crucial when consumers are less sensitive to price changes, allowing firms to maintain higher profit margins over time. Structural characteristics on the demand side—such as information asymmetries or brand commitment—can also create opportunities for the establishment of sustained market dominance (Motta, 2004). Modern behavioral economics also emphasizes the role of demand: Gabaix and Laibson (2006), as well as Kosfeld and Schüwer (2011; 2017), demonstrated that consumers often ignore future or hidden costs, enabling firms to distort competition using so-called "shrouded pricing" strategies. The significance of demand-side dynamics is particularly pronounced in the manufacturing sector, where, beyond technological differences, consumer preferences also shape market structure by influencing entry barriers, pricing, and opportunities for innovation. Accordingly, this dissertation analyzes in detail the key demand-side factors alongside the supply side, which are closely related to profitability and the mechanisms of competition.

Studies on profit persistence most often rely on some form of econometric estimation and typically measure profit using a continuous variable (usually ROA). However, the Markov chain applied in this research approaches the measurement from a different perspective, allowing for the analysis of the probability that a company will transition into a more or less profitable group. The Markov chain provides an appropriate starting point, and based on the results, expectations about the dynamics of competition can also be inferred. I categorized firms into five and ten equal-sized groups based on profitability (ROA), ranked accordingly. The groups were defined from 1 (or 5) to 10, where 1 represents the least profitable and 10 the most profitable firms. The purpose of the ten-group breakdown is to validate the robustness of the results. In the context of profit persistence, values on the diagonal are relevant—the closer they are to 1, the higher the level of persistence, from which it can be concluded that firms' profits are "sticky," meaning they are unlikely to move from their current profitability group.

Due to time invariance and the ability to control for different effects, the dynamic panel model is expected to provide a more accurate picture than the Markov chain analysis. In my case, I used relevant variables such as revenue, short-term risk (current assets divided by short-term liabilities), long-term risk (long-term liabilities as a share of total liabilities), export activity (equal to 1 if the firm has export revenue in a given year, and 0 otherwise), market share based on revenue, industry revenue, market share of the top 10 firms, and the three-year rolling standard deviation of ROA—all of which are assumed to influence profitability.

Table 5: Descriptive Statistics of the Variables

Variable	N	Mean	Median	SD	Min	Max
abnormal ROA.L1	8469	0,116	0,060	0,231	-0,383	1,360
ln revenue	8472	18,778	18,693	2,182	7,601	25,859
short-term risk	8462	0,778	0,537	1,017	0,002	7,395
long-term risk	8469	0,092	0,004	0,163	0	0,874
export dummy	8472	0,192	0	0,394	0	1
ln industry revenue	8472	27,469	27,486	0,279	27,006	27,926
market share	8472	0,001	0,001	0,006	1,49E-09	0,141
top 10 share	8472	0,349	0,343	0,020	0,326	0,393
ROA_AE_sd3	7765	0,117	0,058	0,188	0,001	1,279

Source: own compilation

Based on the research of Hirsch and Gschwandtner (2013), due to the limitations previously discussed, the application of AR models does not provide sufficient reliability for analyzing profit persistence (PP). Therefore, the dynamic panel model—specifically, the Generalized Method of Moments (GMM) developed by Arellano and Bond—appears to be the most suitable tool. According to Hirsch (2018), the GMM method is the most appropriate for estimating PP, as the OLS method tends to produce upward-biased results. This procedure is particularly advantageous when the analyzed period is relatively short, but data from a large number of firms are available.

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

According to the method, in the error term expression ($\varepsilon_{i,t} = \eta_i + \nu_{i,t}.$) the GMM applies first differencing, which enables the elimination of time-invariant firm-specific effects (η_i) (Hirsch and Gschwandtner, 2013). The model can incorporate variables (X_j) that may explain firms' profit persistence. GMM is considered consistent if there is no second-order autocorrelation in the error terms (first-order autocorrelation is not possible due to the use of lagged explanatory variables), and if the instruments are valid. Second-order autocorrelation can be easily tested, while the appropriateness of the instruments can be checked using the Hansen test. The lagged dependent variable is endogenous, while all other explanatory variables in the model are exogenous (Hirsch and Gschwandtner, 2013). The Hansen test is particularly well suited in the presence of heteroscedasticity. Testing practices vary among researchers: Gschwandtner and Hirsch (2018), Puziak (2017), and Hirsch and Hartman (2014) all relied solely on the Hansen test in their studies.

In profit persistence (PP) estimations, the Arellano-Bond procedure is generally considered the default, as the Blundell-Bond method yields more reliable results only when the AR parameter is significant. However, in the manufacturing sector, PP is often low. For this reason, I regard the Arellano-Bond estimates as the primary approach, while the Blundell-Bond estimates are used to test the robustness of the results.

To measure technical efficiency, I used the Stochastic Frontier Analysis (SFA) method. The SFA methodology was independently introduced by Aigner et al. (1977) and Meeusen and van den Broeck (1977).

The general form of the model they proposed can be expressed as follows:

$$y_i = \alpha + \beta' \boldsymbol{x_i} + v_i\text{-}u_i$$

,where y_i denotes the output of firm $\boldsymbol{x_i}$ represents the inputs used by the firm, β is the vector of technological coefficients, v_i is the statistical noise, and u_i denotes technical inefficiency (i.e., the shortfall from the maximum output achievable given the technology). For the empirical estimation of the model, assumptions must be made about the distribution of v_i and u_i. One of the most common assumptions is the so-called normal-half normal distribution model introduced by Aigner et al.:

$$v_i \sim iid\ N(0, \sigma_v^2)$$

$$u_i \sim iid\ N^+(0, \sigma_u^2)$$

,where v_i is an independently and identically normally distributed random variable with a mean of 0 and variance σ_v^2; u_i is a one-sided distribution derived from a normal distribution with zero mean. It is further assumed that v_i and u_i are independently distributed from each other and from the explanatory variables. Under these assumptions, the model can be estimated using the maximum likelihood method.

Since their introduction, SFA models have undergone significant development. Detailed overviews of various SFA models can be found in the following books: Coelli et al. (2005), Fried et al. (2008), and Kumbhakar and Lovell (2000).

The term refers to the fact that traditional panel models (fixed effects or random effects models) can also be used to estimate technical efficiency (Pitt and Lee, 1981; Schmidt and Sickles, 1984), but only with significant limitations:

(1) they are only suitable for estimating time-invariant efficiency, which raises fundamental identification issues, and

(2) they cannot separate the effect of cross-sectional heterogeneity between firms from efficiency (Abdulai and Tietje, 2007; Greene, 2005).

Both models proposed by Greene provide solutions to these problems. However, true fixed effects models can result in biased estimates in cases with short time series and a large number of cross-sectional observations (which characterizes my sample as well), due to the so-called incidental parameter problem. Therefore, in this research, I used the TRE model:

$$y_{it} = \alpha_0 + \omega_i + \beta' \boldsymbol{x}_{it} + v_{it} - u_{it}$$

,where ω_i represents a time-invariant firm-specific random effect (in other words, it captures the impact of heterogeneity across firms), while the other variables are interpreted according to the previous notation. The model in this form can be estimated using the simulated maximum likelihood method.

It is important to note that the TRE model assumes that firm-specific heterogeneity is not correlated with the explanatory variables; therefore, it is sensitive to biases resulting from this assumption (Farsi & Greene, 2005; Farsi et al., 2005; Kuenzle, 2005). One possible method to avoid such bias is the so-called Mundlak specification (Mundlak, 1978). This approach helps to eliminate the distortion problem due to potential correlation and to account for unobserved heterogeneity that may correlate with the explanatory variables. Mundlak's approach models the correlation between unobserved heterogeneity and the regressors in an auxiliary equation, assuming that the unobserved environmental production factors correlate with the group means of the explanatory variables. The Mundlak specification can be incorporated into the above model as follows (Equation x):

$$\omega_i = \alpha' \overline{x_\iota} + \overline{\theta_\iota}$$

,where it is assumed that $\overline{\theta_\iota} \sim N(0, \sigma_{\bar{z}}^2)$. The bar over the variables denotes the time average. This extension essentially decomposes the firm-specific component into two parts: the first part is explained by the observable variables, while the remaining component is considered orthogonal to the explanatory variables. This orthogonality assumption is proven by Mundlak in his paper (Mundlak, 1978).

Another possible extension of SFA models is the incorporation of variables that explain efficiency and/or the error term. There are several ways to achieve this (Kumbhakar and Lovell, 2000). One of the most common approaches is to relax the assumption of homoskedasticity in the base models of efficiency and/or error terms, and instead assume heteroskedasticity. This heteroskedasticity can be parameterized using an observed variable and the corresponding coefficient in the following way (Kumbhakar and Lovell, 2000):

$$\sigma_{u,i}^2 = \exp\,(z'_{u,i}\boldsymbol{w}_u)$$

$$\sigma_{v,i}^2 = \exp\,(z'_{v,i}\boldsymbol{w}_v)$$

,where $z'_{u,i}$ and $z'_{v,i}$ are m × 1 vectors of observable variables, including the constant term, and w_u and w_v are the corresponding m × 1 coefficient vectors.

In the empirical estimation, I assumed a Cobb-Douglas (CD) functional form and included the time variable in the model alongside the inputs to account for technological progress. The estimated empirical model is as follows:

$$\ln(y_{it}) = \alpha_i + \sum_j \beta_j \ln(x_{jit}) + \beta_t * t + v_{it} - u_{it}$$

,where $\alpha_i = \alpha' \overline{x_i} + \overline{z_i}$, t=1,…,T denotes the years. The remaining variables are interpreted as previously defined.

I estimated three different models:

Model 1 – TRE model without Mundlak specification;

Model 2 – TRE model with Mundlak specification; and

Model 3 – TRE model with Mundlak specification including variables that explain efficiency and the error term.

The dependent variable used in the research is the revenue of companies (domestic and export revenue), while the independent variables are material-type expenditures (lx1n), personnel-type expenditures (lx2n), and the total assets of the companies (lx3n). For the analysis, the natural logarithm of the variables was used to reduce scale differences and ensure the normality assumptions. The data were deflated using price indices from the Hungarian Central Statistical Office (KSH): revenues were deflated with the implicit GDP price index, material inputs with the producer price index, personnel costs with the wage index for manufacturing, and assets with the investment price index.

These methodological steps — careful data cleaning, the application of complex models (HLM, dynamic panel, SFA), and the Markov chain approach — ensure that the research provides a nuanced and robust picture of the profitability and efficiency of Hungarian manufacturing companies. The results can be interpreted in multiple ways. On the one hand, from a theoretical economic perspective, they contribute to a better understanding of the relationship between competition, profit persistence (PP), and productivity. On the other hand, from a practical perspective, they provide companies with relevant information on which factors can enhance or undermine profitability, and also offer insights for economic policymakers on where interventions (e.g., innovation or export support, development of risk financing) might be warranted.

The following chapters present the methodology-based results and their detailed interpretation, which may help identify further policy and corporate actions necessary for the sustainable growth and global competitiveness of the Hungarian manufacturing sector.

3. RESULTS AND DISCUSSION

3.1. Results on the Factors Determining Corporate Performance

The results of the model without control variables are presented in Tables 6.a and 6.b, which clearly show that firm-level effects are statistically significant, accounting for an average of 28.17% of the variance in ROA.

The findings of the research suggest that a substantial proportion of profitability variance can be attributed to firm-specific factors. According to the model analysis, the variance distribution across different levels is as follows: on average, the firm-level accounts for 27.87% (ranging between 17.80% and 38.26%), the industry-level (activity effect) contributes 22.92% (ranging from 19.18% to 28.31%), and the regional effect accounts for 22.82% (between 19.54% and 28.05%) of the total ROA variance. The year effect is also similarly significant at 22.89% (ranging from 19.54% to 28.30%).

These proportions are in line with European food industry analyses (Hirsch et al., 2014), which indicate a dominance of firm-level effects across industries. Comparing these findings with previous research (Misangyi et al., 2006; Chaddad and Mondelli, 2013), I also found that profitability is most influenced by firm-level factors, while the second-level effects (industry, region, year) have a more limited impact on profit levels – a pattern that holds true in the case of Hungarian manufacturing firms as well.

However, for firms engaged in wood processing and other vehicle manufacturing, a lower proportion of firm-level influence was observed, suggesting that active managerial decisions have less impact on the profitability of these companies.

Table 6a: Results of the HLM model without control variables (split into two parts due to table size)

Activities	Food manufacturing	Beverage manufacturing	Tobacco products manufacturing	Textile manufacturing	Wearing apparel manufacturing	Wood processing (excluding furniture) manufacturing of wicker products	Paper and paper products manufacturing
Firm effect	33,06%	26,81%	28,12%	32,57%	31,12%	17,80%	27,37%
Year effect	21,19%	23,14%	22,78%	21,31%	19,64%	25,96%	23,02%
Industry effect	21,18%	23,18%	22,78%	21,34%	19,80%	26,04%	23,02%
Regional effect	21,19%	23,13%	22,78%	21,38%	19,74%	26,04%	23,01%
Residual	3,38%	3,75%	3,53%	3,40%	9,70%	4,17%	3,57%

Source: own compilation

Table 6b: Results of the HLM model without control variables (split into two parts due to table size)

Activity	Pharmaceutical manufacturing	Manufacture of fabricated metal products	Manufacture of electrical equipment	Manufacture of other transport equipment	Other manufacturing activities	Repair of industrial machinery, equipment and tools
Firm effect	38,26%	27,49%	34,24%	11,55%	27,35%	30,46%
Year effect	19,54%	22,94%	20,83%	27,80%	23,01%	22,04%
Industry effect	19,54%	22,92%	20,83%	27,80%	23,02%	22,04%
Regional effect	19,54%	22,98%	20,83%	27,67%	23,02%	22,04%
Residual	3,11%	3,67%	3,27%	5,19%	3,61%	3,43%

Source: own compilation

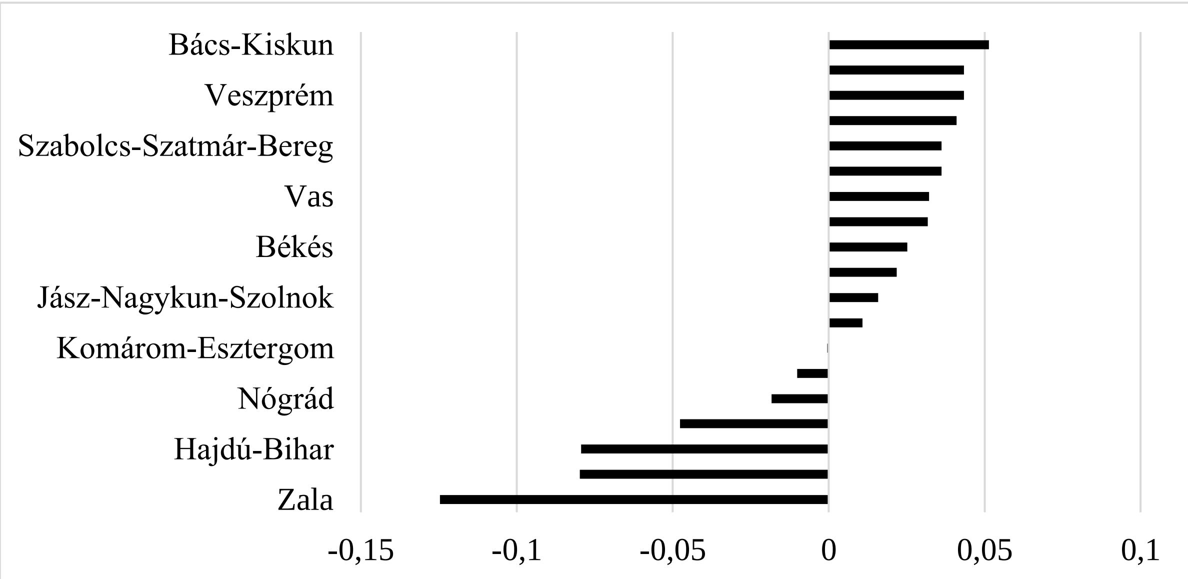
The territorial effect explains 22.56% of the variation in profitability, indicating that regional characteristics (infrastructure, employment levels, market proximity) often influence company performance. These findings suggest that regional disparities are not only statistically measurable but also exert a concrete influence on how different sectors operate.

An examination of average ROA values by region (Figure 3) clearly reveals that the performance of the manufacturing industry is closely tied to a region's infrastructural conditions, economic structure, and labor market characteristics (Kiss and Páger, 2024). In areas showing higher values—such as Bács-Kiskun County—typically there is a more developed road network, strong industrial traditions, and substantial foreign investment, all of which create favorable conditions for business development (Nagy and Lengyel, 2017).

Conversely, in regions with negative profitability—like Zala County—a fragmented corporate structure, weak infrastructure, and a less skilled labor force are more common, which impairs productivity and profitability (Kiss and Tiner, 2021). Although Budapest and its metropolitan area offer excellent transport links and higher purchasing power, the moderate average ROA in Pest County suggests that proximity to the capital does not automatically ensure high profitability. The composition of the economic structure and industrial supply chain is equally critical (Kiss and Páger, 2024).

In summary, the profitability of manufacturing companies exhibits significant spatial heterogeneity. Key explanatory factors include infrastructure and institutional conditions, economies of scale, and the quality of market linkages (Kiss and Páger, 2024; Hungarian Central Statistical Office [KSH], 2019b).

Figure 3: Average ROA Values by Region



Source: own compilation

The year effect is likewise significant, contributing 22.55% to the overall ROA variance, which is consistent with the findings of previous studies (Misangyi et al., 2006; Chadded and Modelli, 2013). This indicates that periodic economic and market fluctuations are closely linked to firm performance and play a major role in shaping inter-industry differences. The average annual ROA values examined over the 2013–2022 period (see Figure 4) reveal pronounced volatility in Hungary's manufacturing sector. The relatively high positive result observed in 2013 (0.0779) was followed by more moderate – and even negative – figures in 2014 and 2015, culminating in the sharpest downturn in 2016 (-0.1640). Subsequently, profitability gradually improved in 2017 and 2018 (from 0.0017 to 0.0185), while remaining positive but on a declining path in 2019 (0.0052).

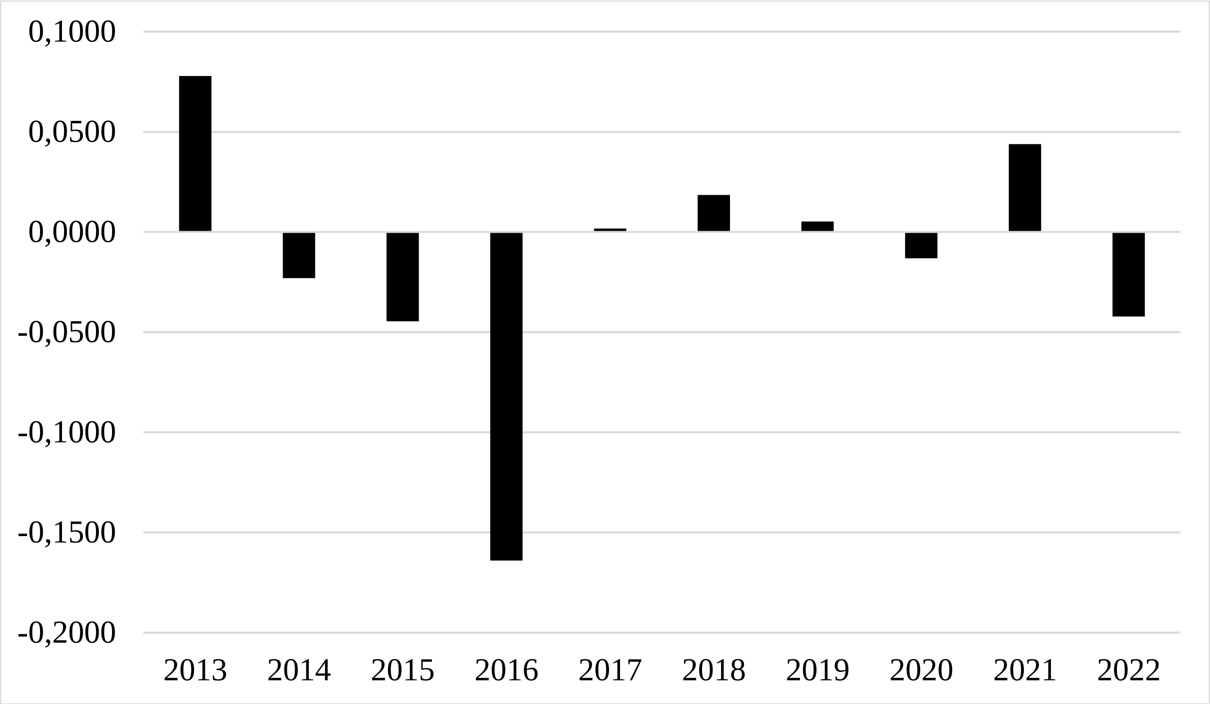
During the COVID-19 pandemic, container shipping costs increased dramatically, and supply chains became frequently disrupted, severely hindering both the procurement of raw materials and the delivery of finished goods. This phenomenon is thoroughly discussed in the study by Kovács-Horváth (2022), which highlights that the global flow of goods was suddenly destabilised, vast shipments were removed from the logistics system, and a significant container shortage emerged—particularly at Asian ports. This imbalance led to shortages in certain regions and surpluses in others. Additionally, fluctuations in domestic demand, rising energy and raw material prices, and structural challenges in the labour market all affected profitability in the manufacturing sector.

The study by Béresné and Maklári (2021) summarises the economic and social impacts of the pandemic in the European Union and Hungary, pointing out that while some sectors experienced setbacks due to public health measures, others underwent significant expansion. The transformation in consumer values and income levels left a mark across all branches of the national economy. These factors contributed to the temporary improvement seen in 2021, which was then followed by a reversal to negative profitability in 2022 (-0.0421), clearly indicating that the manufacturing sector remains highly sensitive to supply chain disruptions and shifting economic conditions.

Such pronounced annual fluctuations in average ROA values can be attributed to both international and domestic cyclical processes. The trough observed in 2016 may be explained by a decline in exports to European markets or temporarily rising operating costs among firms (Nagy and Lengyel, 2016), while the downturn in 2020–2022 was mainly driven by the pandemic-induced economic recession and the related challenges in energy and raw material procurement (Kiss and Tiner, 2021). The temporary recovery in 2021 demonstrates that the short-term negative effects of global economic shocks – such as production halts and increasingly unreliable supplier networks – can be partially offset once conditions begin to stabilise.

Nonetheless, the competitiveness of the manufacturing sector remains heavily dependent on external demand trends, infrastructure quality, technological standards, and region-specific labour market conditions. These factors jointly determine the annual evolution of ROA indicators (Kiss and Tiner, 2021).

Figure 4: Average ROA Values by Year



Source: own compilation

I observed a similarly significant share of variance attributable to industry effects, accounting for 22.58% of the total ROA variance. This indicates that the operational characteristics, technological background, and market position of individual sectors have a substantial impact on firms' economic performance. The average ROA values by activity classification reveal considerable differences in profitability across various manufacturing sectors.

The highest ROA was recorded in the repair and installation of machinery and equipment (NACE 33), exceeding the 0.05 threshold. This suggests that stable demand for specialized engineering services and high value-added contribute to the sector's outstanding profitability (Becker et al., 2010). Similarly favorable results were found in the pharmaceutical manufacturing sector (NACE 21), which closely follows NACE 33 in terms of high ROA. The exceptional profitability in this sector is attributed to a combination of innovation, strong export presence, and high value-added (Kant, 2018).

Paper manufacturing (NACE 17) and the production of electrical equipment (NACE 27) also posted moderate but positive ROA values, reflecting stable demand and efficient production processes (Silva et al., 2019). In contrast, the manufacture of basic metals and fabricated metal products (NACE 25) showed a lower but still positive ROA, indicating the impact of raw material price volatility and intense market competition (MNB, 2018).

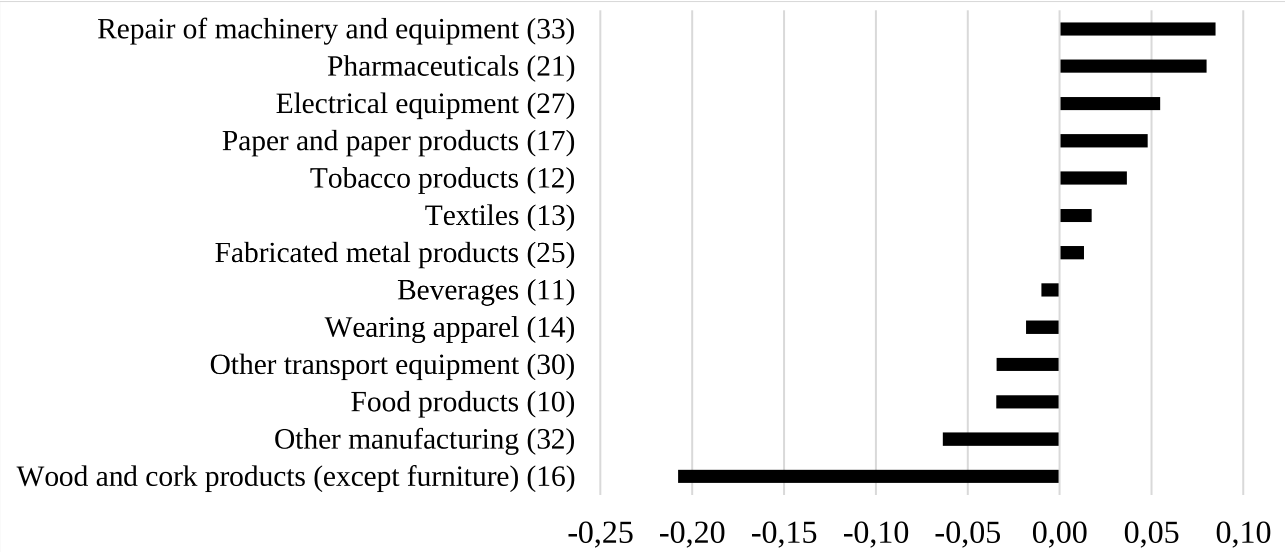
The most markedly negative ROA values were observed in the manufacture of wood and cork products, and woven goods (NACE 16), with values falling below –0.2. This substantial loss can be explained by fluctuating raw material prices, limited access to development funding, and tight market conditions (Kupcák & Smída, 2015).

In the case of food (NACE 10), beverages (NACE 11), and clothing manufacturing (NACE 14), ROA values were also negative, though to a lesser extent. In these sectors, fierce competition, unstable supply chains, and high labor costs inhibit profitability (Madari, 2021).

Other vehicle manufacturing (NACE 30) and industries related to the production of technical and industrial equipment (NACE 32) also fall into the negative ROA category. These results are primarily due to labor market challenges, rising energy prices, and intensifying international competition (Jámbor & Nagy, 2019; Kahn & Mansur, 2010).

Overall, sectors that generate higher value-added, are strongly export-oriented, and possess high levels of innovation—such as machinery repair and installation (NACE 33) or pharmaceutical manufacturing (NACE 21)—are more likely to achieve strong profitability. Conversely, sectors operating at lower technological levels, that are more labor-intensive, or that rely on volatile input prices—such as the wood industry (NACE 16) or textile and clothing manufacturing (NACE 14)—face greater risks with regard to maintaining profitability.

Figure 5: Average ROA Values by Sector of Activity



Source: own compilation based on Appendix 1

The results also revealed that market concentration—measured by the CR4 index—exerts the most significant positive impact on profitability at the industry level. At the firm level, however, size and market share emerge as the most influential determinants. For instance, in the case of firm size, the HLM regression coefficient (+0.45) indicates a statistically significant positive relationship with profitability.

The outcomes related to firm- and industry-level explanatory variables are presented in Tables 7.a and 7.b. The increase in revenue (ln_output)—represented by the logarithm of sales revenue for manufacturing firms—is associated with higher ROA values. This phenomenon is closely aligned with the economic principle of economies of scale. According to economic theory, as firms achieve greater production volumes, unit costs tend to decrease, which directly contributes to improved efficiency and profitability, as reflected in indicators such as ROA (Wheelock and Wilson, 2012; Nicholson, 2005).

This effect is particularly pronounced in the manufacturing sector, where fixed costs can be spread over a larger volume of output. Moreover, technological advancement and automation further reduce average production costs. Larger firms also tend to enjoy stronger bargaining power with suppliers and are better equipped to utilize specialized labor, advanced marketing strategies, and sophisticated IT systems (Syverson, 2011; Bloom et al., 2012). As a result, increased revenues not only amplify cost advantages derived from scale but also positively affect key performance indicators—including ROA. In the present study, rising revenues have a favorable impact on corporate profitability.

Regarding corporate risk, I examined two time horizons. Short-term risk (short_risk) is measured by the ratio of short-term liabilities to current assets, while long-term risk (long_risk) is defined as the ratio of long-term liabilities to current assets.

Table 7a: Results of the HLM model with control variables (split into two parts due to table size)

Activities	Food manufacturing	Beverage manufacturing	Tobacco products manufacturing	Textile manufacturing	Wearing apparel manufacturing	Paper and paper products manufacturing
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
ln_output	0,020**	0,020**	-0,008***	0,027**	0,026**	0,027**
	-(0,003)	-(0,002)	-(0,030)	-(0,005)	-(0,008)	-(0,007)
short_risk	-0,030***	-0,017***	-0,024***	-0,064***	-0,042***	-0,037***
	-(0,004)	-(0,002)	-(0,043)	-(0,015)	-(0,017)	-(0,014)
long_risk	-0,144***	-0,143***	-0,324***	-0,212***	0,032**	-0,272***
	-(0,023)	-(0,017)	(0,126)	-(0,048)	-(0,083)	-(0,083)
ROA_AE_sd3	-0,568***	-0,293***	0,089*	-0,624***	-0,374***	-0,364***
	-(0,055)	-(0,059)	(0,203)	-(0,070)	(0,112)	(0,194)
export	-0,068***	0,000***	0,000***	0,000***	0,000***	0,000***
	-(0,010)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
ln_mo	-0,005***	-0,010***	0,123	-0,064***	-0,049***	0,040**
	-(0,015)	-(0,015)	(0,141)	-(0,044)	-(0,067)	-(0,028)
market_share	-1,427***	-0,657***	0,053*	-2,206***	-0,190***	-0,779***
	(0,542)	(0,406)	(0,175)	(0,516)	(0,123)	(0,351)
_cons	-0,114***	-0,012***	-2,930***	1.309	0,724	-1,463***
	(0,417)	(0,401)	(3,247)	(1,104)	(1,502)	(0,742)
Firm effect (%)	23,30%	27,60%	15,46%	29,53%	9,76%	28,08%
Year effect (%)	24,07%	22,92%	23,75%	22,32%	25,39%	22,76%
Activity effect (%)	24,25%	22,92%	23,97%	22,32%	25,50%	22,76%
Regional effect (%)	24,17%	22,91%	23,33%	22,32%	25,67%	22,76%
Residual (%)	4,21%	3,65%	13,48%	3,51%	13,69%	3,65%

Source: own compilation

Table 7b: Results of the HLM model with control variables (split into two parts due to table size)

Activities	Pharmaceutical manufacturing	Manufacture of fabricated metal products	Manufacture of electrical equipment	Manufacture of other transport equipment	Other manufacturing activities	Repair of industrial machinery and equipment
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
ln_output	0,021**	0,045**	0,028**	0,038**	0,055*	0,066*
	-(0,007)	-(0,003)	-(0,003)	-(0,008)	-(0,008)	-(0,006)
short_risk	-0,149***	-0,061***	-0,073***	-0,028***	-0,048***	-0,070***
	-(0,034)	-(0,005)	-(0,009)	-(0,010)	-(0,016)	-(0,012)
long_risk	-0,232***	-0,231***	-0,201***	-0,172***	-0,172***	-0,311***
	-(0,047)	-(0,022)	-(0,027)	(0,141)	-(0,072)	-(0,040)
ROA_AE_sd3	0,192	-0,280***	-0,166***	-0,273***	-0,281***	-0,032***
	(0,179)	-(0,044)	-(0,073)	(0,132)	(0,101)	-(0,062)
export	0,000***	0,000***	0,000***	0,000***	0,000***	0,000***
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
ln_mo	-0,128***	-0,042***	-0,015***	-0,105***	-0,016***	-0,074***
	-(0,082)	-(0,010)	-(0,009)	-(0,035)	-(0,020)	-(0,015)
market_share	-0,068***	-9,029***	-0,428***	-0,893***	-0,774***	-1,875***
	(0,132)	(2,104)	(0,324)	(0,399)	(0,156)	(1,490)
_cons	3.238	0.481	0,008***	2.194	-0,419***	0.820
	(2,214)	(0,267)	(0,232)	(0,918)	(0,518)	(0,378)
Firm effect (%)	37,32%	27,34%	38,59%	8,54%	19,12%	35,29%
Year effect (%)	19,84%	22,99%	19,39%	28,30%	25,66%	20,49%
Activity effect (%)	19,84%	22,99%	19,40%	28,31%	25,66%	20,49%
Regional effect (%)	19,84%	22,99%	19,39%	28,05%	25,67%	20,49%
Residual (%)	3,16%	3,69%	3,22%	6,81%	3,90%	3,24%

Source: own compilation

Short-term financial risk was found to negatively affect profitability across all activities, indicating that deteriorating liquidity positions lead to declining profitability. This relationship is intuitive, as short-term financial risks are closely tied to a firm's day-to-day liquidity status. When a company lacks sufficient working capital or easily accessible financial resources, its operating costs tend to increase—driven by factors such as expensive short-term loans, invoicing delays, or the loss of supplier discounts—all of which undermine profitability over time (Enqvist et al., 2014). Moreover, when firms are compelled to rely on costly capital or credit sources in the short run, it further diminishes profit margins and can restrict opportunities for long-term investments (Alipour, 2011). These findings emphasize that worsening liquidity and rising short-term risk have a sustained negative impact on corporate performance.

A similar pattern was observed for long-term risk, with the exception of the apparel manufacturing sector, where a positive relationship between long-term indebtedness and profitability was identified. This anomaly can be attributed to the nature of investments in this industry, which often involve long-term payoffs, such as brand development, product innovation, and design improvements. Such strategic investments are better supported by stable, long-term financing sources. This financing approach can ease short-term cash flow volatility and foster long-term profitability (Drobetz et al., 2015). Furthermore, higher levels of long-term debt can provide firms with a tax shield, which under certain conditions supports profitability metrics (Graham and Leary, 2011). In this context, a greater reliance on long-term debt may confer a competitive advantage to apparel firms by providing predictable financial backing for strategic projects, thereby exerting a favorable influence on profitability while easing short-term liquidity constraints.

Regarding risk measured by the 3-year rolling standard deviation of ROA (ROA_sd3), an increase in volatility generally correlated with lower profitability. However, two exceptions emerged: in the tobacco manufacturing sector, uncertainty actually enhanced profitability, while in pharmaceuticals, the relationship was statistically insignificant. Typically, increased risk undermines profitability due to the need for additional financial buffers, precautionary liquidity, and the burden of higher interest or capital costs (Faccio et al., 2011). Yet, in tobacco manufacturing, demand tends to be relatively insensitive to price and business cycles, allowing producers to capitalize on uncertainty, for example, through increased profit margins. Meanwhile, in the pharmaceutical sector, strong intellectual property protection (e.g., patents) and robust regulatory frameworks may exert a stabilizing influence, muting the negative impact of risk on profitability (Grabowski and Kyle, 2008). These findings imply that in certain industries, volatility does not necessarily erode profits, as specific market characteristics can buffer risk effects.

My research also examined export activity, represented by a dummy variable (1 if the firm engages in export sales, 0 otherwise). The results reveal that exporting positively influences profitability for all manufacturing activities, except food production. Exporting is typically associated with increased profitability due to access to broader markets, diversified revenue streams, and enhanced economies of scale (Chen, 2019). Additionally, international market participation can stimulate organizational learning, as firms adapt to the higher quality standards and technological demands of foreign buyers—a phenomenon known as the "learning-by-exporting" effect—which can improve long-term competitiveness. However, in the food manufacturing sector, stringent health and quality regulations, as well as strong dependence on raw materials, can make exporting more expensive and unpredictable, potentially diminishing its positive impact (Maertens and Swinnen, 2009).

Market size (ln_mo), measured by the logarithm of total annual revenue in the firm's primary activity sector, was not significantly correlated with profitability in most cases. While larger markets theoretically offer more opportunities, this does not always translate into greater profitability in practice (Lee, 2009). In certain industries—particularly within manufacturing—rapid market expansion can attract new entrants, intensifying price competition and compressing profit margins (Aghion et al., 2015). Furthermore, firm-level attributes such as operational efficiency, innovation capabilities, and strategic direction often outweigh market size in determining profitability. Thus, in many cases, no statistically significant relationship was observed between market size and firm profitability.

To calculate market share, I divided each firm's revenue by the total revenue of its primary sector. An increase in market share enhances profitability in the tobacco manufacturing sector, while in other sectors, the relationship is negative. This contradicts findings by Bharadwaj et al. (2011), who identified a positive correlation between profitability and market share.

Table 8: Results of the HLM Model Based on Weighted Averages (Using 2022 Revenue Weights)

	Without Control Variables	**With Control Variables**
Firm Effect	30,47%	29,54%
Year Effect	22,00%	22,12%
Industry Effect	22,00%	22,16%
Regional Effect	22,00%	22,11%

Source: own compilation

In the variance decomposition analyses presented thus far, I assumed that each subsector contributes equally to the manufacturing output (i.e., I calculated the arithmetic mean of the values). The calculations shown in Table 8 were conducted by weighting sectors based on their turnover in 2022. The results of the model run without control variables indicate that turnover-weighted estimation yields a higher ROA variance share for the firm effect (30.47%) compared to the unweighted model. This finding supports prior literature (e.g., Bamiatzi et al., 2016; Chaddad & Mondelli, 2013), which asserts that firm-level factors—such as managerial decision-making, strategic resources, and organizational culture—often exert a stronger influence on profitability than industry- or macro-level determinants. Among large-scale, "dominant" firms with higher revenues, the benefits of internal resources and capabilities appear more pronounced, making them key drivers of profitability (Bamiatzi et al., 2016).

In contrast, the regional effect exhibits an inverse relationship when turnover weighting is applied, contributing 22% to the total ROA variance—0.56 percentage points lower than in the original model. One explanation for this may lie in the overwhelming influence of firm size and market dominance—emphasized through turnover weighting—which may overshadow the role of geographical or regional characteristics (Basel & Carree, 2019). This suggests that location-specific advantages (such as agglomeration economies or access to specialized infrastructure) may diminish in importance when strong firm-specific resources and strategies are present, particularly among high-revenue firms.

The effects of time (year) and industry (activity) remain relatively stable, with both showing similar degrees of reduction as the regional effect. These findings imply that while the variance contribution of contextual factors slightly declines under the weighted approach, the overall pattern remains consistent.

The extended model, which incorporates explanatory variables, further reinforces the dominance of firm-level effects, which account for 29.54% of the explained variance. The most substantial decrease is observed in the year effect, which dropped by 4.5 percentage points in terms of its contribution to

ROA variance—aligning with and strengthening the results of earlier studies (Misangyi et al., 2006; Chaddad & Modelli, 2013). Reductions were also observed for the industry and regional effects, to a similar extent as the year effect.

These findings may be further nuanced by acknowledging that seasonality and cyclical fluctuations—particularly relevant in the manufacturing sector—can influence profitability and market share. Therefore, further filtering or sensitivity analyses (e.g., to isolate different phases of the business cycle) would be required to fully assess the robustness of the model.

3.2. Results on the Measurement of Market Competition

This chapter presents a detailed overview of the data collected during the research, including their analysis and interpretation. The objective is to uncover the key determinants of profitability among Hungarian manufacturing firms and to explore the dynamics of market competition from the perspective of profit persistence (PP).

Table 11 displays the estimation results of dynamic panel models for the sector under investigation. Based on the diagnostic tests, there is no second-order autocorrelation, and the Arellano–Bond estimator passes the Hansen test, indicating its validity. The following section presents the Arellano–Bond estimation results, while the Blundell–Bond estimator is used for robustness checks. Any discrepancies between the two models are explicitly noted in the text.

According to the Arellano–Bond results, the PP value is low compared to findings in similar international studies (Isik and Tasgin, 2017; Pervan et al., 2019; Isik et al., 2017). The logarithm of industry revenue exhibits a significant and negative relationship with abnormal returns, suggesting that intensified competition in larger (i.e., higher-revenue) industries tends to suppress above-average firm profits. Growing market demand and the resulting increase in total revenue typically attract new entrants, thereby leveling market positions (Hashmi, 2013). Firms facing increased competition are compelled to reduce margins or invest more in innovation and marketing, which makes extraordinary profits harder to sustain (Correa, 2012). Consequently, profit differentials across the market gradually diminish, and extraordinary profits become increasingly short-lived as competition intensifies.

The non-significant result for the 3-year rolling ROA standard deviation suggests that fluctuations in average ROA do not materially influence abnormal profits. This indicates that moderate performance volatility does not inherently prevent firms from achieving above-average profitability. The literature suggests that strategic resources, managerial capabilities, and adaptive responses to the market environment often play a more pivotal role in sustaining abnormal profits than short-term volatility

(Crook et al., 2011). Thus, firms with volatile earnings can still maintain high profitability if they are supported by stable internal resources and strategies.

An increase in short-term risk (essentially a liquidity indicator) appears to reduce firms' profit margins. This is in line with Borszéki (2008), who argues that rising accounts payable do not necessarily reflect improved financing positions but may rather indicate the presence of debt chains—signs of structural problems within the industry. In the present sector, however, the opposite seems to be true: an improving liquidity position is associated with declining profitability.

An increase in long-term risk leads to a decrease in profitability, suggesting that the cost of external capital may outweigh the benefits of investments and development projects. This is particularly relevant when firms rely heavily on debt financing, as rising interest burdens and tightening credit conditions can undermine sectoral prospects in the long run (Drobetz et al., 2015). As a result, the expected returns on medium- and long-term investments diminish, since firms are forced to allocate more resources to servicing debt—diverting funds from innovation and development (Graham and Leary, 2011). Elevated debt levels not only reduce financial flexibility but may also contribute to a long-term decline in competitiveness and performance.

The coefficients for the export dummy and market share variables are not statistically significant, indicating that export activity and intra-industry market position have no meaningful effect on ROA. This aligns with prior empirical studies suggesting that neither exporting nor higher market share inherently guarantees greater profitability. Competitive advantage is more often shaped by strategic factors such as product differentiation, innovation capacity, and brand equity (Boso et al., 2013; Hirsch and Hartmann, 2014). As such, some firms may achieve exceptional profitability despite limited export activity, while others may fail to do so even with a dominant market share—if they lack the necessary resources or capabilities to build sustainable advantages.

The Blundell–Bond estimation results support the trends observed in the Arellano–Bond model, with the lagged value of abnormal ROA remaining non-significant. The natural logarithm of revenue (ln revenue) shows a positive and significant relationship with profitability, suggesting that larger firms perform better. This supports earlier findings indicating that larger scale enables firms to spread fixed costs more efficiently, enhance bargaining power with suppliers, and implement more effective production technologies and management practices (Serrasqueiro and Nunes, 2008; Lee, 2009). These scale economies are particularly important in capital-intensive sectors where production and market expansion require substantial investment. Therefore, the ability to leverage economies of scale is of critical importance for manufacturers aiming to enhance profitability and secure long-term market positions.

The variable representing the top 10 market share shows a strong positive effect, reinforcing the dominance of leading firms. This finding is consistent with Porter's (1980) theory of competitive strategy, which posits that firms with large market shares can influence industry structure and maintain competitive advantages. Conversely, general market share is negatively associated with abnormal returns, implying that greater market share is often accompanied by intensified competition, which erodes profitability. Anderson and Reeb (2003) support this view, showing that increased market share does not always translate into higher profitability due to pricing pressure and margin compression. These findings highlight a dual effect: while growing market share may strengthen leadership, it also intensifies competition—negatively impacting profitability. This duality is essential for understanding industry dynamics and developing corporate strategy.

Short- and long-term risk indicators are again found to be non-significant, and the export dummy variable likewise does not exhibit a statistically meaningful effect on abnormal profits.

The results of the dynamic panel models reveal that abnormal profits in the sector exhibit low persistence, indicating rapid market corrections. The positive influence of revenue and top 10 share confirms the dominance of larger firms, consistent with Porter's (1980) framework, where market leaders maintain strong positions. In contrast, the negative effects of market share and the logarithm of industry revenue reflect intensified competition, aligning with Williamson's (1981) transaction cost theory, which holds that increasing competition erodes the profitability derived from market power.

Diagnostic tests confirm the models' validity, the appropriateness of instruments, and the absence of autocorrelation. This analysis underscores the close relationship between sectoral profitability and competitive dynamics. The results highlight the advantage of higher revenues and market leadership—also emphasized by Frösén et al. (2016)—as firms with greater market shares tend to enjoy strategic advantages. Conversely, smaller players face greater competitive pressure, as Holmes and Schmitz (2010) observe, arguing that lower market concentration increases competition and challenges the viability of less dominant firms. These insights are particularly relevant for regulators and investors seeking to enhance sectoral efficiency and maintain balanced competitive conditions.

Table 11: Results of the Dynamic Panel Estimation

Arellano-Bond	**Coefficient**	**Robust standard error**	**p-value**
abnormal ROA.L1	-0,605	0,696	0,385
ln revenue	0,022	0,017	0,197
short-term risk	-0,002	0,003	0,534
long-term risk	-0,038	0,023	0,105
export dummy	0,015	0,022	0,485
ROA_AE_sd3	-0,897	1,024	0,381
ln industry revenue	-0,020	0,007	0,007***
market share	-0,797	0,308	0,010**
top10 share	0,706	0,219	0,001***
	Test		
AR(2)	z = -1,12		0,263
Hansen	Chi^2 (9) = 12,68		0,178

Blundell-Bond	**Coefficient**	**WC-robust standard error**	**p-value**
abnormal ROA.L1	0,020	0,021	0,344
ln revenue	0,166	0,052	0,001**
short-term risk	-0,003	0,002	0,192
long-term risk	-0,003	0,005	0,487
export dummy	0,185	0,294	0,528
ROA_AE_sd3	-0,298	0,246	0,226
ln industry revenue	-0,163	0,046	0***
market share	-2,183	1,119	0,051*
top10 share	0,439	0,146	0,003***
	Tests		
AR(2)	z = -1,730		0,0836

*** p<0,01; ** p<0,05; * p<0,1

Source: own compilation based on STATA output

The results indicate that firm-level factors—including size, innovation, and managerial decisions—play a crucial role in shaping profitability (Simon et al., 2011). Drawing from international examples, there is a particularly strong case for supporting technological investments and process innovations in the manufacturing sector, as many firms still rely on traditional technologies and possess limited financial capacity, which hinders their competitiveness (Damanpour & Aravind, 2012). This observation is especially relevant in the context of Hungarian manufacturing. From an economic policy perspective, preferential loan schemes, R&D subsidies, and the provision of skilled labor represent key instruments to enhance the long-term sustainability and profitability of the industry (Nordås & Kim, 2013).

The role of the regional level is equally significant. Based on the 22–23% share of variance explained, the development of advanced infrastructure and an investor-friendly environment is essential

(Rodríguez-Pose, 2013). The low to moderate level of profit persistence observed in the industry also suggests that market regulation—such as the activity of competition authorities or the encouragement of industry-level cooperation—can meaningfully influence long-term profitability (Holmes & Schmitz, 2010).

3.3. Results of the Analysis of Production Efficiency

During the research, I estimated three different TRE (True Random Effects) models to analyze the technical efficiency of the Hungarian manufacturing sector. These models enabled me to examine the sector's efficiency from various perspectives, taking into account the heterogeneity across plants and regions. The results are detailed below, comparing the performance of the three models and the conclusions drawn from them in the light of the relevant literature.

The objective of the first model was to provide a baseline estimation of the technical efficiency in the Hungarian manufacturing industry. The results are presented in Table 12.

Table 12: TRE Model without Mundlak Specification

	Coefficient	Standard error	z	P>z	95% confidence interval	
Material-type expenditures (lx1)	0.538	0.002	231.810	0.000	0.534	0.543
Labour (lx2n)	0.192	0.002	88.450	0.000	0.187	0.196
Assets (lx3n)	0.244	0.003	94.290	0.000	0.239	0.249
t	0.028	0.000	56.180	0.000	0.027	0.029
_cons	0.284	0.005	53.490	0.000	0.274	0.295
Usigma						
_cons	-2.183	0.018	-120.890	0.000	-2.219	-2.148
Vsigma						
_cons	-2.872	0.013	-212.860	0.000	-2.899	-2.846
Theta						
_cons	0.428	0.005	80.810	0.000	0.418	0.438
sigma_u	0.336	0.003	110.740	0.000	0.330	0.342
sigma_v	0.238	0.002	148.230	0.000	0.235	0.241
lambda	1.411	0.004	331.810	0.000	1.403	1.419

Source: own compilation

Based on the results of the first model, material inputs (lx1n) and labor (lx2n) significantly contribute to the companies' revenues: materials increase output by 53.8%, while labor accounts for a 19.2% increase. This also reflects the limited availability of labor. As a proxy for capital, I used the asset value. Capital (lx3n) contributes an additional 24.4% to output. According to the time trend variable (tn), technological progress is approximately 2.8% per year, indicating a positive rate of technological advancement.

The values of Usigma and Vsigma are relatively low, suggesting a significant presence of random effects in the model. This implies that both technical inefficiency and random shocks play a notable role in explaining output variation across firms. The high and positive value of Theta reflects the substantial heterogeneity among firms. The lambda value is greater than 1, indicating that technical inefficiency explains more of the residual variation than random noise.

The second model (Table 13) incorporates the Mundlak specification, which allows for the treatment of correlation between unobserved, firm-specific effects and the explanatory variables. As a result, the contribution of labor and capital decreases, providing a more accurate representation of the differences across production units.

Table 13: TRE Model with Mundlak Specification

	Coefficient	Standard error	z	P>z	95% confidence interval	
Material-type expenditures (lx1)	0.536	0.003	192.500	0.000	0.530	0.541
Labour (lx2n)	0.172	0.002	69.200	0.000	0.167	0.177
Assets (lx3n)	0.209	0.003	64.570	0.000	0.203	0.216
tn	0.032	0.001	59.960	0.000	0.030	0.033
lx1m	-0.027	0.005	-5.510	0.000	-0.036	-0.017
lx2m	0.067	0.005	14.060	0.000	0.058	0.077
lx3m	0.061	0.006	10.590	0.000	0.050	0.072
_cons	-1.013	0.053	-19.070	0.000	-1.117	-0.909
Usigma						
_cons	-2.150	0.018	-120.450	0.000	-2.185	-2.115
Vsigma						
_cons	-2.894	0.014	-209.800	0.000	-2.921	-2.867
Theta						
_cons	0.400	0.005	81.930	0.000	0.391	0.410
sigma_u	0.341	0.003	112.040	0.000	0.335	0.347
sigma_v	0.235	0.002	144.990	0.000	0.232	0.238
lambda	1.450	0.004	337.860	0.000	1.442	1.459

Source: own compilation

The contribution of material inputs (lx1n) decreases to 53.6%, while personnel-related expenditures (lx2n) drop to 17.2%. This highlights the importance of accounting for the correlation between inputs and random effects. The time trend increases slightly to 3.2%, suggesting that when plant-specific factors are considered, the pace of technological progress appears somewhat higher.

The third model (Table 14) allows for an even more detailed understanding of the role of technological and environmental factors in the efficiency of manufacturing firms.

Table 14: TRE Model with Mundlak Specification and Variables Explaining Efficiency and Error Terms

	Coefficient	Standard error	z	P>z	95% confidence interval	
Material-type expenditures (lx1)	0.532	0.003	192.860	0.000	0.527	0.538
Labour (lx2n)	0.168	0.002	67.940	0.000	0.163	0.173
Assets (lx3n)	0.212	0.003	65.210	0.000	0.206	0.219
tn	0.032	0.001	61.690	0.000	0.031	0.033
lx1m	-0.024	0.005	-5.050	0.000	-0.033	-0.015
lx2m	0.062	0.004	13.920	0.000	0.053	0.071
lx3m	0.047	0.006	8.450	0.000	0.036	0.058
_cons	-0.803	0.052	-15.320	0.000	-0.905	-0.700
			Usigma			
erat	-10.809	0.669	-16.150	0.000	-12.121	-9.497
_cons	-2.066	0.016	-128.620	0.000	-2.098	-2.035
			Vsigma			
cons	-2.885	0.012	-247.830	0.000	-2.908	-2.862
			Theta			
_cons	0.371	0.004	82.680	0.000	0.362	0.380
E(sigma_u)	0.327				0.326	0.328
sigma_v	0.236	0.001	171.810	0.000	0.234	0.239

Source: own compilation

The third model, by incorporating an additional explanatory variable (erat: the share of export revenue in total revenue), enabled a more detailed analysis of technological and environmental factors. The contribution of material inputs (lx1n) further declined to 53.2%, while the contribution of personnel-related expenditures (lx2n) decreased to 16.8%, indicating that accounting for heteroskedasticity further improves the accuracy of the production model. The time trend remains stable, showing a 3.2% increase, which confirms the ongoing effect of technological progress.

Overall, the results presented in this chapter suggest that the profitability of the Hungarian manufacturing sector is highly dependent on firm-level decisions (strategy, size, innovation activity), while industry- and region-level factors also play a significant role. The analysis of market competition reveals persistent differences in profitability and efficiency across firms, although long-term “stickiness” appears to be moderate. According to the TRE and SFA results on production efficiency, both the annual rate of technological progress and export activity are key determinants. Future research should place greater emphasis on the robustness of data, the inclusion of non-financial factors (e.g., innovation, digitalization, sustainability), and the potential impacts of external shocks (e.g., COVID-19, energy crisis, geopolitical risks), all of which may further nuance the current findings.

These conclusions can serve as a valuable starting point for corporate and policy decision-makers when designing support programs or developing business strategies. The results indicate that, on the one hand, market concentration and economies of scale confer significant competitive advantages; on the other hand, technological development and infrastructural disparities across regions fundamentally influence firms' growth and profitability prospects.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

The results of my research provide a comprehensive overview of the key determinants of profitability and efficiency in the Hungarian manufacturing sector, utilizing three distinct methodological approaches. The findings demonstrate that firm-level decisions and strategies have a substantial impact on profitability, while market structures and technological efficiency also fundamentally shape industry performance.

Using the Hierarchical Linear Modeling (HLM) framework, I found that firm-specific effects account for the largest share of profitability variance (28.17%), followed by temporal (22.55%), regional (22.56%), and industry-specific (22.58%) effects. These results clearly indicate that internal corporate decisions—such as strategic orientation and organizational processes—play a pivotal role in sustaining and enhancing profitability. Revenue growth is positively correlated with firm profitability, suggesting that policy measures supporting corporate expansion and increased market share can be especially impactful. Export activity also exerts a significantly positive effect, underscoring the importance of export-oriented strategies and improved access to international markets. Conversely, risk exposure generally has a negative effect on profitability, highlighting the necessity for robust risk management practices.

The analysis of profit persistence (PP) revealed that PP is significant in the Hungarian manufacturing sector, indicating that firms achieving high profits are more likely to sustain their positions, while less profitable firms face difficulties in catching up. Dynamic panel model estimations showed that firm size, revenue, and both short- and long-term risk levels are key determinants of profitability. Industry-level variables, such as market concentration and total sectoral revenue, were also found to exert significant influence. Such structures may impede the competitive efficiency-enhancing effects of the market, particularly when the dominance of large firms limits market access for new entrants.

Industry concentration, firm efficiency, and profit persistence are all individually important factors for understanding market functioning; however, their full significance becomes apparent only when analyzed alongside the structure of the demand side. This dissertation approaches manufacturing markets primarily from the supply-side perspective, evaluating competitiveness at the firm and industry levels, with a particular focus on distortions of competition and disparities in technical efficiency. High concentration does not inherently lead to market failure if the demand side remains responsive to price changes and market entry barriers are low (Tsitsiklis & Xu, 2014). However, if demand is inelastic or consumers are strongly brand-loyal, firms can build sustained market dominance—this phenomenon reflects the link between profit persistence and demand-side characteristics (Ailawadi et al., 2003).

Economies of scale and returns to scale can also only be fully assessed in light of demand elasticity: if increased production volume is not matched by adequate market demand, cost advantages cannot be automatically translated into competitive advantages (Lin & Bitar, 2019). The theoretical framework of this dissertation emphasizes the importance of the demand side, highlighting the roles of consumer behavior, price sensitivity, and product differentiation in shaping competition. Furthermore, the behavioral economics perspective provides new insights into the relationship between market distortions and profitability—especially through mechanisms that reduce competitive pressure via consumer biases.

For future research, a promising direction would be the deeper integration of demand-side factors into quantitative models—for instance, through structural demand estimation, consumer segmentation analysis, or price elasticity studies. These approaches could contribute to a more complete understanding of market equilibrium and enable finer calibration of corporate strategies (Gandhi & Nevo, 2021).

Finally, long-term indebtedness was found to negatively impact firm profitability, which may hinder investment and erode competitiveness. These processes ultimately reduce the intensity of market competition and diminish both price and quality competition, with adverse implications for overall social welfare and innovation.

The analyses conducted using the Stochastic Frontier Analysis (SFA) methodology yielded significant insights into technical efficiency. The results revealed that labor and capital inputs have a substantial influence on firm productivity. However, these effects may be overestimated if heterogeneity across plants is not accounted for. By incorporating the Mundlak specification into the models, I obtained a more accurate picture of the role of firm-level differences. Firms engaged in export activities exhibited higher technical efficiency, suggesting that participation in international markets and compliance with stricter quality requirements positively impact productivity. These findings emphasize that promoting technological advancement and innovation is crucial for enhancing efficiency.

For the future of the Hungarian manufacturing sector, it is essential to recognize that corporate-level initiatives and market mechanisms will only yield lasting results if they are complemented by coordinated actions at the industry and regional levels. It is worth assessing which territorial disparities hinder or support the development of individual firms, as the research highlights that infrastructure, the availability of skilled human resources, and local economic policy all substantially affect competitiveness. Reducing the regional development gap remains a priority, as nationwide improvements in productivity and profitability can only be achieved if disadvantaged regions are also integrated into technological modernization. The findings also underscore the importance, for corporate decision-makers, of fostering international competitiveness through continuous innovation, the adoption of Industry 4.0 solutions, and the strategic elevation of export activities. Governmental and EU-funded programs supporting investment and innovation could provide effective assistance in meeting international quality standards if appropriately coordinated.

The results further underscore that aligning corporate strategies with market trends is essential for long-term sustainability. Maintaining stable market positions and continuously pursuing technological innovation are key to preserving competitiveness. Furthermore, workforce training and development programs—especially in export-oriented sectors—can contribute significantly to boosting productivity. The findings also point to the importance of firms paying closer attention to global supply chains, as flexible procurement and distribution channels can stabilize performance more rapidly in times of external shocks or crises. Additionally, sustainability and environmental considerations are likely to become increasingly influential, as green technologies and low-impact production processes gain prominence in international markets.

A key conclusion is that enhancing the performance of manufacturing firms cannot rely solely on firm-level measures. Industry-wide economic policy initiatives—such as export promotion, support for technological innovation, and the improvement of competitive conditions—are equally essential. Emphasizing the regional dimension of the industry is also critical, as regional differences in economic and infrastructural development fundamentally shape firm-level opportunities. The research suggests that regulatory bodies should consider implementing market-supporting mechanisms that reduce entry barriers, encourage investment, and foster innovation. In doing so, a more balanced market environment may emerge—one where smaller firms can more effectively participate in higher value-added activities and larger firms can compete sustainably in the long run.

The empirical evidence gathered throughout the research supports the view that preserving the long-term competitiveness of Hungary's manufacturing sector requires the formulation of sustainable growth strategies. In addition to reinforcing the performance of export-oriented firms, particular attention must be paid to improving the conditions of small and medium-sized enterprises operating in the domestic market. Promoting inter-firm cooperation—through industrial clusters or joint innovation initiatives—could provide additional momentum for sectoral development. Firms with more flexible organizational structures, solid financial foundations, and strategically developed human capital will be better positioned to adapt to market disruptions and evolving international regulations.

Overall, the findings of this research highlight that improving the profitability and efficiency of the manufacturing sector requires not only the support of firm-level strategies and decision-making but also the implementation of effective industry-level regulations and economic policy measures. Initiatives such as supporting small and medium-sized enterprises, promoting exports, and facilitating technological development can not only enhance the sector's overall performance but also contribute to the long-term sustainability and competitiveness of the broader economy. Based on the results, further research is recommended to deepen the understanding of the relationship between market competition and technical efficiency, especially through the lens of regional and international dynamics. Future studies should aim to explore how global macroeconomic processes, digital transformation trends, and sustainability requirements shape the adaptability and value-generating potential of manufacturing firms.

4.2. Directions for Future Research

The findings of this dissertation provide a valuable foundation for a deeper understanding of the efficiency, competitiveness, and profitability of the Hungarian manufacturing sector. The research results and correlations presented here offer a comprehensive perspective on economic processes and raise topics that may promote sustainable industrial development and competitiveness. The following sections outline the most important future research directions and their relevance.

I. The Impact of Industry 4.0 and Digitalization: Technological Innovation in a New Era of Competitiveness

Industry 4.0 technologies—including artificial intelligence, big data, automation, and the Internet of Things (IoT)—herald a comprehensive transformation of the manufacturing sector. Future research should investigate how these innovations affect production processes, enhance efficiency, and reduce operational costs. Attention should also be given to how digitalization influences labor market structures, corporate flexibility, and export capabilities. Of particular interest is the unequal access to digital technologies, which creates regional and sectoral disparities. Research can help identify the barriers hindering the adoption of advanced technologies and contribute to long-term sustainable competitiveness by proposing appropriate solutions.

II. Sustainable Development and Green Technologies: Economic and Environmental Impacts

Sustainable development is no longer solely an environmental issue—it increasingly constitutes a competitive advantage for manufacturing firms. Future research could explore how green technologies reduce the ecological footprint of production, improve firm-level efficiency, and generate economic returns. It is essential to examine how the adoption of environmentally friendly technologies can be incentivized through regulatory frameworks and support schemes, and to determine the optimal policy tools that foster sustainability within the industrial sector.

III. Regional Disparities in Manufacturing: Innovation Potential and Structural Challenges

Regional performance differences in Hungary's manufacturing industry have significant policy implications. Research should explore how regional variations in industrial development influence production efficiency, innovation capacity, and export readiness. Special attention must be given to the roles of infrastructure and education, which underpin the formation of regional innovation clusters. Such analyses may provide important insights into reducing spatial inequalities and supporting balanced industrial growth across regions.

IV. International Competitiveness: Export Orientation and Global Supply Chains

Hungary's manufacturing competitiveness is strongly linked to its level of export activity and integration into global supply chains. Future research should identify which industrial sectors hold the greatest global market potential and how the role of Hungarian exporters can be strengthened. Another key research avenue concerns the impact of geopolitical dynamics on international economic relations and the strategies that help domestic firms maintain their position in foreign markets.

V. The Role of SMEs: Innovation and Agility

Small and medium-sized enterprises (SMEs) are vital to Hungary's economic structure. Enhancing their technological capabilities and innovation potential is essential for achieving sustainable development and competitiveness. Future research should investigate the strategies through which SMEs can improve their technological readiness and access global markets. It should also explore the necessary support mechanisms that help SMEs overcome market challenges and ensure their long-term viability.

VI. Profit Persistence and Market Distortions: Structural Analyses

Profit persistence (PP) serves as a key indicator of market distortions and weakened competition. Research should focus on identifying the factors that allow certain firms to sustain abnormal profits and on how such distortions affect overall economic competitiveness. Studies should consider the interplay between market concentration, innovation, and entry barriers, as well as the regional and sectoral implications of these dynamics in Hungarian manufacturing.

VII. Technological Advancements and Training Systems: The Role of Education and Innovation

The success of technological development hinges on a well-prepared workforce and continuous training. Future research should examine how educational reforms and vocational training at both secondary and tertiary levels align with technological requirements. It is also essential to analyze how training programs influence labor market supply and demand and facilitate faster adoption of innovations within the manufacturing sector.

VIII. International Benchmarking: Assessing Sectoral Performance in a Global Context

Understanding Hungary's manufacturing competitiveness requires cross-country comparisons. Comprehensive benchmarking can help evaluate the global positioning of Hungarian firms and identify weaknesses and improvement areas that may serve as potential competitive advantages. This research direction would support the adaptation of international best practices, particularly in digitalization, automation, and Industry 4.0. Benchmarking findings would also inform economic policy decisions aimed at increasing international market share.

IX. Market Dynamics and Corporate Strategy: Interlinkages between Innovation and Sustainability

Exploring the interaction between market dynamics and firm strategies is key to not only achieving but sustaining competitive advantage. Research in this area should investigate how technological innovation, sustainable production practices, and export-oriented partnerships influence corporate competitiveness. Strategies aimed at reducing the ecological footprint and integrating circular economy principles are particularly relevant in the context of global climate goals. These investigations may support sustainability and competitiveness both at the firm level and in broader sectoral and regional frameworks.

X. Economic Policy Interventions: Evaluating the Effectiveness of State Instruments

Assessing the impact of economic policy tools—such as tax incentives, state aid, and regulatory reforms—is crucial for improving industrial competitiveness. Special attention should be paid to how these interventions reduce market distortions and contribute to productivity and technological advancement. A particularly relevant research area is the optimization of state involvement, whereby targeted, sector-specific applications of policy instruments can maximize contributions to sustainable growth.

These research directions not only deepen the understanding of the domestic manufacturing sector but also provide a scientific basis for both policy and corporate decision-making. The proposed research agendas support the development of sustainable growth models that simultaneously enhance international competitiveness and domestic economic stability.

5. NEW SCIENTIFIC CONTRIBUTIONS

I. The dominance of firm-specific effects in determining profitability was demonstrated by the fact that, within the Hungarian manufacturing sector, 28.17% of the variance in corporate profitability is explained by firm-specific effects. In contrast, the effects of years, counties, and industry classifications contributed to a lesser extent (22.55–22.58%). This result confirms that firm-level decisions and strategies play a key role in maintaining and enhancing profitability.

II. One of the novel findings of the research is that, alongside the dominance of firm-level factors, the evolution of industry structure also exerts a strong yet time-varying influence on profitability. While previous international studies have confirmed the importance of firm-level effects, industry concentration has often been treated as a static factor. The novelty of this research lies in the simultaneous inclusion of market concentration (CR4) and firm market share in both the HLM and dynamic panel models, revealing that corporate strategy and market structure are in continuous interaction.

III. The research revealed that profit persistence is not present in the Hungarian manufacturing sector, which limits the functioning of market competition. High-profit firms are more likely to retain their positions, while low-profit firms have greater difficulty in catching up. This result highlights the significance of market concentration and entry barriers within the sector. Although many studies have investigated profit persistence, few have explored the role of regional (county-level) heterogeneity in such detail. This dissertation demonstrated that geographical factors, infrastructure, and labor availability substantially influence the ability of firms to maintain abnormal profits. This is particularly relevant for Hungary, where considerable economic disparities exist between regions.

IV. Based on the SFA results, export-oriented firms were found to exhibit significantly higher technical efficiency compared to those serving domestic markets. The international market competition and stricter quality requirements associated with export activity may have contributed to improved productivity. This result underscores the importance of promoting exports and facilitating access to international markets.

V. The application of various models, especially the Mundlak specification, revealed that accounting for plant-level heterogeneity is essential for the accurate estimation of technical efficiency.

VI. The research found that long-term indebtedness negatively affects profitability and investment activity, potentially resulting in competitive disadvantages and exclusion from international markets. This effect does not apply to the manufacture of wearing apparel. While similar conclusions have been reached in international studies, this dissertation is distinct in quantifying this effect specifically within the Hungarian manufacturing sector.

6. PUBLICATIONS RELATED TO THE TOPIC OF THE DISSERTATION

Scientific Journal Articles

Peer-reviewed article published in a foreign academic journal (in English)

Molnár, D., Horváth, T., & Bareith, T. (2023). Investigating Profit Persistence Among Hungarian Plastic Manufacturing Companies. Regional and Business Studies, 15(1), 33–45. https://doi.org/10.33568/rbs.4429

Peer-reviewed article published in a Hungarian academic journal (in Hungarian)

Molnár, D., Csonka, A., & Bareith, T. (2023). Az exportképesség és jövedelmezőség kapcsolata a dél-dunántúli feldolgozó szektorban 2014 és 2019 között. Köz-Gazdaság, 41–60. https://doi.org/10.14267/retp2023.01.03

Conference presentations published in conference proceedings

Molnár, D., Csonka, A., & Bareith, T. (2022). „Az exportképesség és jövedelmezőség összefüggései a dél-dunántúli feldolgozó szektorban", In: Molnár, Dániel; Molnár, Dóra (szerk.) XXV. Tavaszi Szél Konferencia 2022. Absztraktkötet, Budapest, Magyarország : Doktoranduszok Országos Szövetsége (DOSZ) (2022) 799 p. pp. 354-355. , 2 p.