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Assessing the Correlation Between Digitalization and Economic Performance: An Empirical Analysis for European Countries

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SUMMARY

The rapid growth of information and communication technology (ICT) has profoundly impacted how societies and economies function, making digitalization a key factor in progress. This study explores how digitalization influences economic growth in European Union (EU) countries between 2017 and 2022, using the Digital Economy and Society Index (DESI) from the European Commission as a measure of digital readiness. By applying a panel data analysis within the Cobb-Douglas production framework, we uncover a strong link between digitalization and economic performance. Our findings show that a 1% increase in digitalization, as measured by DESI, leads to a 0.3838% rise in GDP growth. This highlights the transformative power of digital technologies and the need for governments and policymakers to embrace digital innovation. By leveraging these advancements, countries can drive sustainable economic growth and build resilience in an increasingly digital world.

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1. INTRODUCTION

Economic growth has long been a central topic in academic research due to its significant impact on a nation's social, political, and economic stability. Countries with strong economies often demonstrate balanced development across these sectors, laying the groundwork for overall prosperity (Hanushek & Woessmann, 2020).

The importance of economic growth extends beyond mere statistics; it enhances a nation's global standing, strengthens its influence, and fosters resilience amid global challenges (Gründler & Potrafke, 2019). In recent decades, the rapid advancement of information and communication technologies (ICT) has transformed the global economy, introducing new drivers of growth and productivity. Emerging technologies such as the Internet of Things (IoT) and artificial intelligence (AI) have accelerated digitalization, leading to significant changes in economic and social structures (Audretsch & Fritsch, 2002; van Stel et al., 2005).

As we advance further into the digital era, digitalization has emerged as a significant force driving economic transformation. It is redefining traditional economic models of production, consumption, and trade by fostering innovation, enhancing productivity, and boosting competitiveness. Consequently, digital transformation has become a foundational element of economic modernization, recognized by governments and businesses around the world as crucial for sustainable growth. Major economies have responded by making substantial investments in digital infrastructure and technologies contributing to a global digital economy that now represents approximately 15 % of world GDP about $16 trillion. Furthermore, reaching universal broadband access alone is expected to require more than $400 billion in investment by 2030 underscoring the scale of digital infrastructure spending worldwide according to the World Bank's Digital Progress and Trends Report 2025 (World Bank, 2025).

Developing countries also stand to gain significantly from this shift, as digitalization can improve capital and labor productivity, provide access to global markets, and accelerate economic development (Arendt, 2015).

1.1. Novelty and Contribution of This Study

This study contributes to the existing literature by examining the impact of digitalization on economic growth within the European Union, specifically focusing on the EU-27 countries from 2017 to 2022. A unique aspect of this research is its utilization of the Digital Economy and Society Index (DESI), developed by the European Commission as a comprehensive measure of digitalization. Unlike traditional ICT metrics, DESI offers a multi-dimensional assessment that includes indicators such as digital infrastructure, digital skills, technology adoption, and digital public services. By employing DESI, this study provides a more comprehensive understanding of how digital transformation influences GDP growth, offering insights that extend beyond conventional ICT measurements.

This paper presents a novel approach to measuring digitalization as a multi-faceted driver of economic growth. Specifically, the research aims to answer two key questions:

1. How did digitalization progress among EU-27 countries from 2017 to 2022?
2. Is there a significant relationship between digitalization, as measured by the Digital Economy and Society Index (DESI), and GDP growth within these countries?

By addressing these questions, this study seeks to enhance the understanding of digitalization's role in economic growth within the EU. The findings are particularly relevant for EU policymakers who aim to nurture a resilient digital economy and strengthen the region's global competitiveness. By emphasizing the importance of digital infrastructure, digital skills, and technology adoption, this research provides a data-driven foundation for strategic decision-making in the EU. Additionally, it offers insights into the EU's progress in achieving its Digital Agenda, an initiative designed to build a robust and inclusive digital economy.

This paper is organized into five main sections, each exploring different aspects of how digitalization impacts economic growth within the EU-27. The introduction section establishes the context for the study, highlighting the transformative role of digitalization in driving economic growth. It outlines the study's objectives and research questions and introduces the Digital Economy and Society Index (DESI) as a key metric for analyzing the relationship between digitalization and GDP growth in the EU. The Literature Review section provides an overview of both foundational and recent studies regarding the role of digitalization in economic growth. It focuses on areas such as ICT infrastructure, digital skills, and technology adoption. By situating the study within broader academic discourse, this section supports the use of DESI as a relevant and comprehensive measure of digitalization. The Methodology part describes the empirical approach. This involves using the Cobb-Douglas production function to model the relationship between economic growth and inputs such as capital, labor, and digitalization. The section explains how DESI is utilized as a proxy for digitalization and details the fixed-effects panel data model used for analysis, including descriptions of the data sources and the reliability of the results. And finally, in the Results and Discussion section we highlight the findings that reveal a positive correlation between DESI and GDP growth, indicating that digitalization significantly drives economic growth in the EU. The results are discussed in relation to existing research, highlighting the policy implications of investing in digital infrastructure and human capital. The Conclusion section summarizes the study's key contributions, emphasizing the impact of digitalization on GDP growth and the EU's advancements in achieving its digital transformation goals. It also addresses the study's limitations and suggests potential avenues for future research, such as examining individual components of DESI to gain a more nuanced understanding of the economic impact of digitalization. In summary, this study examines the impact of digitalization, as measured by the Digital Economy and Society Index (DESI), on economic growth in the EU-27. By analyzing data from 2017 to 2022 using a fixed-effects panel model, the research provides empirical evidence that digital infrastructure, digital skills, and technology adoption are vital for economic growth. These findings are consistent with the work of Brodny and Tutak, (2022); Mura and Donath (2023); Toader et al. (2018) and others who highlight the essential role of digitalization in enhancing economic performance.

The insights from this study emphasize the significance of digitalization as a driver of sustainable growth, competitiveness, and resilience within the EU. As digitalization continues to influence global economies, it is crucial to understand its effect on economic growth to develop policies that foster inclusive and sustainable development. By utilizing DESI as a comprehensive measure of digitalization, this study contributes to a deeper understanding of its role in contemporary economic systems, making it a valuable resource for both academics and policymakers who are navigating the complexities of digital transformation.

2. Literature Reviews

This literature review examines how digitalization influences economic growth across the EU-27, with a focus on two primary questions: (1) How has digitalization progressed among EU countries? and (2) What is the relationship between digitalization, as measured by the Digital Economy and Society Index (DESI), and GDP growth? This review synthesizes core theories, concepts, and recent empirical findings to offer insights into how digitalization impacts economic performance

within EU member states. Additionally, it identifies notable gaps in existing literature and highlights emerging research trends that underscore the need for further, targeted study.

2.1. Defining Key Concepts: Digitization, Digitalization, and Digital Transformation

To understand digitalization's economic impact, it is essential to distinguish between digitization, digitalization, and digital transformation. Savić (2019) delineates these as stages in the digital integration process: digitization (converting physical information into digital formats), digitalization (using digital tools to improve processes), and digital transformation (a comprehensive restructuring of business models and public services).

Recent literature focuses on the transformative potential of advanced digital technologies, such as artificial intelligence (AI), the Internet of Things (IoT), and cloud computing. Bharadwaj et al. (2013) highlighted how digital transformation enables governments and businesses to respond to evolving demands more efficiently, thereby improving service delivery and citizen engagement. Ghobakhloo and Iranmanesh (2021) further argued that digital transformation is critical for economies to adapt to rapidly changing environments, fostering both short-term resilience and sustained economic growth.

These distinctions are relevant to the DESI framework, which captures various stages of digital integration across dimensions like human capital, connectivity, and digital public services. However, few studies systematically examine how each stage of digitalization, especially digital transformation, affects economic growth within the EU-27. This gap underlines the need for research that explores digital transformation's specific contributions to economic resilience and competitiveness within the EU, an area this study aims to address.

2.2. Digitalization as a Catalyst for Economic Growth:

The positive relationship between digitalization and economic growth has been extensively studied, particularly regarding ICT infrastructure and connectivity. In the EU context, Toader et al. (2018) highlighted that ICT investments are linked to increased GDP per capita, positioning digitalization as a driver of productivity and competitiveness in global markets. Furthermore Fernández-Portillo et al. (2020) support this idea highlighting that progress in the deployment and use of ICT drives the economic growth of countries that are within the framework of developed European economies.

Recent research has expanded the digitalization–growth literature by shifting attention from productivity gains toward economic resilience, particularly in the face of systemic shocks such as the COVID-19 pandemic. Papaioannou (2023) provides compelling macroeconomic evidence from European countries, showing that economies with higher ICT intensity experienced significantly lower cyclical GDP losses during the pandemic. Using a difference-in-differences approach, the study demonstrates that the economic impact of COVID-19 was uneven across Europe and closely linked to national levels of ICT adoption. These findings suggest that digital infrastructure plays a stabilizing role during crises by enabling economic continuity, facilitating remote work, and supporting digital service delivery. At the firm level, Furceri et al. (2022) reach similar conclusions, showing that firms operating in more digitalized industries suffered smaller revenue declines during economic downturns, with the resilience effect becoming even stronger during the COVID-19 recession. Their results remain robust across a wide range of digitalization measures, including ICT inputs, digital skills, online sales, automation, and intangible assets. Taken together, these studies indicate a clear evolution in the role of digitalization from a driver of efficiency and innovation in normal times to a critical mechanism for absorbing shocks and enhancing adaptive capacity, particularly in digitally advanced economies such as those of the European Union.

Despite extensive literature on the link between digitalization and growth, limited empirical work focuses specifically on the EU-27, particularly studies that utilize the DESI framework. This gap suggests a need for region-specific analyses that consider the EU's unique economic, policy, and social contexts. Much of the existing research centers around ICT infrastructure alone, often neglecting other digitalization dimensions, such as digital skills and public services, which are critical for a comprehensive understanding of digital transformation. Addressing these gaps can provide a more holistic view of how digitalization drives growth across the EU.

Empirical studies consistently demonstrate that digitalization positively influences economic growth, especially when coupled with strong ICT infrastructure, broadband access, and digital public services. Toader et al. (2018) found that ICT investments within the EU significantly contribute to GDP growth, affirming digitalization's role in economic performance. Mura and Donath (2023) also emphasized that digitalization enhances productivity in sectors such as education, healthcare, and public administration.

Large-scale cross-country evidence from the Katz and Callorda (2020) global study confirms that broadband expansion and digitalization play a significant role in driving economic performance, with effects that vary by income level. Using a structural econometric model for 139 countries, the study finds that a 10 percent increase in fixed broadband penetration raises GDP per capita by 0.8 percent globally, with stronger effects in high-income economies, where the same increase leads to a 1.4 percent rise in GDP. In contrast, mobile broadband exerts a larger impact in less developed economies, reflecting its role as a substitute for fixed infrastructure where broadband access remains limited. Beyond connectivity, the study shows that broader digitalization measured through the CAF Digital Ecosystem Development Index significantly

enhances economic outcomes. A 10 percent increase in the digitalization index is associated with a 1.3 percent increase in GDP per capita globally and a 1.4 percent increase in OECD countries, alongside notable gains in labor and total factor productivity. Overall, these findings highlight digitalization as a structural driver of growth, particularly in digitally advanced economies such as those of the European Union.

2.3. Measuring Digitalization in the EU: The Digital Economy and Society Index (DESI)

The EU utilizes the DESI as its primary metric for measuring digitalization, which evaluates digital progress across four dimensions: human capital, connectivity, integration of digital technology and digital public services. While other indices like the ICT Development Index (IDI) and the Global Connectivity Index (GCI) provide global perspectives, they do not consider EU-specific policy frameworks and socioeconomic conditions Thus, DESI provides a comprehensive measure that aligns with the EU's goal of fostering digital innovation and resilience (Almeida de Figueiredo, 2024).

This study builds on DESI by analyzing data from 2017 to 2022, addressing digitalization's role on economic growth within the EU-27. By focusing on DESI, this study contributes to the literature by linking digital dimensions to economic growth metrics, offering insights that are highly relevant for EU policymakers aiming to bridge digital divides across member states.

2.4. The State of Digitalization in the EU-27: Insights from DESI Data

DESI data offers a detailed overview of digitalization trends within the EU, tracking progress in areas such as human capital, connectivity, digital technology integration, and public services. According to European Commission DESI Reports (2017–2024) (European Commission, 2023), EU countries have shown steady improvement in DESI scores, reflecting significant strides toward digital transformation. However, a study by Hunady et al. (2022) points to ongoing disparities, with Northern European countries generally leading in digital readiness while Southern and Eastern European countries lag, particularly in connectivity and digital skills.

These disparities suggest a "dual speed" digital economy within the EU, where some countries reap greater benefits from digitalization than others. Such uneven progress underscores the importance of targeted policies to ensure balanced digital transformation across member states. By analyzing recent DESI data, this study assesses digitalization's progression within the EU-27 and its influence on economic growth, directly addressing the research question on digitalization's trajectory.

In fact, increasing digitalization across all significant facets of modern society and the economy has become more than just a topic for academic study; instead, it is the underlying reality that motivates the creation of various laws and regulations. Digitalization is currently the focus of most global economic ambitions. As a result, one of the primary courses of action for achieving a national goal is frequently to increase digitalization; thus, significant efforts are being made to foster digital development. In fact, DESI is a well-known metric for measuring digital progress among EU member states, and it has been used for monitoring purposes since 2014.

Since it is a composite index, the four primary directions that the DESI now focuses on human capital, connectivity, integration of digital technology, and digital public services are seen as indicative of the digital world's progress.

2.4.1. Human capital

This component underlines the relevance of the population's digital capabilities, which are critical for capitalizing on the benefits provided by digital technologies. Human capital refers to the extent to which European individuals use the Internet and other digital tools and services. The measure of internet usage represents people's efficiency in accessing digital resources.

2.4.2. Connectivity

Connectivity is a dimension that measures the extent of fixed broadband coverage, reflecting the proportion of homes that use different broadband technologies such as DSL, cable, MiMAx, and FTTP. It also measures mobile broadband usage, which is expressed as the number of persons that use mobile data per 100 people. Internet access is also evaluated based on speed, regarded as adequate if it exceeds 30 Mbps. Affordability is another connectivity component, with fixed broadband prices ranging from 12 to 30 Mbps. It is critical to increase access to digital services and boost communication and collaboration.

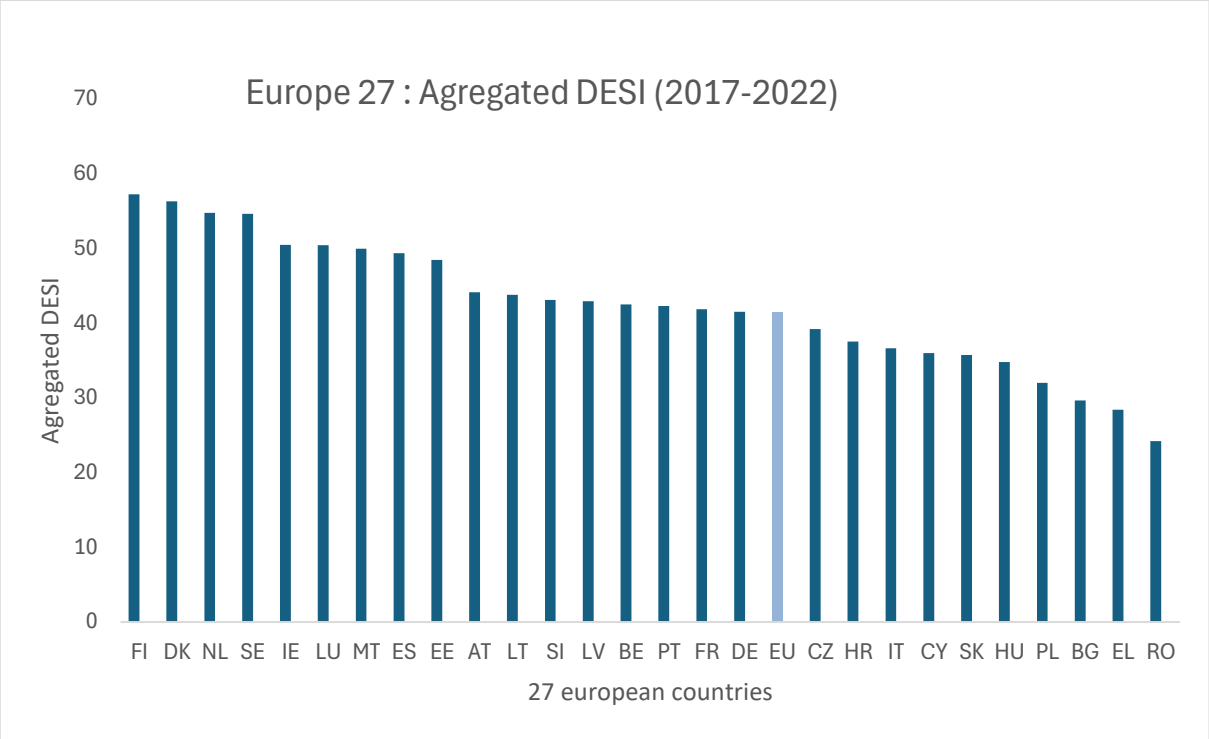
2.4.3. Integration of digital technology

Integration of digital technology includes variables like corporate digitization and e-commerce. Business digitalization consists of numerous components. It involves electronic information sharing, in which firms use software for duties such as resource planning and information exchange between departments. Second, it involves the use of Radio Frequency Identification technology to transport or identify items. Additionally, businesses use social media platforms such as networks, websites, and blogs to improve their digital presence.

2.4.4. Digital public services

Digital public services, often called eGovernment, aim to modernize public administration and improve citizen services. The connectivity component refers to the extensive infrastructure and its quality.

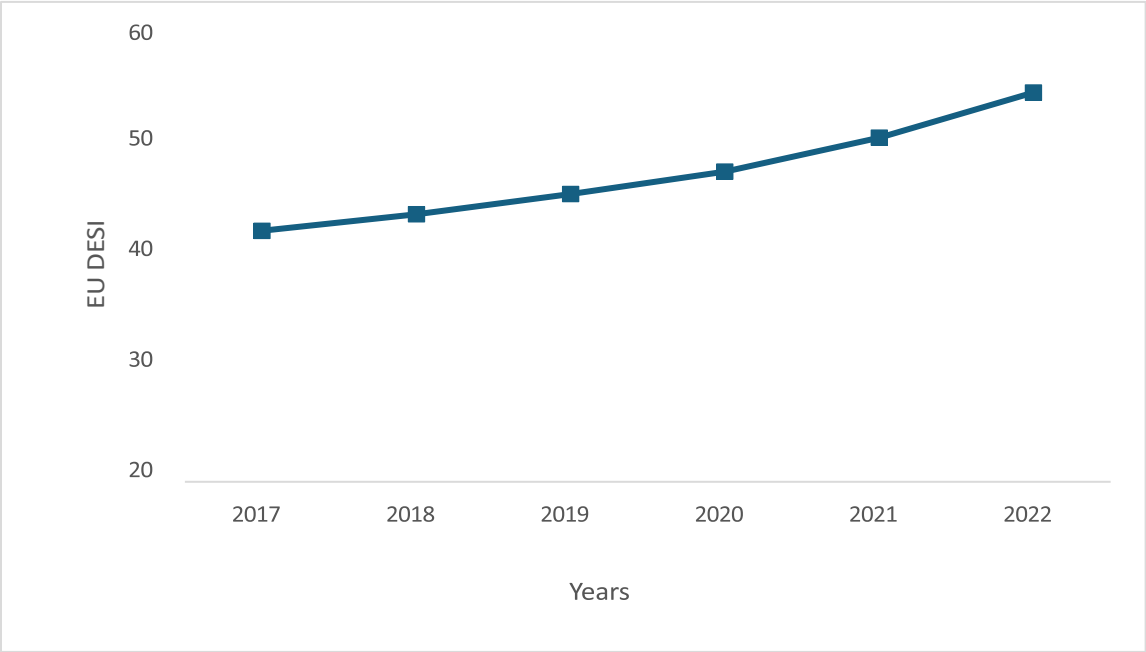
The DESI Index publications provide a comprehensive overview of EU member states' digital progress, which is an excellent place to start, as they are more relevant to the intended goal than analyzing the index's methodology.



Source: Author's compilation based on (European Commission, 2023)

Figure 1: Europe 27-Aggregated DESI (2017-2022)

The Figure 1 reveals an additional obstacle to the future of the European digital agenda. Even though the combined rating for the 27 European countries is higher (41.48) as per the lighter blue bar, one-third of the nations are still in the transitional stage of digitization. Furthermore, the level of DESI evolution in EU countries has an overall upward trend, as Figure 2 illustrates.



Source: Author's compilation based on (European Commission, 2023)

Figure 2: Evolution of EU average DESI (2017-2022)

The reviewed literature underscores digitalization as a vital economic growth driver, primarily through ICT infrastructure and digital skills. DESI's multidimensional structure captures these elements, offering a robust framework for assessing digitalization's impact within the EU-27.

By analyzing DESI data from 2017 to 2022, this study seeks to bridge the gap, providing a nuanced understanding of digitalization's economic influence within the EU. In doing so, it offers new insights into the EU's progress toward the Digital Agenda which can guide policies that foster inclusive digitalization. Ultimately, this study contributes to the broader literature on digital transformation and economic growth, emphasizing the importance of targeted interventions that ensure all EU member states can benefit from the economic advantages of digital transformation.

3. Methodology

3.1. Theoretical Framework

This study aims to analyze the impact of digitalization on economic growth within EU-27 countries by using a production function model that incorporates traditional inputs (capital and labor) along with a digitalization index (DESI). After adjusting for labor and capital, we assess how digitalization influences GDP. This assessment is achieved by employing a panel data approach, which allows us to consider both time series and cross-sectional dimensions.

Panel data regression is particularly suitable for this type of research as it reduces biases caused by unobserved heterogeneity, those unique characteristics specific to each country but not explicitly measured in the model (Baltagi, 2021).

This methodological approach addresses both heterogeneity and endogeneity issues, where heterogeneity refers to differences in characteristics across countries, and endogeneity reflects correlations between independent variables and unobserved factors that may influence economic growth (Gujarati, 2003).

The Cobb-Douglas production function is widely recognized in economic research for capturing the non-linear relationship between inputs (capital and labor) and outputs (GDP growth).

In traditional economic growth models, GDP is a function of capital and labor, with each factor contributing to the output in a multiplicative manner .The Cobb-Douglas model has been validated in empirical economic studies for its robustness in analyzing production dynamics and growth factors across various economies (Cobb & Douglas, 1928). This model's flexibility allows for the inclusion of additional variables, which in this study is digitalization as measured by DESI.

One of the model's advantages is its ability to allow for elasticity calculations, which quantify how responsive GDP growth is to each input. This feature is particularly useful here as it enables us to measure the unique contribution of digitalization (proxied by DESI) alongside traditional factors like labor and capital. Previous studies, such as those by Mankiw et al. (1992) and Tripathi and Inani (2020) have successfully employed the Cobb-Douglas model to explore the roles of traditional

inputs in growth, demonstrating its validity in similar contexts. Their evidence that the Cobb-Douglas model is effective in studying production dynamics across various economies further validates its use here. In this study, we introduce DESI as a third variable to capture digitalization's potential impact on growth, exploring whether it serves as an additional driver alongside capital and labor. By incorporating DESI as an additional input, the Cobb-Douglas model provides a robust framework for examining the role of digitalization alongside capital and labor in driving GDP growth. Specifically, DESI serves as a proxy for digital infrastructure and digital readiness, capturing various dimensions of a country's digital environment, including human capital, connectivity, integration of digital technology, and digital public services (European Commission, 2023).

This inclusion aligns with recent studies that integrate digitalization metrics into growth models, emphasizing the importance of digital infrastructure in modern economic systems (Brodny & Tutak, 2022; Mura & Donath, 2023)

In this context, my study seeks to determine if DESI acts as a complementary input to capital and labor in influencing GDP growth. Study of Habibi and Zabardast (2020) also used digitalization indices to model the economic effects of ICT infrastructure, further supporting the use of a Cobb-Douglas framework with digitalization as an added factor.

The Cobb-Douglas function is be expressed in log-linear form as follows:

$$\log(GDPit) = a1\log(Capitalit)+a2\log(Laborit)+a3\log(DESIit)+ \varepsilon it$$

where

- GDP: Gross Domestic Product (current USD)
- Capital (GFCF): Gross fixed capital formation (current USD)
- Labor refers to the whole labor force
- DESI serves as a proxy for digitalization
- i indicates the sample countries
- t refers to the time period
- the regression coefficients (a_1, a_2, and a_3) are estimated using panel data regression
- ε is a random residual term.

The variables included in the empirical model are defined as follows:

1. Gross Domestic Product (GDP): Our dependent variable, GDP, represents the economic output of each country and is measured in current US dollars. GDP is a widely accepted measure of a country's economic performance and is often used in studies of economic growth (World Bank, 2023)
2. Capital (Gross Fixed Capital Formation - GFCF): Capital input is measured through GFCF, representing investments in physical assets such as infrastructure, machinery, and equipment. This measure captures the role of physical capital in driving productivity and is expressed in current US dollars. GFCF is a standard proxy for capital in economic research, as seen in foundational studies like (Solow, 1956; World Bank, 2023)
3. Labor Force: The labor input is captured by the total labor force in each country, which includes individuals employed or actively seeking employment. Labor is a crucial factor in economic models, reflecting the human resources available to drive production. This measure aligns with previous economic growth study, such as
4. Digitalization (Digital Economy and Society Index - DESI): developed by the European Commission, serves as a proxy for digitalization in this study. DESI aggregates multiple dimensions of digitalization, including connectivity, human capital, use of internet services, integration of digital technology, and digital public services. This index provides a holistic view of digital readiness and infrastructure in each EU country, making it an ideal measure for understanding digitalization's economic impact (European Commission, 2023)

The inclusion of capital and labor is based on established economic theory, specifically the Cobb- Douglas production function, which identifies these factors as fundamental drivers of economic output. Adding DESI as a measure of digitalization reflects recent shifts in economic growth theory, acknowledging that technological infrastructure and digital skills have become essential components of modern economic systems. The use of DESI aligns with the growing body of literature that highlights digitalization's critical role in enhancing productivity and growth.

The data for GDP, capital (GFCF), and labor force were obtained from the World Bank's World Development Indicators database (World Bank, 2023), ensuring consistency and reliability across countries and years. DESI data were sourced from the European Commission database, providing insights into the digitalization progress across EU member states.

This study uses annual data from 2017 to 2022, covering 27 EU countries, to analyze the impact of digitalization on economic growth. The data, sourced from Eurostat and the World Bank, ensures a comprehensive and reliable foundation for examining how digital advancements interact with traditional economic factors like capital and labor.

3.2. Empirical Analysis: Panel Data Regression and Model Selection

3.2.1. Panel Data and Choice of Regression Models

In this study, we employ panel data analysis to capture both country-specific and time-specific variations in the EU-27, which allows for a more nuanced understanding of how digitalization influences economic growth. Panel data combines time-series and cross-sectional dimensions, enabling us to observe changes within each country over time while also accounting for differences across countries. When analyzing panel data, there are three commonly used regression models: Pooled Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE).

Pooled OLS treats all observations as part of a single dataset, ignoring unique country-specific characteristics. While straightforward, it assumes that there are no correlations between independent variables and unobserved factors, which is often unrealistic for panel data. Due to its limitations in accounting for individual country differences or changes over time, Pooled OLS is not suitable for this study.

The Fixed Effects (FE) and Random Effects (RE) models address the limitations of Pooled OLS by allowing for unobserved heterogeneity. These models account for country-specific factors that might influence GDP growth but are not explicitly measured in the model.

- **Fixed Effects (FE) Model**: The FE model is particularly effective when unobserved characteristics vary across countries but remain constant over time. This model introduces a unique intercept for each country, enabling us to capture country-specific effects. The FE model is especially useful for our study as it helps control endogeneity the correlation between independent variables (such as digitalization) and unobserved individual effects that might simultaneously affect GDP growth.
- **Random Effects (RE) Model**: The RE model assumes that unobserved country-specific effects are random and uncorrelated with the independent variables. This model is typically used when observations (countries) are randomly drawn from a larger population. However, this assumption does not hold in our case, as we focus on a specific set of EU countries rather than a random sample.

To determine the most appropriate model, we employ the Hausman test, which examines the correlation between regressors and unobserved effects. If this test reveals a correlation, this suggests that the FE model is more suitable, as it provides unbiased estimates in the presence of endogeneity. In this analysis, the Hausman test favors the FE model, indicating that fixed effects capture the country-specific factors better than random effects. To further refine our model, we apply robust standard errors to address potential issues related to heteroskedasticity and autocorrelation.

The FE model is selected due to its ability to control for unobserved country-specific factors that are constant over time, which is particularly important given the diversity in digitalization and economic structures among EU countries. According to Gujarati (2003) the FE model is suitable for datasets with relatively few time periods and numerous cross-sectional units that are not randomly selected, as is the case in our study. Other research, including studies by Mura and Donath (2023); Toader et al. (2018) has also demonstrated the value of the FE model in examining economic growth across countries with significant heterogeneity and potential endogeneity.

3.2.2. Model Estimation and Addressing Econometric Issues

We use the Least Squares Dummy Variable (LSDV) method to estimate the coefficients of the FE model. This technique includes dummy variables for each country, allowing for country-specific intercepts that account for unobserved heterogeneity across countries. The LSDV approach is appropriate for our dataset, as we are working with the complete set of EU-27 countries rather than a random sample (Gujarati, 2003).

In panel data analysis, issues like heteroskedasticity (unequal variance of errors) and autocorrelation (correlated errors across time) can affect the accuracy of our results.

- **Heteroskedasticity**: This occurs when error variances differ across countries, potentially leading to inefficient estimates. To mitigate this, we use robust standard errors, which adjust for non-constant variance in the residuals, thus improving the reliability of our results (Cobb & Douglas, 1928; Solow, 1956)

- Autocorrelation: Autocorrelation can arise when errors are correlated over time within the same country, which may introduce biases. We test for autocorrelation and confirm that residuals are not correlated across time, ensuring the accuracy of our regression results.

To ensure the robustness of our findings, we conduct diagnostic tests to check for normality, autocorrelation, and heteroskedasticity in the residuals. The model achieves an R-squared value of 0.9983, indicating that it explains 99.83% of the variation in GDP based on the independent variables (capital, labor, and digitalization). This high R-squared value demonstrates the model's strong fit, suggesting that our chosen variables effectively capture the key drivers of GDP growth across the EU.

The Fixed Effects model, validated by the Hausman test and complemented by robust standard errors, allows us to accurately account for country-specific differences within the EU, reduce biases, and measure the influence of digitalization on economic growth. By addressing potential econometric issues and rigorously testing the model, we have strengthened the reliability of our findings. This methodology not only aligns with best practices in econometric analysis but also enables a deeper understanding of how digitalization, alongside traditional economic factors, contributes to GDP growth across the EU. This approach is consistent with prior research and enhances the validity of our conclusions regarding the role of digitalization in shaping modern economic performance.

4. Results and Discussion

In this section we're going to highlight the empirical regression results for our Model.

The analysis represented in Table 1 provides a comprehensive examination of the relationship between GDP growth and three key variables: capital, labor, and digitalization (captured through the Digital Economy and Society Index, or DESI) across the EU-27 from 2017 to 2022. Utilizing a Cobb-Douglas production function within a fixed-effects model, this study quantifies the distinct contributions of each variable to economic growth while controlling for country-specific, time-invariant characteristics. This approach enables a nuanced understanding of how digitalization interacts with traditional economic inputs, such as capital and labor, to drive growth within the European Union.

In this model, the dependent variable is the natural logarithm of GDP, while capital, labor, and DESI serve as independent variables, also in logarithmic form. To improve the robustness and representativeness of our findings, we excluded significant outliers, including Germany, Italy, and France. These economies exhibit unique characteristics and more advanced digital infrastructures, which could distort the model's results. By focusing on a more homogenous subset of EU countries, we aim to capture the broader impact of digitalization on economic growth without the disproportionate influence of the largest and most digitally advanced states.

Diagnostic tests confirmed the model's reliability. The acceptance of the null hypothesis in normality and autocorrelation tests indicated that residuals are normally distributed and uncorrelated over time, meeting essential assumptions for regression analysis. However, the heteroskedasticity test suggested inconsistent variances across observations, prompting the use of robust standard errors to mitigate any potential bias. This rigorous approach enhances the credibility of our findings and ensures that the coefficient estimates are both reliable and statistically significant.

Our regression analysis reveals a strong positive association between GDP growth and the three primary independent variables: capital, labor, and DESI. With an R-squared value of 0.9983, the model demonstrates an exceptional fit, explaining 99.83% of the variation in GDP across the EU-27. This high explanatory power underscores the effectiveness of our model in capturing the dynamics of economic growth within the European Union.

A particularly noteworthy finding is the significance of the DESI coefficient, which is both positive and statistically significant at the 1% level (coefficient = 0.3838, p-value = 0.0057). This implies that a 1% increase in digitalization, as measured by DESI, corresponds to a 0.3838% increase in GDP growth. This result highlights the pivotal role of digital infrastructure and digital capabilities in fostering economic expansion. It suggests that digitalization has moved beyond being a complementary element to traditional economic inputs such as capital and labor to become a core driver of productivity gains and competitiveness across various sectors.

The elasticity indicated by the DESI coefficient also points to the transformative impact of digitalization on economic structures. Digital infrastructure not only enhances efficiency within existing frameworks but also reshapes production processes, enabling innovation and greater productivity. This aligns with endogenous growth theories, which posit that knowledge and technological advancements are central to sustainable economic growth. By complementing traditional inputs, digitalization amplifies the productivity of both capital and labor, unlocking new avenues for economic development that conventional resources alone cannot achieve.

Table1: LSDV model through Fixed effects

Fixed-effects, using 144 observations Included 24 cross-sectional units
Time-series length = 6
Dependent variable: l_GDP
Robust (HAC) standard errors

Variable	Coefficient	Std. Error	t-Ratio	p-value
constant	15.8926	3.22487	4.928	8.30E-07
l_capital	0.220726	0.173834	1.27	0.2042
l_labortotal	0.211515	0.294064	0.7193	0.472
l_DESI	0.383838	0.138756	2.766	0.0057

Effects Specification

Mean dependent var	25.82187	S.D. dependent var	1.19997
Sum squared resid	0.344705	S.E. of regression	0.05428
LSDV R-squared	0.998326	Within R-squared	0.71262
Log-likelihood	230.1841	Akaike criterion	−406.3683
Schwarz criterion	−326.1833	Hannan-Quinn	−373.7856
rho	0.139397	Durbin-Watson	1.36345

Joint test on named regressors
Statistic test: F(3, 23) = 102.279
with p-value = P(F(3, 23) > 102.279) = 1.91256e-13

Distribution free Wald test for heteroskedasticity
Null hypothesis: the units have a common error variance
Asymptotic test statistic: Chi-square(24) = 324.794

Residual normality test
Null hypothesis: error is normally distributed
Test statistic: Chi-square(2) = 4.33508

Wooldridge test for autocorrelation in panel data
Null hypothesis: No first-order autocorrelation (rho = -0.5)
Test statistic: F(1, 23) = 4.10634

Correlation Coefficients, Two-tailed critical values for n = 144: 5% 0.1637, 1% 0.2140

	l_GDP	l_capital	l_labortotal	l_DES
l_GDP	1.0000	0.9862	0.8704	0.1489
l_capital		1.0000	0.8413	0.1992
l_labor			1.0000	-0.2018
l_DESI				1.0000

Source: Author's compilation based on (European Commission, 2023) and (World Bank, 2023)

Our findings are consistent with and extend previous research on the relationship between digitalization and economic growth. For instance, Toader et al. (2018) found that ICT investments significantly boost GDP within the EU, a result corroborated by our study, which highlights DESI's continued relevance as an economic growth driver post-2017. Similarly, Mura and Donath (2023) demonstrated a positive link between DESI and economic performance, further supporting our assertion that DESI is a reliable metric for evaluating the economic impact of digitalization in the EU.

Beyond the European Union context, international evidence further underscores the importance of digitalization for economic growth. Habibi and Zabardast (2020) report similar positive effects of ICT development in both OECD and Middle Eastern countries, highlighting the broad and universal role of digital infrastructure as a key driver of productivity. Using fixed-effects OLS and GMM estimation techniques, the authors find that ICT is positively associated with economic growth in both groups.

These findings highlight the universal relevance of digital infrastructure as a productivity driver. Our study contributes to this body of literature by providing an EU-specific analysis that links DESI dimensions with economic growth, offering actionable insights for policymakers within the EU.

5. Conclusion

This study has shown that digitalization, represented by the Digital Economy and Society Index (DESI), is a key driver of economic growth in the EU-27. By incorporating DESI into a Cobb- Douglas production function within a fixed-effects panel model, we were able to quantify the impact of digital infrastructure on GDP growth. The findings reveal that a 1% increase in digitalization corresponds to a 0.3838% rise in GDP, underscoring the transformative power of digitalization. These results demonstrate that digital infrastructure and capabilities are not just complementary to traditional inputs like capital and labor, they are essential drivers of innovation, productivity, and economic resilience.

5.1. Validation of EU Policy Frameworks

These findings strongly validate the European Union's current digitalization policy framework, particularly its Digital Decade objectives, which aim to foster economic resilience in Europe through digitalization. The positive correlation between DESI and GDP growth underscores the rationale behind the EU's push for widespread digital adoption and infrastructural enhancements across member states.

For EU policymakers, our findings provide empirical support for digitalization as a central component of economic growth strategies. The results emphasize that countries with lower DESI scores – indicating lagging digital infrastructure, digital skills, and digital public services – stand to benefit significantly from targeted investments in these areas. By bridging digital divides across the EU, particularly in less digitally advanced regions, these policies can contribute to economic convergence within the bloc, fostering a more balanced and inclusive digital economy. For member states that already score highly on DESI, further investments in advanced technologies such as artificial intelligence, cloud computing, and automation, drive continued productivity gains and secure their leadership in emerging technology sectors. These insights suggest that the EU's digital policy framework should not only focus on broad-based infrastructure and skills development but also encourage innovation-driven digital investments in digitally mature economies.

5.2. Broader Implications for Economic Theory and Growth Models

From an economic theory perspective, our study contributes to the evolving understanding of growth models in an increasingly digitalized economy. Traditional growth models, which focus on physical capital and labor as primary inputs, fall short of explaining the full impact of intangible, technology-driven factors like digital infrastructure. By incorporating DESI into the Cobb- Douglas production function, this study extends growth modeling to reflect the pivotal role of digital skills and infrastructure as essential productivity drivers in modern economies.

This finding aligns with endogenous growth theories proposed by scholars like Solow (1956) who argue that knowledge and technology are vital for sustained economic growth. The strong positive relationship between DESI and GDP growth suggests that digital infrastructure should be regarded as a core economic input, alongside capital and labor, in contemporary growth models. These results imply that digitalization not only complements traditional inputs but fundamentally transforms production capabilities, enhancing productivity and fostering resilience in ways that were previously unachievable.

5.3. Future Research Directions and Study Limitations

While our study provides valuable insights, several limitations warrant further exploration. First, by excluding the largest EU economies (Germany, Italy, and France), we may have limited the model's applicability to the entire EU-27. Future studies could explore methods to account for economic size and digital maturity, enabling a more comprehensive view of digitalization's impact across the full spectrum of EU countries.

Additionally, examining the sector-specific impacts of digitalization could reveal more granular insights, as the effects of digital infrastructure may vary across industries. Further research could also dissect the individual dimensions of DESI to determine which components are most influential in driving growth. Expanding this analysis to include non-EU regions would provide a comparative perspective, shedding light on the global relevance of the EU's digitalization policies.

Finally, extending the timeframe of the analysis would allow future studies to examine the long- term effects of digitalization on economic growth. As new digital technologies and policy frameworks emerge, continually updating digitalization metrics will be essential for capturing the evolving impact of digital transformation on economic resilience and productivity.

In conclusion, as digitalization continues to shape economies worldwide, understanding its role in economic growth will be crucial for crafting policies that foster inclusive, sustainable development. The EU's commitment to digital transformation, as reflected in the DESI index, presents a model for building resilient, forward-looking economies, a strategy that other regions might consider as they navigate the challenges and opportunities of the digital age.

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Data availability statement

The data that support the findings of this study are available from the author, **Ensem Mourou** ensemmourou13@gmail.com, upon reasonable request.

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Impact of SMEs on Local Economic and Social Communities from the Perspective of Small Enterprises Growing Medicinal Plants

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SUMMARY

In this study, we sought to answer how herbalists perceive the extent and quality of their contribution and impact on the life of small settlements from an economic and social perspective. We conducted semi-structured professional interview research with 32 herbalist professionals and 4 settlement leaders. The semi-structured interviews contained 32 questions for the growers. According to small herbalist businesses, tax revenues, job creation, settlement promotion and tourism are the most important types of impact with which participate in the life of settlements. They have a medium quality relationship with other enterprises and have a closer relationship with the residents of the settlements, but there are enterprises that have no relationship with the local population at all. We examined the impact of herbal medicine growing enterprises on their settlement in terms of 18 factors and in general environmental, health-conscious and ecological factors were rated highest by the interviewees.

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1. INTRODUCTION, RESEARCH QUESTION

The demand for medicinal plants is increasing, especially in the field of health treatments and beauty. 80% of the world's population still uses medicinal plants, primarily as medicine, according to research Variskhanov et al., 2024. In 2020, it was estimated that the value of herbal medicines and dietary supplements on Earth was 115 billion dollars (Witkittiluck & Kortana, 2021). Countries with high market value in the medicinal plant market were Japan, Korea, China, France, Germany and other Asian countries. In Thailand, for example, more than 300 types of medicinal plants can be found on the market (Variskhanov et al., 2024).

In a 1993 study, the WWF reported that the market for traditional medicine in Africa is constantly growing due to the high level of urbanization. As a result, wild medicinal plants are not enough or cannot be collected in sufficient quantities in many cases. The problem is that they are not collected sustainably (Cunningham, 1993). In South Africa, approximately 400-500 species of medicinal plants are sold, of which 99%, according to some sources, come from collection (Williams, 1996). In the Chiang Mai Declaration in 1988, experts already stated that in the long term, such a large-scale collection would make the current, unsustainable collection practice unsustainable. Instead, the emphasis should be on sustainable collection and cultivation as a suitable alternative (Bodeker, 2007). In India, it is estimated that 800 million health-conscious consumers and health professionals use more than 7,500 types of medicinal plants (FRLHT, 2002).

In a European study, in neighboring Slovakia, about 200 types of medicinal plants are currently used in healthcare (Salamon, 2014). In Romania, nearly 300 medicinal plants are used and known for therapeutic purposes. According to some research, 38 medicinal plant species in Romania have a higher collection potential, the amount of which may exceed 1,500 tons (Vasile et al., 2018). In total, researchers estimate that around 70,000 plant species are used in folk medicine on Earth today (Farnsworth & Soejarto, 1991). Cultivation of medicinal plants can therefore be a suitable alternative for sustainability and the production of high-quality raw materials (Farnsworth & Soejarto, 1991).

There are 50,000 plants on Earth that are currently known to have medicinal properties, which is almost 10% of all those discovered so far, which is a significant number (Table 1; Schippmann et al., 2002).

Table 1

Number of medicinal plants found on Earth

NAME OF COUNTRY SURVEYED	NUMBER OF PLANT SPECIES (PCS)	NUMBER OF HERBAL SPECIES (PCS)	%
China	26.092	4.941	18,9
India	15.000	3.000	20,0
Indonesia	22.500	1.000	4,4
Malaysia	15.500	1.200	7,7
Nepal	6.973	700	10,0
Pakistan	4.950	300	6,1
Philippines	8.931	850	9,5
Sri Lanka	3.314	550	16,6
Thailand	11.625	1.800	15,5
USA	21.641	2.564	11,8
Vietnam	10.500	1.800	17,1
Average	**13.366**	**1.700**	**12,5**
Earth	**422.000**	**52.885**	

Source: Own editing based on Schippmann et al., 2002

Herbal medicine cultivation can be carried out economically even on a relatively small area, it is not necessary to think in terms of tens of hectares, this activity provides an income-generating opportunity even on one or two hectares (Sokszínű Vidék, 2017).

There are approximately 400 medicinal plants in our country, which is a lot compared to other countries at a European level. This is due, among other things, to the extremely optimal climatic conditions (Bernáth et al., 2014).

Herbal medicines are appearing more and more frequently in the lives of small settlements, as many people, whether through local government maintenance or as private individuals, are starting to grow, process or sell them (Barabási, 2019). The demand for high-quality, high-active ingredient preparations is growing and this can be considered an international trend today (Marshall, 2011). In many cases, the cultivation of medicinal plants is carried out by small businesses, which can have a greater or lesser impact on local economic and social processes and communities, influencing the livelihood, tourism direction or even the image of a community (Pászk & Szűcsné Markovics, 2024a). In Hungary, we can also find many such settlements, where local governments have organized around medicinal plants as tourist attractions, for example Bükkszentkereszt (Barabási, 2019).

Often, a small settlement far from the interested party can be visited because of the medicinal plant growing businesses, since here it is often not only possible to purchase the finished product, but there is also the opportunity to visit factories and gardens, participate in workshops or even watch, try out and learn other processes from professionals (Pászk & Szűcsné Markovics, 2023). This can have a very positive impact on local communities, as it can boost tourism, accommodation bookings, local spending (e.g. catering establishments, grocery stores), increase the sales of locally produced, mainly artisanal, organic products, which can greatly contribute to the livelihood of the local population. After all, these small rural settlements, which are often deprived of major traffic, would otherwise be visited by few people. These processes and the presence of these businesses can therefore contribute to the viability and survival of settlements and communities in the long term (Pászk, 2024).

In this study, we sought to answer how herbalists see the extent and quality of their contribution and impact on the life of small settlements from an economic and social perspective. Currently, research on the domestic herbalist sector can be said to be incomplete, there is little literature available and even those that do examine the topic mainly from an agricultural perspective, rather than from an economic and social perspective.

2. Literature Review

2.1. *Potential impacts of SMEs on local economic and social communities from the perspective of small herbal-medicine-growing enterprises*

The analysis and examination of the social impact of companies is not yet given sufficient emphasis today, according to most sources, despite the fact that their impact is quite significant. After all, they employ people, pay taxes, carry out production and service activities, solve social problems and create significant value (Siemieniako et al., 2021). The impacts of companies on society can be very diverse due to their uniqueness, which is why it is difficult to make a complex, summary list of them, most literature only collects a few of them (Radácsi, 2021; Table 2).

Table 2

Some of the social impacts of companies

PART OF THE SOCIAL IMPACT OF COMPANIES		
improving living conditions	developing a more health-conscious attitude	creating environmentally friendly working conditions
poverty reduction	creating a cleaner environment	strengthening an environmentally friendly approach
creating a healthier environment	strengthening ecological awareness	building growing trust
improving individual skills and competencies	improving equal opportunities	strengthening social cohesion
creating a more open society	strengthening the civil sector	promoting volunteering
promoting social innovation	preservation and strengthening of local culture	ensuring more competitive education

Source: Own editing based on Radácsi, 2021; Reisinger, 2022

Most studies do not only highlight one economic or social impact from each factor, but also highlight several benefits that herbal farming businesses can contribute to the life of small settlements. Singh's 2025 study also highlights the development of the local economy, the promotion of female labor force participation, health benefits, and the preservation of biodiversity (Singh, 2025). Based on African examples, it can be said that medicinal plant cultivation can contribute to increasing the income of the rural population, improve sustainability, and open up new markets (Mofokeng et al., 2022).

If we wanted to create major summary categories for the economic and social impacts of small businesses, we could create the following 6 categories:

1. Job creation and local employment

Small herb-farming enterprises operating in small settlements often employ workers from the local population, thereby reducing unemployment, including in disadvantaged areas (Kulcsár et al., 2023). They can thus improve the local quality of life, local incomes and promote staying in the countryside (Csurgó et al., 2025).

2. Community cohesion and knowledge transfer

As mentioned earlier, small herbal-medicine-growing businesses often organize herbal medicine education programs for interested parties, where they present, among other things, the cultivation, processing, and possible uses of herbs. This can strengthen community cohesion and facilitate the transfer of knowledge (Szente et al., 2021).

3. Inclusion of women and disadvantaged groups

It is particularly typical that rural SMEs employ women or disadvantaged people, especially Roma women, as they can adequately perform seasonal agricultural work even without a degree (e.g. harvesting, sorting). This increases social

equality and promotes integration (Erdész-Kozak, 2008). A study involving 360 farmers in Iran found that herbal medicine cultivation increases the income of rural households, thereby reducing poverty (Dalir et al., 2024).

4. Improving health awareness and local quality of life

Products containing medicinal herbs, produced and sold by SMEs can greatly contribute to a healthy lifestyle and its promotion, which can improve the health awareness of the population and, as a result, even the quality of life (Pászk, 2024). According to another study, medicinal plants and their cultivation also play a significant role in healthcare in developing countries, as they can reduce healthcare costs (Wairimu, 2025).

5. Sustainability and environmental awareness

In many small towns, herbal medicine businesses are choosing organic or bio production, increasing the health benefits of their products and improving sales opportunities, as many people prefer to buy products free of chemicals and additives. SMEs can thus promote environmental sustainability (Benedek et al., 2020).

6. Stimulating local economy and tourism

The workshops and professional programs held by herbalists stimulate tourism, increase the benefits accrued at the local level, and expand the tourist offer in many areas of the country (Pászk & Szűcsné Markovics, 2024b). In addition to traditional knowledge, medicinal plants also appear as a resource that strengthens the local economy, according to research in Hungary and the Carpathian Basin (Molnár et al., 2025). International research also shows that herbal medicine businesses represent a significant source of income in rural communities (India, China) (Pergola et al., 2024).

Based on our previous research, the stakeholder analysis of the sector highlights that there is a close system of relationships between individual sector players and herbal medicine growing enterprises (e.g. suppliers, input suppliers, technology service providers). Thanks to this system of relationships, herbal medicine growing enterprises often cooperate with local service providers, providing work for several small-town enterprises. After all, whether it is a question of an agricultural mechanized work process or a large-scale procurement of seedlings, if the enterprise can solve it locally, then it will choose this (Pászk & Szűcsné Markovics, 2024b).

2.2. Some international and domestic examples of the community-building and supportive impact of herbal medicine growing businesses

We can find many good examples and good practices on Earth, both in Hungary and outside Europe. In the Romanian settlement of Lókod, the tourist appeal of the region was boosted with medicinal herbs and the professional programs related to them (Barabási, 2019). In India and China, since healing with medicinal herbs is still a present method today, there are great opportunities in the field of employment (Bodeker, 2007). Often, the medicinal herb sector can be the only source of income for rural women, especially in the less developed parts of Asia and South America (Marshall, 2011).

The Swiss-based Weleda AG cultivates herbs in a sustainable way, in collaboration with local producers, for whom it can provide a fixed income. In addition, the company supports local schools and events related to healthy lifestyles (Dalir et al., 2024). Pukka Herbs, operating in the United Kingdom, pays special attention to fair trade partners (sustainable cultivation and collection), to whom it pays a higher price for herbs, thereby supporting local organic or eco-growing communities (Smallbone & Welter, 2001). Amazonia Herbs in Brazil supports indigenous communities. They work closely with indigenous communities along the Amazon, who collect and grow herbs for them. Part of the income is used for community development, helping the local population (FAO, 2019).

The collection, cultivation and processing of medicinal herbs often take place in disadvantaged regions and settlements, as labour, land and processing are cheaper here, among other things. In our country, we can often find local government medicinal herb growing or collecting initiatives launched in the Cserehát, Ormánság and Szécsényi districts in order to catch up (Virág, 2017). Herbária Zrt. provides work in several rural settlements, mainly during the medicinal herb collection period, in summer and early autumn. This is a source of income for disadvantaged, low-educated and mainly uneducated people. For HerbaHáz Kft., the employment of women is extremely important, especially in part-time employment, as this way they have time for their family and children in addition to their work (Pászk, 2024).

3. Materials and Methods

3.1. Objective, methodology and results of interview research conducted with small herbalist businesses and village leaders

3.1.1. Research purpose and methodology

As the primary part of our research, we conducted semi-structured professional interviews with 32 medicinal-plant-growing experts and 4 settlement leaders from different parts of the country. The interviewees were selected from small settlements with a population of less than 5,000 people from both groups. The interviews were conducted by telephone between May and June 2025. The semi-structured interviews contained 32 questions for the growers and 18 questions for the settlement leaders. The average interview took 50 minutes to complete.

In this study, we would like to present some of the results of the interviews, exploring the similarities and differences between the responses of herbalist cultivation experts and comparing them with the literature.

In order to make the sector and its contribution to the life of small settlements sufficiently transparent, we considered semi-structured professional interview research to be the most effective of the primary research methods, as it allows us to collect more relevant information than with other methods. With the help of the chosen research method, we were able to obtain useful information, data, and the opinions of herbalists on certain issues, with the help of which the sector can be more transparent and developed.

The results of the interviews were processed as follows: The answers to the individual questions were recorded in an Excel spreadsheet based on our paper-based notes and audio recordings, then we categorized them after content analysis, and finally we coded the answers according to a nominal scale so that they could be used for statistical calculations. The results of the interviews of the herbal growing businesses are presented on this basis.

The results were processed and statistical analyses were performed using Microsoft Excel 365 and IBM SPSS 28.0.1. Due to the small sample size, we were only able to perform specific statistical analyses that are specifically designed for analyzing small sample sizes. For each question, a correlation analysis was performed with other questions, using Kendall's Tau-b correlation calculation, and then significance levels were examined.

In all cases, the interviewees received detailed verbal and written information about the research and gave their consent to the research by completing a consent form. Participation in the research was voluntary and entailed complete anonymity.

Semi-structured professional interviews are a qualitative research method in which researchers study people's experiences, actions and reflections. Qualitative research is a more personal and qualitative research method that provides more information, and also allows for the inclusion of questions that may arise during the research (Jackson et al., 2007). Thanks to semi-structured professional interviews, we were able to learn more about the interviewees' opinions on the questions and their reasons (King, 2004). Semi-structured professional interviews are based on question lists, but they are more flexible and give more space to both the interviewee and the researcher (Jackson et al., 2007). During the qualitative content analysis, we performed a coding process (Cho & Lee, 2014). We used Kendall's Tau-b correlation calculation to calculate the correlation. It is based on ranks, but uses a different mathematical approach. It measures monotonic relationships and can be used well even with small sample sizes (Walker, 2016).

Our results are detailed below.

4. Discussion of Main Findings and Their Relation to the Reviewed Literature

4.1. Results and their analysis

One of the most important questions of our interview research was the following: **In your opinion, what impact does the presence and operation of your small business have on your settlement?**

The answers to the question were first categorized, then the data were summarized and evaluated (Table 3). As can be seen in the table, most interviewees indicated the increase in tax revenues as the most important impact on the life of their settlement, 78.12% (25 people). This was followed by job creation with 43.75% (14 people), then the promotion of the settlement and tourism at 37.5% (12 people), and finally other impacts (such as bringing grant money to the settlement) 21.87% (7 people). We compared the other impact with the question of what impact the surveyed enterprises have on other enterprises operating in the settlement, there is a medium-strong significant relationship between the two questions ($\tau b = 0.402$, $p = 0.023$). We compared the question of whether it has an impact on job creation with the size of annual sales, based on which we obtained a medium-strong significant relationship ($\tau b = 0.390$, $p = 0.027$).

The fact that the vast majority of respondents identified increased tax revenues as the primary impact is consistent with the literature on the local role of SMEs, which classifies the direct fiscal contribution and economic embeddedness of enterprises among the most easily perceived, "hard" impacts (taxes, turnover, local spending), as opposed to the "soft" community impacts that materialize in the longer term (cohesion, strengthening of the civil sphere). The moderately strong, significant relationship between job creation and sales volume (τb=0.390; p=0.027) can be interpreted in terms of the scale and labor absorption characteristics of SMEs: according to domestic and international examples, more marketable enterprises with increasing sales are more likely to expand their employment (especially in rural and disadvantaged areas), while the smallest units often operate with family labor or seasonally, with limited job creation capacity (Kulcsár et al., 2023; Csurgó et al., 2025). The same logic appears in the summary of SME impact categories: increasing employment and local incomes belongs to the "economic side" of the impact chain and is typically size and market dependent (Table 2; Radácsi 2021). The occurrence of tourism and local promotion (37.5%) resonates well with the examined case studies: several Hungarian examples (e.g. Bükkszentkereszt) and the practice in Lókod (RO) show that herbal businesses are able to generate local traffic, accommodation bookings and retail spending through workshops, garden and factory visits, thereby multiplying their impact on the local economy through tourism (Barabási, 2019; Pászk-Szűcsné Markovics, 2023; 2024b). Short sales channels and community programs – including activities to strengthen health awareness – can be organized into a tourist offer, which explains why some of the respondents also emphasize the promotional effect.

Table 3

The impact of small herbal-medicine-growing businesses on the life of their settlements

EFFECT TYPE	YES (pcs)	NO (pcs)	YES RATE (%)
Tax revenues	25	7	78,12%
Job creation	14	18	43,75%
Town promotion, tourism	12	20	37,5%
Other	7	25	21,87%

Source: own editing

To illustrate the relationship between the different impact types, we created a correlation matrix, which is shown in Table 4. The correlation matrix shows how much the choice of each impact type is associated with the respondents. A higher value means a stronger relationship. The strongest relationship is between job creation and settlement promotion and tourism (0.23), but even this is weak, and the other relationships are negligible.

The weak covariances in the correlation matrix in Table 4 indicate that the examined types of effects do not appear in a "package", but rather company-specific, depending on size, market and network embeddedness; this is consistent with the relevant literature, according to which the "hard" (fiscal, employment) and "soft" (cohesion, civil society, health awareness) effects of SMEs unfold differently in time and intensity (Table 2; Radácsi 2021; Reisinger 2022).

Table 4

Correlation matrix of the relationship between different types of effects

	tax revenues	job creation	town promotion, tourism	other
tax revenues	1,00	0,13	0,09	0,01
job creation	0,03	1,00	0,23	0,09
town promotion, tourism	0,09	0,23	1,00	0,08
other	0,01	0,09	0,08	1,00

Source: own editing

As a next step, we summarized how many types of impacts were indicated by the respondents:
0 impacts: 6 people
1 impact: 17 people
2 impacts: 18 people
3 impacts: 13 people
4 impacts: 2 people responded in total.

Most respondents mentioned 1 or 2 effects, but some mentioned 3 types of effects.

The second of the research questions, which we analyze in this article, was the following question: **On a scale of 1-6, please rate how your herbal medicine growing business affects the economic processes of the settlement? 1: It does not affect at all – 6: It has a strong influencing effect.**

Table 5 shows the occurrences in numbers for each value, as well as basic statistics from the data. The most common values for occurrence were 1 and 3, which were answered by 10 people each, followed by value 4 (5 people), then value 5 (3 people), and finally values 2 and 6, which were chosen by 2 people each. The average (2.84) shows that respondents tend to classify themselves in the lower-middle range for this question, meaning they do not perceive a strong economic influence, but they do not consider their impact to be negligible either. In the case of the median (3.0), half of the respondents gave a value lower than 3 and half gave a value higher than 3, which again shows that the majority of interviewees perceive the impact to be medium or weaker. In the case of the standard deviation (1.57), the value shows a fairly large dispersion, meaning that the opinions of the respondents are quite different. The minimum (1) and maximum (6) show that all possible answers were given by the participants. Most small businesses marked a lower value, which shows that they do not feel that they are a very influential force in the local economy. We examined the question by comparing it with the relationship of the given business with other businesses in the settlement, and we found a moderately significant relationship between them ($\tau b = 0.509$, $p = 0.001$).

The frequency pattern in Table 5 suggests that the majority of respondents perceive a moderate but not negligible economic impact, while the perceived impact is highly heterogeneous. This picture fits well with the distinction summarized in the literature between the "hard" (fiscal, employment) and "soft" (community, health awareness, tourism) impacts of SMEs: the former can be measured more stably, the latter appear more slowly and context-dependently, therefore self-assessments are widely dispersed (Table 2; Radácsi 2021; Reisinger 2022).

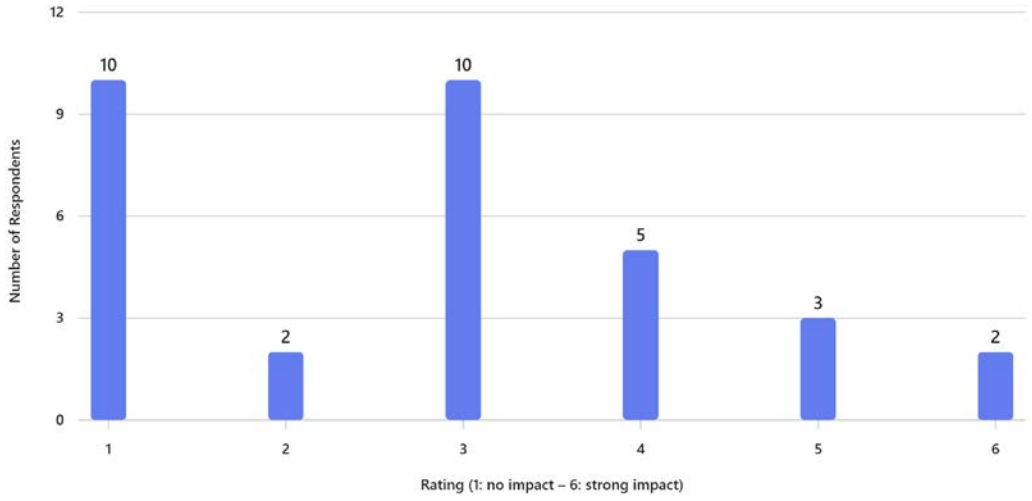
Table 5

Basic statistics

	Occurrences (main)	Average	Median	Spread	Minimum	Maximum
1	10	2,84	3,0	1,57	1	6
2	2					
3	10					
4	5					
5	3					
6	2					

Source: own editing

Figure 1 shows the distribution of the economic impact of herbal medicine growing SMEs (scale 1-6), comparing the number of respondents and their evaluation.



Source: own editing

Figure 1: Distribution of the economic impact of herbal medicine growing SMEs

The third of the research questions, which we analyze in this article, was the following question: **On a scale of 1-6, please rate the relationship of your herbal medicine growing business with other businesses operating in the settlement. 1: No relationship – 6: There is a very close relationship.**

Table 6 shows the occurrences in number for each value, as well as the basic statistics from the data. The most common value for occurrence was 3, which 14 people chose, followed by 2 (5 people) and 6 (4 people), then 1 (4 people), and finally 4 (3 people) and 5 (2 people). The average (3.19) shows that the relationship system is around the average value, but not too close. In the case of the median (3.0), half of the respondents gave a value less than 3 and half gave a value greater than 3, which again shows that the majority of the interviewees feel the relationship is average or weaker. In the case of the standard deviation (1.47), the value shows quite a large dispersion, meaning that the opinions of the respondents are quite different. The minimum (1) and maximum (6) show that the participants gave all possible answers. Most small businesses indicated a lower value, which shows that they do not feel very connected to other businesses in their locality.

The distribution in Table 6 suggests that the system of relationships between local businesses is typically "functional but not close", i.e. basic cooperations (supply, service purchases) exist, but close network collaborations are rarer; this is reinforced by the high standard deviation (1.47), which indicates heterogeneous embeddedness (there are both relationship-oriented and more isolated actors). The literary background describes the same duality: herbal SMEs are able to increase the turnover of other local businesses through local value chain relationships (mechanical work, packaging, logistics), but "soft" network benefits (joint promotion, tourism packages, community programs) only appear more strongly where they are consciously built on workshops, garden and factory visits, and short sales channels (e.g. Bükkszentkereszt, Lókod case studies). The moderately significant correlation between relationship intensity and other impact choices (τb levels) also supports this picture: where local embeddedness is stronger, economic and promotional impact is perceived as higher, but this is not general across the entire sample.

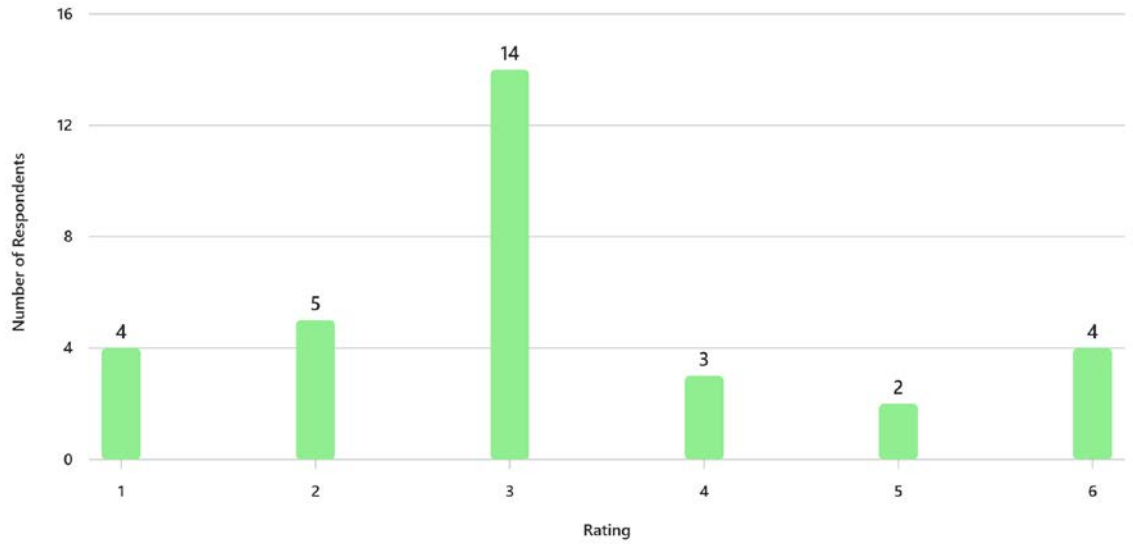
Table 6

Basic statistics

	Occurrences (main)	Average	Median	Spread	Minimum	Maximum
1	4	3,19	3,0	1,47	1	6
2	5					
3	14					
4	3					
5	2					
6	4					

Source: own editing

Figure 2 shows the relationship of herbal medicine growing SMEs with other businesses in their locality (scale 1-6), comparing the number of respondents and their evaluation.



Source: own editing

Figure 2: Relationship of herbal medicine growing SMEs with other businesses in their locality

The fourth of the research questions, which we present in this article, was the following question: **On a scale of 1-6, please rate the relationship your herbalist business has with the people living in the settlement. 1: No relationship – 6: There is a very close relationship.**

Table 7 shows the occurrences in number for each value, as well as the basic statistics from the data. The most common values for occurrence were 2 and 6, answered by 8 people each, followed by 4 (5 people) and 5 (5 people), then 3 and 1, with 3 people each. The average (3.78) shows that the majority of interviewees indicated a medium or closer relationship with the local population. The median is 4.0, the standard deviation is 1.77. The minimum (1) and maximum (6) show that all possible answers were given by the participants, so there are businesses that have no relationship with the local population at all, while there are those where the relationship is very close.

The pattern in Table 7 indicates that the relationship between businesses and the local population is fragmented: on the one hand, many actors only maintain loose, ad hoc relationships, on the other hand, very close, regular interactions are visibly present (e.g. garden and plant visits, workshops, health awareness programs). The domestic and international examples presented in the literature support the same duality: where herbal activity is organized into a tourist and community offering, the relationship becomes more intense and results in close embeddedness; where conscious community and market opening is lacking, interactions remain at a low intensity (e.g. Radácsi 2021; Reisinger 2022; Pászk-Szűcsné Markovics 2023, 2024b; Barabási 2019).

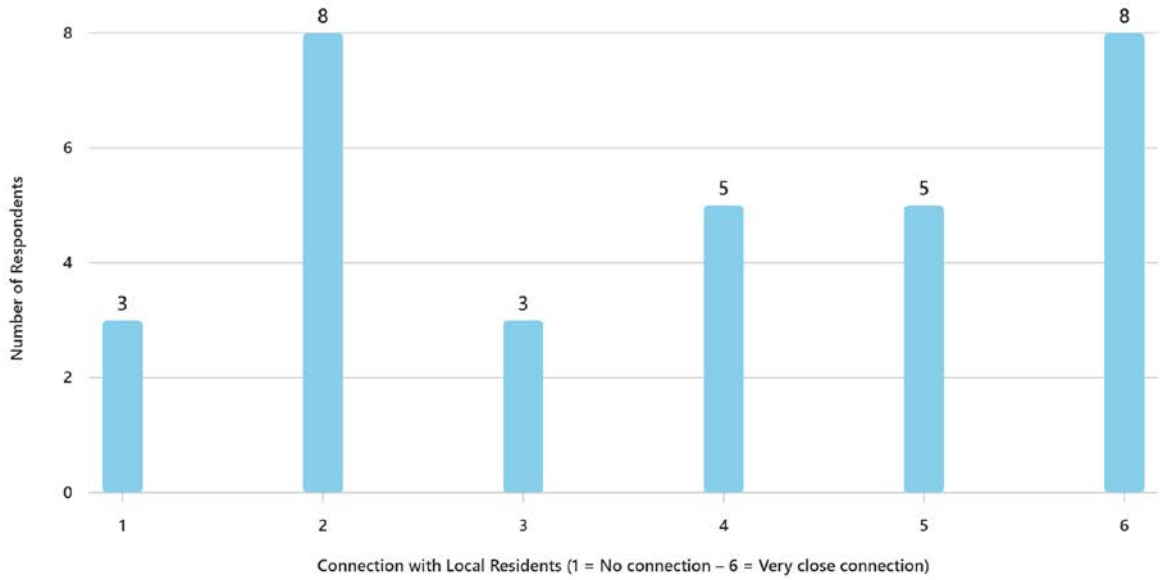
Table 7

Basic statistics

	Occurrences (main)	Average	Medián	Spread	Minimum	Maximum
1	3	3,78	4,0	1,77	1	6
2	8					
3	3					
4	5					
5	5					
6	8					

Source: own editing

Figure 3 shows the relationship of herbal medicine growing SMEs with the people living in their locality (scale 1-6), comparing the number of respondents and their evaluation.



Source: own editing

Figure 3: Relationship of herbal medicine growing SMEs with residents of their settlements

The next question we present was: **On a scale of 1–6, rate how your herbal medicine business affects the following factors in your municipality (1: does not affect at all- 6: has a very strong impact). The interviewees had to rate 18 factors.**

Table 8 shows the basic statistics calculated from the responses. In terms of mean and median, the highest averages were for the factors creating a healthier environment (3.97), forming a more health-conscious attitude (4.55) and strengthening an ecological attitude (4.06). So, the respondents mostly have a significant positive impact in the environmental and health-conscious areas. The lowest averages were for the factors reducing poverty (1.52), strengthening the civil sector, and promoting volunteering (1.87-1.87), so according to the businesses, these factors have less impact.

In the case of standard deviation, higher values indicate different opinions. For example, factors such as creating a healthier environment (1.76), forming a more health-conscious attitude (1.77), and improving individual skills (1.64) have high values, so some people rated them very positively, while others rated them less positively. Low standard deviation indicates relatively uniform opinions. For example, the factor reducing poverty was one such factor, where almost all interviewees gave a low value (0.96).

In the case of minimum and maximum, the full scale occurs for all factors, however, for most, 1 and 2 are in the majority, except for the environmental and health-conscious factors.

In terms of occurrences, high ratings (5-6) occurred mainly for environmental, health-conscious and ecological factors. Lower ratings (1-2) occurred mostly for social, economic and educational factors.

The results of Table 8 are coherent with the literature background: the environmental and health-conscious dimensions (healthier environment, more health-conscious attitude, ecological attitude) receive the highest averages, which is consistent with the synthesis that the strongest, short-term perceptible “soft” effects of herbal SMEs appear in the areas of environmental quality, ecological attitude and health behavior – partly through awareness-raising activities related to organic production, local programs (garden and factory visits, workshops) and short sales channels (see Table 2). In contrast, the low averages of poverty reduction, strengthening the civil sphere and volunteering indicate that these longer-term, institution- and network-dependent effects materialize less frequently and more unevenly in the sample. Higher standard deviations (e.g. healthier environment, health-conscious attitude, individual skills) indicate company-specific implementation methods and different degrees of local embeddedness, while the low standard deviation for poverty reduction reflects a uniformly weak perceived contribution. The pattern of minimum–maximum covering the entire scale confirms that there is a large variance even within the same impact category: where conscious value chain relationships, tourism and community development activities are built, high (5–6) ratings appear for environmental/health-oriented factors; where these are absent, socio-economic and educational factors tend to receive low (1–2) values.

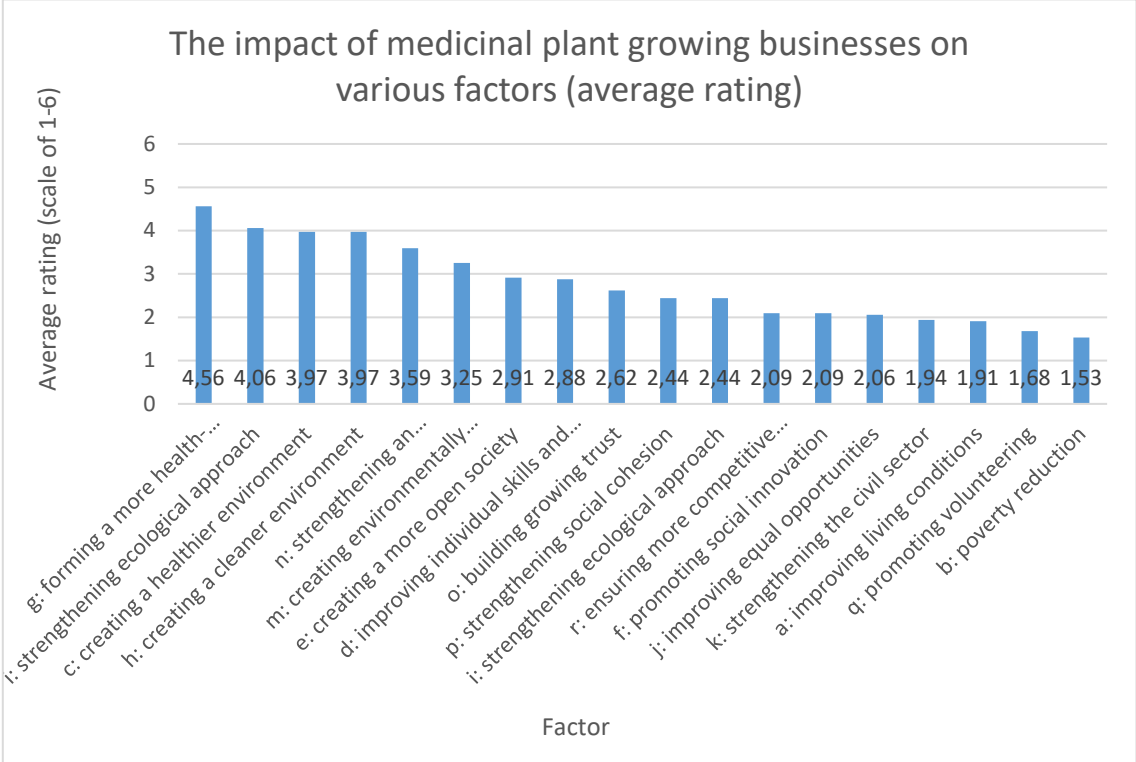
Table 8

Basic statistics

Factor	Average	Medián	Spread	Minimum	Maximum	1	2	3	4	5	6
a: improving living conditions	1,9	1	1,33	1	6	17	7	3	2	1	1
b: poverty reduction	1,52	1	0,96	1	4	23	2	4	2	0	0
c: creating a healthier environment	3,97	4	1,76	1	6	5	1	6	5	6	8
d: improving individual skills and competencies	2,81	2	1,64	1	6	9	8	2	5	6	1
e: creating a more open society	2,84	2	1,7	1	6	8	8	6	3	2	4
f: promoting social innovation	2,03	2	1,45	1	6	15	10	1	1	3	1
g: forming a more health-conscious attitude	4,55	5	1,77	1	6	3	2	4	3	4	15
h: creating a cleaner environment	3,9	4	1,49	1	6	4	1	5	8	10	3
i: strengthening ecological approach	4,06	4	1,48	1	6	3	2	4	7	11	4
j: improving equal opportunities	1,97	1	1,58	1	6	20	3	2	3	1	2
k: strengthening the civil sector	1,87	1	1,57	1	6	21	4	1	0	4	1
l: preserving and strengthening local culture	2,45	2	1,69	1	6	14	5	3	4	3	2
m: creating environmentally friendly working conditions	3,29	3	1,55	1	6	6	0	16	0	6	3
n: strengthening an environmentally friendly approach	3,55	3	1,69	1	6	6	1	10	2	8	4
o: building growing trust	2,55	2	1,61	1	6	11	7	5	3	3	2
p: strengthening social cohesion	2,39	2	1,73	1	6	14	6	5	0	3	3
q: promoting volunteering	1,87	1	1,52	1	6	21	3	2	1	3	1
r: ensuring more competitive education	2	1	1,67	1	6	20	3	3	1	1	3

Source: own editing

Figure 4 also shows the results in a diagram, in relation to the various factors and the evaluations received for them.



Source: own editing

Figure 4: The impact of herbal medicine growing SMEs on the various factors examined

Table 9 shows the proportion of very high and very low ratings by factor. In some cases, the proportions are quite illustrative. For example, in the case of the factor of forming a more health-conscious attitude, the proportion was 62% high and only 16% low. In the case of reducing poverty, the proportion was 0% high and 81% low. The situation is similar in the case of the factor of improving living conditions, where the proportion was 6% high, while 78% low.

The extreme value ratios in Table 9 clearly outline the asymmetry between the "soft" environmental-health behavior and "hard" social impacts of herbal SMEs: while the predominance of high ratings for the factor of developing a more health-conscious attitude (62% vs. 16%) indicates that awareness-raising activities related to organic production, garden and factory visits, workshops and short sales channels generate a quickly noticeable positive impact, poverty reduction (0% high, 81% low) and improvement of living conditions (6% high, 78% low) are longer-term, institution- and network-dependent dimensions that require stable, broad-based collaborations and resources – in their absence, the perceived contribution remains low. The literature background – by separating the economic/fiscal and community/ecological components of corporate impacts, and by using examples such as Bükkszentkereszt and Lókod – describes exactly this pattern: environmental and health-oriented results materialize more quickly, while poverty reduction, strengthening the civil sphere and volunteerism can only materialize in a meaningful way on long-term, networked development paths.

Table 9

Proportion of evaluations by factor

Factor	Very high (5-6) ratio	Very low (1-2) rate
a: improving living conditions	0,06	0,78
b: poverty reduction	0	0,81
c: creating a healthier environment	0,44	0,19
d: improving individual skills and competencies	0,25	0,53
e: creating a more open society	0,22	0,5
f: promoting social innovation	0,12	0,78
g: forming a more health-conscious attitude	0,62	0,16
h: creating a cleaner environment	0,44	0,16

i: strengthening ecological approach	0,47	0,16
j: improving equal opportunities	0,12	0,72
k: strengthening the civil sector	0,16	0,78
l: preserving and strengthening local culture	0,16	0,62
m: creating environmentally friendly working conditions	0,28	0,22
n: strengthening an environmentally friendly approach	0,41	0,22
o: building growing trust	0,19	0,56
p: strengthening social cohesion	0,19	0,62
q: promoting volunteering	0,12	0,78
r: ensuring more competitive education	0,16	0,72

Source: own editing

We also calculated correlations from the results, which showed a significant relationship for certain factors. The highlighted, strongest (strong, $|r| \geq 0.6$) correlations are the following:

- Creating a healthier environment ↔ Forming a more health-conscious attitude: 0.84
- Creating a healthier environment ↔ Creating a cleaner environment: 0.78
- Creating a more health-conscious attitude ↔ Strengthening an ecological attitude: 0.86
- Creating a cleaner environment ↔ Strengthening an ecological attitude: 0.88
- Creating environmentally friendly working conditions ↔ Strengthening an environmentally friendly attitude: 0.85
- Strengthening the civil sector ↔ Promoting volunteerism: 0.93
- Creating growing trust ↔ Strengthening social cohesion: 0.87
- Promoting social innovation ↔ Improving equal opportunities: 0.83
- Improving individual skills and competencies ↔ A more open society design: 0.81

The pattern of the strongest correlations clearly outlines two or three "effect blocks": in the environmental–health behavior cluster, "healthier environment ↔ more health-conscious attitude" (r=0.84), "healthier ↔ cleaner environment" (0.78), "healthier attitude ↔ strengthening ecological attitude" (0.86), and "cleaner environment ↔ strengthening ecological attitude" (0.88), as well as "environmentally friendly working conditions ↔ environmentally friendly attitude" (0.85) move in the same direction, which indicates that environmental and health-oriented interventions are strengthened together and are worth treating as a package. In the community participation dimension, "strengthening the civil sector ↔ encouraging volunteerism" (0.93) is in almost complete overlap, which suggests that the development of volunteerism and civil capacity building are direct complements. On the axis of social cohesion, the strong correlation of "increasing trust ↔ social cohesion" (0.87) points to the key role of local trust-building mechanisms (events, community learning). The relationship between social innovation and opportunity creation (0.83) and (v) "skill and competence development ↔ more open social planning" (0.81) suggests that the expansion of individual capacities and inclusive planning practices are moving on a mutually reinforcing path. Overall, these high correlations indicate that the effects do not appear in isolation, but in thematic packages; accordingly, the local development toolbox should be designed and evaluated along cluster logic (e.g. environmental–health block; civil–volunteering block; skills and openness block).

5. Conclusion and summary

The integrated analysis of the literature and the interview-based empirical research reveals that the social and economic role of small medicinal herb–growing enterprises is more complex and more sector-specific than what in the Hungarian publications. While the international literature consistently highlights the multifunctional contribution of small agricultural enterprises—ranging from rural job creation to community embeddedness, local knowledge transfer and landscape management—our results show that the medicinal herb sector embodies these functions in an uneven and highly selective way.

First, the interviews confirmed a central insight also found in the literature on rural SMEs: enterprises tend to perceive their most immediate and measurable local contribution in fiscal rather than social terms, with tax-revenue generation ranked as their primary impact. This pattern is consistent with wider European SME studies, which describe how micro-enterprises often identify themselves more as economic actors embedded in local markets than as community

institutions. The fact that tax contribution clearly overshadowed job creation in the respondents' perceptions suggests that these firms operate with limited labour absorption capacity and often rely on family labour or seasonal informal labour. This helps explain why only some of enterprises reported local job creation.

The moderate but statistically significant associations between the impact variables (e.g. between job creation and the promotion of tourism; or between perceived economic role and annual revenues) indicate that medicinal herb–growing SMEs form a heterogeneous group whose influence on local socio-economic processes depends strongly on their size, structure and market integration. Contrary to assumptions that small agricultural firms naturally serve as basic of local development, the interviews show that many herb-growing businesses maintain weak or only transactional relationships with other local enterprises. This partially contradicts the literature that emphasises horizontal cooperation and clustering in agricultural value chains. The discrepancy suggests structural constraints: geographical isolation, limited production capacity, and the absence of coordinated local supply-chain development all appear to limit the formation of dense local business networks.

The relationship between the enterprises and the local population revealed a dual pattern. While several businesses maintain close, trust-based ties with residents, others report almost no interaction. This divergence aligns with international findings on multifunctional agriculture, which show that firms with stronger community embeddedness often diversify into agritourism, direct sales or educational activities, whereas those producing mainly for wholesale or contract markets tend to remain socially "invisible." This has important implications: without deliberate community-oriented activities, even environmentally valuable production such as medicinal herb cultivation does not automatically translate into broader rural social development.

The analysis of the 18 settlement-level impact factors provides further conceptual clarity. The consistently high scores given to environmental and health-related impacts—such as fostering a healthier environment, promoting health-conscious behaviour, and strengthening ecological attitudes—suggest that herb-growing enterprises understand their mission primarily in cultural and environmental terms, rather than in terms of socio-economic transformation. This orientation reflects the intrinsic characteristics of the sector: medicinal herb cultivation carries strong symbolic and practical connections to tradition, naturalness and well-being, which aligns with global trends in sustainable and alternative agriculture. By contrast, the low scores associated with poverty reduction, civil-sector strengthening or improving living conditions highlight that these enterprises do not perceive themselves as agents of structural social change, nor do they possess the capacities typically required for such roles.

We can conclude that small medicinal herb–growing enterprises contribute meaningfully—but unevenly—to local development. Their strongest impacts emerge in areas linked to environmental awareness, ecological culture and health-related attitudes, while their weakest contributions appear in domains demanding long-term institutional engagement or substantial financial resources. These results nuance the assumptions often found in rural-development policy, where such enterprises are portrayed as uniformly beneficial across multiple dimensions. The evidence instead points to a sector with high soft-impact potential but limited hard-impact capacity.

This distinction has strategic relevance. If local governments or development agencies aim to leverage the strengths of herbal enterprises, the most promising areas lie in health education, ecological awareness programmes, local identity building and tourism-related initiatives. Conversely, expecting these SMEs to deliver substantial poverty reduction, employment expansion or community-institution building is unlikely to succeed without external support, coordinated programmes or integration into larger regional value chains.

Overall, the study demonstrates that medicinal herb–growing enterprises represent a valuable but underutilised asset in small settlements. Their contributions could be amplified through targeted development plans—such as networking initiatives, cooperative models, or community-facing educational programmes—which would allow them not only to strengthen their market position but also to convert their environmental and cultural influence into broader socio-economic benefits.

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Author's contribution

Pászk Norbert: Conceptualization 90%, Formal analysis 90%, Funding acquisition 90%, Supervision 90%, Validation 90%, Writing – original draft 90%, Writing – review & editing 90%, overall: 90%.

Szűcsné Dr. Markovics Klára: Conceptualization 10%, Formal analysis 10%, Funding acquisition 10%, Supervision 10%, Validation 10%, Writing – original draft 10%, Writing – review & editing 10%, overall: 10%.

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No potential competing interest to declare by the author

Generative AI Declaration Statement

The authors declares that no generative artificial intelligence (AI) tools or services were used in the research, writing, analysis, or any other aspect of this work.

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All data generated or analyzed during this study are included in this published article [and its supplementary information files]

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Russia's "Soft Power" in Georgia's Political-Economic Sphere: Historical Dynamics and Contemporary Realities

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SUMMARY

This study analyzes the instruments of Russia's "soft power" influence in Georgia's political-economic sphere. The analysis spans the period from the dissolution of the Soviet Union to the present. Particular emphasis is placed on the tools activated by Russia following the onset of its full-scale war in Ukraine in 2022. Drawing on leading academic and research literature, the paper evaluates the outcomes of these instruments' implementation in Georgia. It also explores Joseph Nye's concept of "soft power" and its evolution within the context of contemporary international relations. The study presents conclusions regarding the effectiveness and consequences of Russia's soft power mechanisms in Georgia's political-economic landscape. Historically and currently, Russia's key soft power levers include cultural ties, the notion of unity based on language and Orthodox Christianity, economic tools, and informational influence. Finally, the paper offers perspectives on strategies for addressing the challenges posed by these influences.

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1. INTRODUCTION

In contemporary world, soft power remains a vital instrument in international relations. This is especially true in the post-Soviet space, where historical memory, cultural ties, and economic dependencies continue to shape foreign policy decisions. Within this context, soft power transforms into a powerful political lever.

In this regard, the Russian Federation's use of soft power acquires particular importance in Georgia—a country that, since gaining independence, has strived to institutionalize Western values, while simultaneously facing external and domestic political challenges.

Russia's use of soft power manifests in diverse forms: cultural diplomacy, informational influence, economic instruments, and support for pro-Russian organizations and political parties. In recent years, especially since the outbreak of Russia's full-scale war in Ukraine in 2022—these processes have undergone significant transformation. Georgian public opinion has become increasingly critical of Russia, and solidarity with Ukraine and support for the Western orientation have grown. However, simultaneously, Russia has escalated its use of soft power tools in a more coercive and aggressive manner. The intensification of contradictory dynamics within the country may call into question Georgia's sovereign development trajectory and jeopardize its historic opportunity to join the European Union.

Given the relevance of the issue, this **study aims** to analyze the instruments of Russia's soft power in relation to independent Georgia from the 1990s to the present. It further explores the impact of the developments following the 2022 war in Ukraine on the use of Russian soft power, and synthesizes their outcomes in Georgia based on a review of leading academic and empirical research.

To achieve these objectives, the study addresses the following key **research tasks**:

1. A conceptual analysis and contemporary interpretation of soft power;
2. Examination of Russia's soft power in Georgia: historical dynamics and instruments;

3. Investigation of the operation of Russian soft power tools in Georgia's current political-economic environment;
4. Analysis of the factors contributing to the success or failure of Russian soft power;
5. Conclusions and policy recommendations to address the anticipated implications of Russian soft power in Georgia under current geopolitical conditions.

The research draws on recent Georgian and international academic literature, reports by national and international organizations, and expert observation. It also compares and contrasts assessments presented across various information platforms. The study is interdisciplinary in nature and employs a methodology that integrates analysis and synthesis, induction and deduction, and logical as well as chronological/historical approaches.

2. The Concept of Soft Power and Its Contemporary Interpretation

The term *soft power* was first introduced into the theory of international relations by the American political scientist Joseph Nye (1990). According to his definition, soft power is a state's ability to achieve desired outcomes not through military or economic coercion, but through the attractiveness of its culture, values, and foreign policy (Nye, 2004).

According to Nye (2004), the three primary components of soft power include:

1. Culture, arts, and media that are appealing to others;
2. Political values, particularly when these are upheld both domestically and internationally;
3. Foreign policy, which relies on diplomatic relations to forge alliances and reshape international norms.

The theory of soft power emphasizes a nation's ability to influence others through voluntary attraction rather than coercion. This approach gained significant relevance following the end of the Cold War and the collapse of the Soviet system, when diplomacy emerged as a dominant tool in foreign policy and international relations. Even for smaller or less developed countries like Georgia, soft power can serve as a strategic instrument to shape foreign policy goals and generate unpredictable strategic responses, particularly amid regional complexities. At the same time, countries like Georgia are vulnerable to the external use of soft power, necessitating careful strategic choices.

Although Nye's original conception of soft power (1990) focused on attraction through culture, values, and diplomacy, modern scholars have expanded and developed the theory in light of 21st-century challenges. Significant contributions to its evolution include:

- Stephanie Winkler (2020), who critiqued the conceptual clarity of soft power within its historical evolution (Nye, 2021);
- Jean-Marc F. Blanchard (2012), who explored the methodological challenges of empirically studying soft power, especially in the context of emerging powers such as China;
- Utpal Vyas (2010), who applied constructivist theory to soft power, emphasizing identity and perception in shaping international influence;
- Marco Bettine and Lia Picoli (2022), who studied the role of science, technology, and innovation (STI) in strengthening soft power.

A significant contribution to the empirical and conceptual development of soft power has been made by MacDonald and Murray (2024), which has conducted comparative studies across 18 countries. Their findings highlight the transformation of soft power theory in the digital age and how nations are adapting their strategies to a multi-polar and technology-driven global environment.

Thus, the diversification of soft power theory spans from constructivist and empirical critiques to intersections with innovation, digital diplomacy, and geopolitical strategy.

Modern informational and technological developments have transformed both the substance and instruments of soft power. Digital tools have acquired growing relevance, enhancing the role of *digital soft power*. Nations now utilize social media, digital diplomacy, and online cultural exports to shape global narratives. Platforms such as TikTok, X (formerly Twitter), and YouTube allow for direct engagement with foreign audiences, while simultaneously posing risks such as disinformation and algorithmic bias.

Later, Nye (2021) the concept of *smart power*—a strategic combination of "soft" and "hard" power. This approach acknowledges that attraction alone may not be sufficient in a complex geopolitical environment. Smart power, as conceptualized by Nye, involves the strategic integration of military, economic, diplomatic, and cultural instruments to achieve foreign policy goals.

In sum, while Nye's initial concept of soft power emphasized attraction through culture, values, and diplomacy, contemporary theoretical developments have expanded its scope to reflect the influence of technological, communicational, and geopolitical transformations.

3. Russia's Soft Power in Georgia: Historical Dynamics and Instruments

In the modern world, where the information space plays a critical role, the significance of soft power has grown substantially. Unlike Western interpretations, however, Russia's soft power is not limited to attraction alone; it encompasses targeted information campaigns, economic leverage, and humanitarian policies that often transform from legitimate means into instruments of political pressure.

Following the collapse of the Soviet Union, Georgia gained sovereignty and the opportunity to pursue an independent foreign policy. However, internal crises, separatist conflicts, and Russia's political agenda significantly complicated the country's development (Rondeli, 2001). As the central power of the former socialist union, Russia sought to maintain its influence through cultural, economic, and military tools.

In the early years of independence, Georgia joined the Commonwealth of Independent States (CIS), which led to the continued presence of Russian military bases and limitations on national sovereignty (MIF of Georgia, 2006). Georgia's accession to the CIS coincided with the civil war and the conflict in Abkhazia. Later, the Kremlin began emphasizing shared history and religious-cultural ties as part of its policy toward Georgia, reinforcing soft power influence.

After the „Rose Revolution ", President Saakashvili sought to enhance economic cooperation with Russia, yet embargoes and politicization of energy supplies by Russia exacerbated bilateral tensions (Devdariani, 2006). Notably, after the withdrawal of Russian military bases from Georgian territory, the Kremlin intensified its soft power efforts to maintain influence. Historically, Russia's main soft power levers in Georgia have included cultural ties, the idea of unity based on language and Orthodox Christianity, economic pressure, and informational influence.

Georgia's strategic location has made it vulnerable to regional conflicts, including Russian occupation and pressure following the 2008 August War. Consequently, Georgia's Constitution and National Security Strategy clearly reflect Euro-Atlantic integration as the most realistic mechanism for ensuring national security.

The August 2008 war, during which Russia occupied 20% of Georgia's territory, demonstrated that the Kremlin's traditional soft power instruments were insufficient (Kintsurashvili & Gelava, 2019). Russia's policy expanded to include disinformation, anti-Western narratives, and hybrid influence strategies (Kintsurashvili & Ratiani, 2024). While Russia initiated a new phase of engagement with Georgia after the war, including partial dialogue and cultural projects, military and political pressure continued unabated (Phkhaladze, 2010). The war resulted in an estimated direct economic loss of $1.7 billion for Georgia—roughly 15% of GDP at the time. Foreign direct investment fell by 58% in the second half of 2008. Additionally, perceptions of the security of the Trans-Caspian and South Caucasus energy corridors deteriorated, weakening trust among potential international partners (NBG, 2024).

This period saw increased Russian geo-economic pressure on Georgia. Russia actively utilized economic levers such as:

- Trade embargoes (2006, 2013);
- Manipulation of energy prices;
- Suspension of tourism flows, among others.

These actions were intended to influence Georgia's foreign policy orientation. After 2010, Georgia experienced marked economic growth, partly due to the partial reopening of the Russian market and export diversification in the region. Despite the 2008 war and Georgia's clear pro-European political course, Russia and other CIS countries remained important trade partners, reflecting the enduring economic inertia rooted in historical ties between post-Soviet states. In parallel, Georgia signed the Association Agreement with the European Union, which led to a significant increase in exports to the EU and initiated energy independence strategies.

During this time, the Kremlin continued using Gazprom—a state-owned company—as a policy tool (Toroshelidze, 2008). Although Georgia partially succeeded in reducing its dependency on Russian energy resources, attempts at cooperation exposed the country to increased manipulation risks (Goldthau, & Belyi, 2015). To this day, Russian state and commercial ownership of strategic energy assets in Georgia remains a significant challenge (Lekashvili, 2024).

Since 2012, following the rise to power of the Georgian Dream coalition, there have been efforts to normalize relations with Russia, including visa liberalization, cultural and sporting exchanges, and the appointment of a special representative (Kapanadze, 2015). In 2012, then-Prime Minister Bidzina Ivanishvili declared that "confrontation with Russia is a thing of the past" and that "normalizing trade and cultural relations is realistic and should be achieved in the near future" (Civil Georgia, 2012). Specific steps were taken, such as abolishing the visa regime with Russia, participating in the Sochi Olympics, and granting amnesty to Russian spies in 2013 (Kapanadze, 2015, p. 163). Nevertheless, Russia did not reciprocate with goodwill and continued pursuing imperial interests. Simultaneously, the Kremlin deepened ties with occupied territories, erected barbed wire along administrative boundary lines, and maintained a creeping occupation, alongside other soft power mechanisms.

One of Russia's soft power tools in Georgia remains the labor market and employment opportunities for Georgian citizens in Russia, which continues to drive economic emigration. Remittances sent by nearly one million Georgians living in Russia have had a considerable impact on Georgia's economy (Kapanadze, 2015). Other economic levers include trade, energy, and investment, which provide Russia with additional influence over Georgia's economy (Kapanadze, 2014). From

2013, Georgian exports to the Russian market increased, reaching 10% of total exports in 2014, further deepening Georgia's dependency on Russia (Kapanadze, 2015).

The Kremlin also employs its "protection of compatriots" policy, which includes passportization, funding of social programs, and cultural initiatives (Phkhaladze, 2010). The promotion of the Russian language and culture through media and pro-Russian organizations supports the dissemination of anti-Western narratives and influences public attitudes (Kintsurashvili & Ratiani, 2024; Kapanadze, 2015). Of particular significance is the influence of the Georgian Orthodox Church, historically linked to the Russian Orthodox Church under the notion of shared faith. The Church often serves as a channel for disseminating conservative and anti-Western messages, and it is frequently used by the Kremlin as a key instrument of its soft power strategy.

4. Contemporary Impact of Russia's Soft Power Instruments on Georgia's Political-Economic Environment

Since 2016, Russia's soft power strategy in Georgia has become increasingly active, particularly in the information and media space. Anti-Western and anti-liberal narratives have become more widespread across Georgian media and social networks, aiming to reduce public trust in the European Union and NATO (Kintsurashvili & Gelava, 2019; Kintsurashvili, 2021). These efforts are supported financially and organizationally by Russia, increasing the influence of pro-Russian organizations (Kintsurashvili & Ratiani, 2024).

Economic tools remain a critical component of Russia's influence strategy. While Georgia has made strides toward energy diversification, Russia continues to be a significant trade partner, contributing to the country's economic vulnerability (Kapanadze, 2020). For example, the steady increase in Georgian wine exports to Russia has led to a growing concentration of trade with the Russian market. In 2024, wine exports totaled approximately $263.3 million, 67% of which was directed to the Russian Federation—demonstrating Georgia's heightened exposure to external shocks emanating from that market. However, according to preliminary data from the National Statistics Office of Georgia for the first quarter of 2025, Russia's share in total exports dropped from 12.1% to 9.3%, potentially reflecting ongoing diversification efforts and an awareness of geopolitical risks.

Russia's full-scale invasion of Ukraine in February 2022 significantly altered the regional security landscape and affected Georgia as well. This development enhanced pro-European sentiments in Georgian society and increased support for a Western foreign policy orientation (CRRC, 2024). Nevertheless, Russia has intensified its use of soft power instruments in an attempt to preserve and expand its influence in Georgia.

One of Russia's main tools has been support for pro-Russian media outlets and online platforms that disseminate anti-Western and anti-liberal messages. These narratives aim to diminish trust in NATO and the EU, while swaying segments of the population toward pro-Russian positions (Kintsurashvili & Ratiani, 2024; ISFED, 2024).

Russia's soft power also extends to economic relations between Georgia and the Commonwealth of Independent States (CIS), where Russia remains the dominant player. In 1995, Georgia's exports to CIS countries totaled $97.9 million; by 2024, this figure had surpassed $4.5 billion. Imports from CIS countries rose from $161 million in 1995 to nearly $3.3 billion in 2024. Russia's role in shaping these figures remains substantial. Between 2022 and 2024, these trade levels remained consistently high—possibly due to the redirection of imports through Georgia following the imposition of international sanctions on Russia. Russia ranks third among Georgia's export countries in 2025 (see Table 1), and in the first quarter of 2026, Russia ranks second among importing countries of Georgia (see Figure 1), which confirms the growing trend of Georgia-Russia trade relations.

Table 1

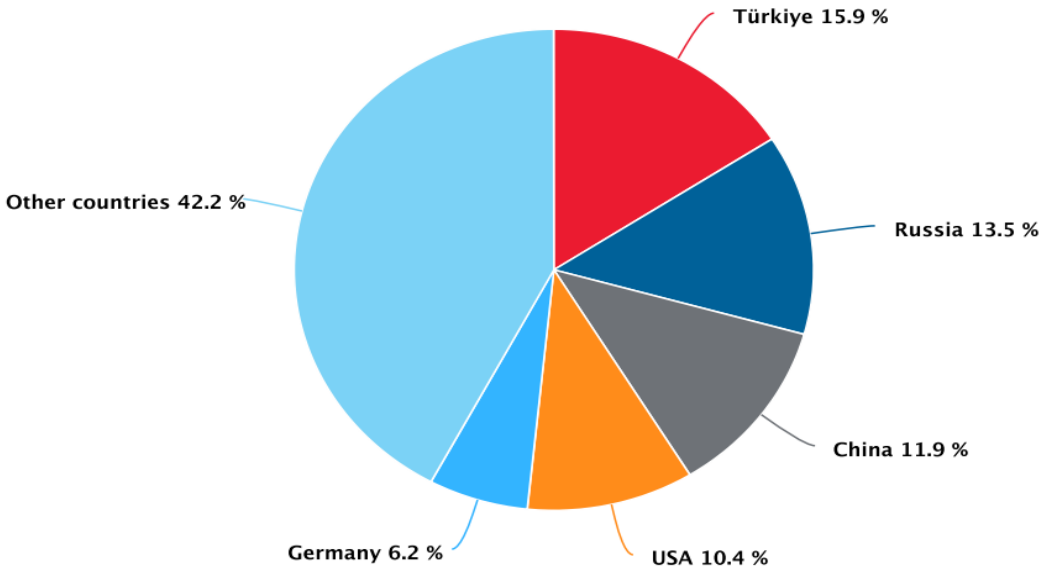
Georgia's export countries in 2025

Georgia Exports by Country	Value, $
Kyrgyzstan	1 508 M
Kazakhstan	909.99 M
Russia	749.30 M
Azerbaijan	697.26 M
Armenia	552.93 M
Turkey	332.91 M
China	332.58 M

Source: Tradingeconomics, https://tradingeconomics.com/georgia/exports-by-country (Accessed 12.06.2026)

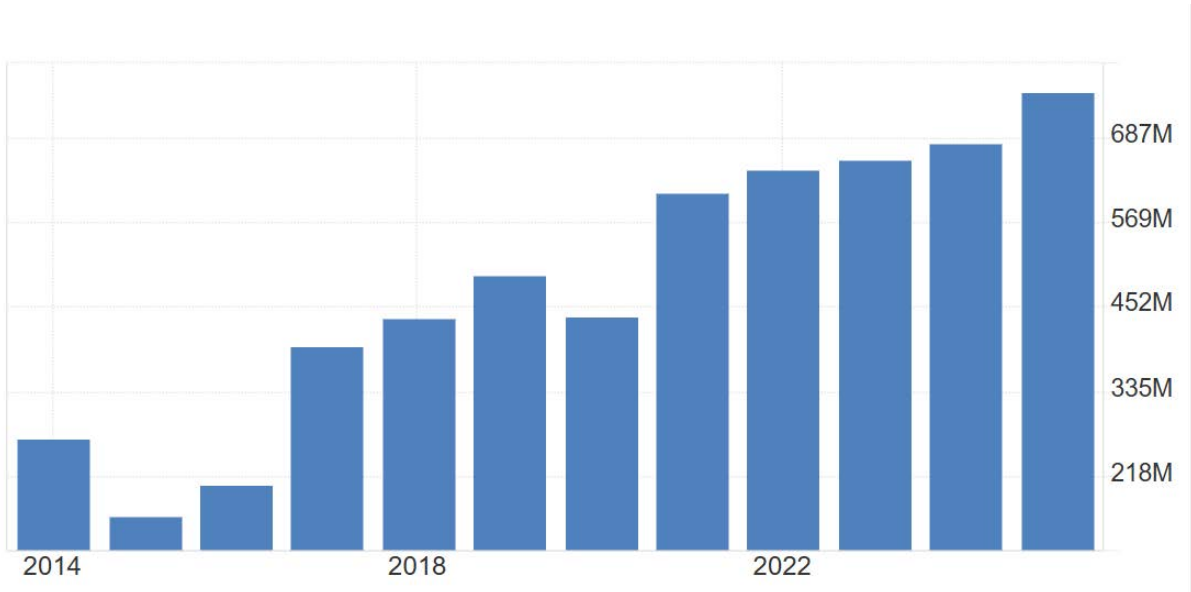
In addition, the dynamics of Georgia's exports to Russia in 2014-2024 is characterized by a constantly growing trend (see Figure 2). Only in 2015 was the lowest level of export volume recorded, which can be explained by geopolitical factors: the conclusion of the Association Agreement between Georgia and the European Union (which also includes a Deep and Comprehensive Free Trade Area- DCFTA) was signed on June 27, 2014, and entered into full force on July 1, 2016) and the results of the 2014 Russia-Ukraine war.

Following the outbreak of war in Ukraine, Georgia experienced an unprecedented influx of Russian citizens. In 2022 alone, approximately 1 million Russian nationals entered the country, with around 100,000 staying long-term (Radio Free Europe/Radio Liberty, 2022). According to the National Statistics Office of Georgia, more than 1.2 million visitors from Russia entered the country in 2023—an increase of 35% compared to 2022. A significant portion of these arrivals involved individuals who opted to settle in Georgia for extended periods.



Source: Geostat, https://www.geostat.ge/en/modules/categories/638/import (Accessed 12.06.2026)

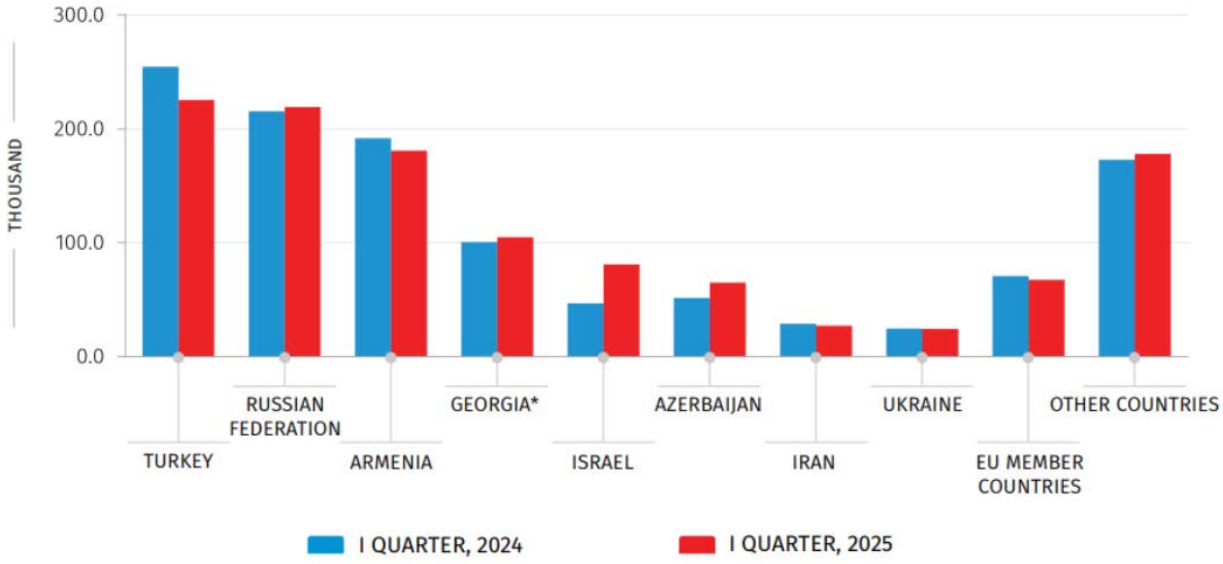
Figure 1: Share of the top trading parties in total Imports in January – April 2026



Source: Tradingeconomics, https://tradingeconomics.com/georgia/exports-by-country (Accessed 12.06.2026)

Figure 2: Georgia Exports to Russia

According to the Georgian Statistics Service, in the first quarter of 2024-2025, the Russian Federation is leading in the number of incoming visitors and the process is growing. Their number amounted to 19.3% of the total number of visitors (187,700 visitors) (see Figure 3). By 2025, Russian citizens will also be leading in the issue of obtaining Georgian citizenship (see Figure 4). This trend has led to considerable social and economic changes, influencing demographic dynamics and expanding the space for Russian soft power influence.



Source: Geostat, https://civil.ge/archives/678792 (Accessed 12.06.2026)

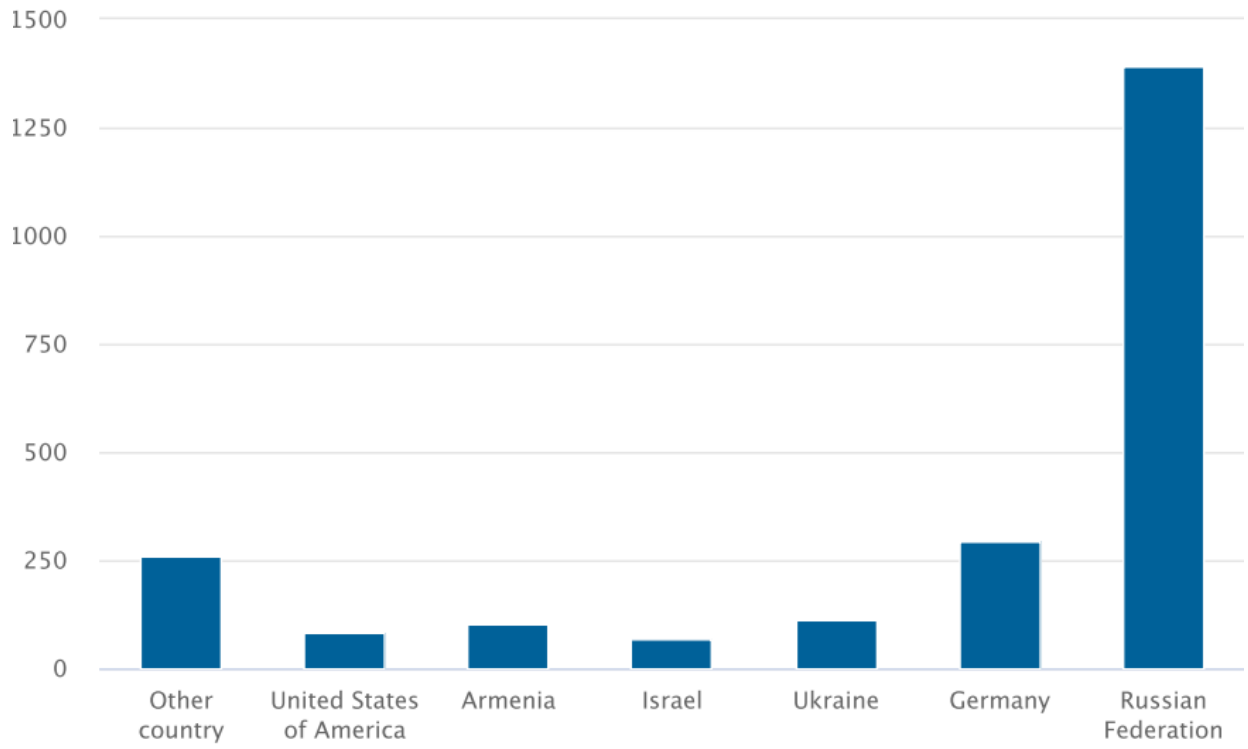
Figure 3: Distribution of the number of visits made by inbound visitors by country of citizenship in the I quarters of 2024-2025

A particularly critical challenge linked to this migration is its effect on the housing market. The massive influx of Russian citizens has driven up real estate prices, making housing less affordable for the local population (Babych, 2023). While migrants have had a positive impact on Georgia's current account balance, their influence on the property market and, over the long term, on national sovereignty and security warrants serious analysis and potential revisions to migration policy. Inflation—especially in food and fuel—continues to pose a key economic risk, affecting food security and poverty levels (Babych, 2023).

Amid the ongoing war in Ukraine, Georgia has seen a sharp increase in capital inflows from Russia, which has had a dual impact on the economy. On the one hand, this surge has positively influenced macroeconomic indicators, including a rise in private remittances, which represent a major source of foreign currency inflows. The tourism sector has also grown, driven by visitors from Russia, Belarus, and neighboring countries—resulting in a notable increase in service-sector revenues. According to the National Bank of Georgia, remittances from the Russian Federation exceeded $2 billion in 2023, nearly double the 2021 figure. These transfers played a critical role in strengthening Georgia's current account balance and accelerating economic growth: the real GDP growth rate reached 7.5% in 2023 (NBG, 2024). Increased consumption and growth were largely fueled by this inflow. In 2022, for example, remittances were a key driver behind Georgia's 10.4% GDP growth. However, the subsequent decline in remittances from Russia in 2023 contributed to a deceleration of growth, which averaged around 7% (Shamugia, 2024).

The increase in air travel between Georgia and Russia suggests a strategic policy choice by the Georgian government to maintain a degree of independence in its external relations (European Commission, 2024). However, this development may also be interpreted as a facilitator of Russia's soft power strategy.

Russia's war in Ukraine has fundamentally reshaped the regional economic and political context, directly and indirectly influencing trade and investment flows in Georgia (Ormotsadze & Evgenidze, 2025). Georgia has seen an increase in re-export activity to Central Asia through its territory, partly due to sanctions on Russia. While this has driven short-term economic growth, it is also accompanied by uncertainty- stemming from both global political processes and Georgia's evolving domestic political landscape and foreign economic orientation.



Source: Geostat, https://www.geostat.ge/en/modules/categories/322/migration (Accessed 13.06.2026)

Figure 4: Acquisition of Georgian citizenship by previous country of citizenship, 2025

In sum, Russia's soft power strategy in Georgia has undergone a transformation since the onset of the 2022 war. It has become more multifaceted and assertive, encompassing informational manipulation, economic levers, migration flows, and cultural influence—including via the Church. The overarching objective of this strategy is to weaken Georgia's Western trajectory and advance Russia's strategic interests in the region.

5. Factors Determining the Success and Setbacks of Russia's Soft Power

The strengthening of Russia's soft power influence in Georgia has been facilitated by the ruling party, *Georgian Dream*, through its reassessment of the country's pro-Western orientation and the intensification of anti-Western narratives. In the October 26, 2024 parliamentary elections, *Georgian Dream* officially declared victory with the support of approximately 54% of the population. Although the elections were technically well-organized according to the OSCE/ODIHR final report, significant systemic violations were recorded, including the misuse of administrative resources, vote buying, violations of ballot secrecy, and other irregularities that impacted the overall fairness of the process (Civil Georgia, 2024).

In recent years, a clear trend has emerged in Georgia: the ruling elite increasingly employs anti-Western narratives derived from Russian propaganda to consolidate its political power and discredit opposition forces. While Georgia officially maintains a pro-Western course, on several occasions the government has echoed messages similar in style to Russian propaganda for internal political gains (Kintsurashvili & Ratiani, 2024).

One of the key mechanisms involves sowing public distrust toward Western institutions and NGOs, using state-aligned and pro-Russian media channels (ISFED, 2024). Anti-Western rhetoric serves to mobilize segments of the population that are skeptical of the West, allowing the ruling party to portray itself as a "sovereign power" defending national interests.

In addition, Eurosceptic statements occasionally surface in the rhetoric of government officials, signaling a defense of "national interests" amid Western criticism. This strategy aligns closely with a central narrative of Russian propaganda—that the West threatens Georgia's traditions and identity, while the government protects national values (Kintsurashvili & Gelava, 2019).

These messages are often accompanied by smear campaigns targeting civil society activists and critical media, portraying them as "foreign agents." Such strategies not only undermine democratic processes but also contribute to

societal polarization, enabling the government to strengthen its control and maintain power amidst internal division (CRRC, 2024).

A notable factor is the strategic use of the Orthodox Church's influence. Government officials often reproduce conservative narratives that mirror Russian propaganda, focusing on the defense of traditional values, the "threat of liberalism," and the reinforcement of national identity.

Although the Georgian government has publicly expressed support for Ukraine, it has refrained from joining Western sanctions against Russia—sending mixed messages in the international arena (Salomé, 2024).

The adoption of Russia-style propaganda narratives by the Georgian government represents a deliberate political technology aimed at power consolidation, opposition marginalization, and the consolidation of public support under the guise of defending national identity and traditional values.

Russia's soft power strategy in Georgia remains a major political challenge, with its primary goals being the weakening of Georgia's Western alignment, the strengthening of pro-Russian sentiments, and the erosion of trust in democratic institutions. Both international and local research indicate that, despite the Georgian public's increasing pro-European orientation, the Kremlin employs a range of instruments—often reinforced by internal political dynamics.

Since the 2008 war, Russia's toolkit has expanded to include disinformation, hybrid warfare, and the systematic spread of anti-Western narratives. Its soft power activity has intensified since the full-scale invasion of Ukraine, though the effectiveness of some instruments has declined. According to recent research (CRRC, 2024; ISFED, 2025; Kintsurashvili & Ratiani, 2024; Chedia, 2026), Russia's key levers include cultural and religious influence, economic dependency, media, and information campaigns.

Through cultural and religious instruments, Russia attempts to amplify pro-Russian attitudes in segments of Georgian society by promoting shared historical memory, Orthodox Christian values, and the Russian language. Segments of the Georgian Orthodox Church are often critical of the West and reinforce Kremlin-aligned narratives (Kintsurashvili & Ratiani, 2024).

Economically, Russia uses trade, energy, and tourism to increase Georgia's vulnerability. For instance, in 2023, the mass influx of Russian citizens into Georgia expanded Russia's presence in Georgian markets (Chedia, 2026). Russian energy companies also maintain key positions in Georgia's strategic sectors (CRRC, 2024).

Media and information campaigns are among the Kremlin's most effective tools for spreading anti-Western rhetoric. According to Kintsurashvili and Ratiani, (2024), such campaigns aim to discredit the West and portray Russia as the defender of traditional values. ISFED (2025) reports a particularly strong narrative suggesting that the West promotes "color revolutions" and threatens national identity.

Political influence through pro-Russian NGOs and minor political parties is another significant tactic. These actors oppose Western integration and foster skepticism toward the EU and NATO (Chedia, 2026; ISFED, 2025).

However, recent surveys (CRRC, 2024; NDI, 2023) show that a majority of Georgians still support European integration. Although support for the EU and NATO increased after Russia's invasion of Ukraine, there has been a slight decline—due in part to internal political developments and disinformation campaigns. For example, CRRC (2024) reports that support for EU membership stands at 68%, approximately 5–7% lower than in 2022, while NATO support remains between 66–67%.

The Orthodox Church remains a key actor in propagating anti-Western messages, reinforcing conservative discourse, and supporting Kremlin objectives. Government representatives often echo such rhetoric, contributing to polarization (Kintsurashvili & Gelava, 2019; CRRC, 2024).

The 2024 parliamentary elections confirmed that domestic political developments can align with Russia's propaganda interests. While the OSCE/ODIHR deemed the elections technically well-organized, they noted irregularities such as the misuse of administrative resources and vote buying (Civil Georgia, 2024). ISFED (2025) monitoring reports that Russian disinformation campaigns became more sophisticated and intensified particularly during the pre-election period.

Following the 2024 elections, a statement by the Prime Minister signaling a shift in Georgia's foreign policy away from the West triggered mass protests. Despite government use of force and arrests of opposition leaders, public demonstrations have continued for ten consecutive months—demonstrating the Georgian public's strong commitment to the country's European path (CRRC, 2024; Transparency International Georgia, 2024).

6. Conclusions and Recommendations

Thus, Russia's soft power policy in Georgia has evolved over time: initially focusing on historical ties and economic–energy dependence, and later shifting toward information manipulation and public opinion shaping. Russia's soft power strategy remains flexible and multidimensional. Nevertheless, a significant portion of Georgian society continues to support the country's pro-European orientation.

In order to achieve Georgia's strategic goals, it is essential to enhance information security, support democratic institutions, and strengthen civic education and media literacy across all levels of the educational system to reduce the influence of external propaganda.

From an economic standpoint, Georgia's strategic imperative is to diversify trade routes, deepen ties with Western partners, and minimize economic dependence on Russia, thereby mitigating associated risks (Ormotsadze & Evgenidze, 2025). It is also crucial to restrict Russian companies from exerting influence over Georgia's energy infrastructure, as well as from freely operating in the real estate sector or engaging in opaque financial and economic relations—at least until fair, transparent, independent, and accountable governance structures are fully established in the country (Lekashvili, 2024).

On the external front, the EU's and NATO's cautious approach to enlargement, combined with Russia's ongoing pressure and regional instability, creates a dual strategic squeeze. This situation necessitates diplomatic agility and an acceleration of domestic institutional reforms.

In addition, Georgia can leverage digital platforms to globally amplify its democratic values and cultural identity. It has the potential to balance these efforts with strategic security partnerships.

By emphasizing constructivist diplomacy, Georgia can also contribute to shaping regional narratives centered around peace, cooperation, and resilience—particularly in the South Caucasus.

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Author's contribution

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The Limits of Incrementalism in the Green Transformation of the Iron and Steel Industry

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SUMMARY

Incrementalism is a dominant decision-making paradigm, characterised by stepwise adjustments rather than structural transformation, and is often viewed as a pragmatic and politically feasible approach. Yet sustainability scholarship increasingly highlights its inadequacy in addressing the scale and urgency of today's environmental challenges. Following this critique, the paper investigates the limitations of incrementalism within the context of industrial decarbonisation, focusing on the steel sector. Rather than analysing political institutions or behaviour, the study examines macro-level decarbonisation pathways and EU policy instruments using incrementalism as a conceptual perspective to interpret how policies shape the pace and direction of change. Through a review of emerging pathways for green steel production, the analysis demonstrates that marginal improvements within the incumbent process are insufficient to achieve deep emissions reductions. The industry's transition demonstrates that sustainability goals cannot be achieved through incremental adjustments alone; they require systemic technological, infrastructural, and institutional change. Incremental approaches adjust expectations, but fail to deliver structural transformation, revealing how the myth of incrementalism obscures the transformative shifts necessary. Consequently, more ambitious and transformative policy interventions are required for a viable green transformation in the industry.

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1. INTRODUCTION

Steel is a vital material in modern life, and the steel industry is an important sector within the global economy. However, the iron and steel sector has the largest CO_2 emissions among the heavy industries and is the second-largest consumer of energy. The industry is a hard-to-abate sector because the production is highly energy-intensive and relies on fossil fuels; current technologies make it difficult to achieve significant emissions reductions (IRENA, 2024; Kumar et al., 2024). Greenhouse gas emissions are a major environmental concern; complying with climate goals and sustainability targets will require the industry to undergo substantial transformation. The total apparent steel consumption is projected to rise in the future by approximately 40% in 2050 compared with today's level. This anticipated growth reinforces the sector's already significant carbon footprint and raises important questions about whether incremental measures are sufficient to meaningfully shift such a carbon-intensive trajectory. Given the scale of emissions, long investment cycles of existing production assets, the need to deploy low-carbon production routes and supporting infrastructure, incremental adjustments risk delaying the adoption of alternative production routes.

2. Objective of the Study and Research Methodology

2.1. Objectives

The broader research project examines the green transition (understood here as the decarbonisation of iron and steel production) of the Hungarian steel industry. As Hungary is an EU Member State, national transition prospects must be understood within the wider EU27 context. At the same time, the steel sector operates within globally integrated markets, production technologies and industrial systems; therefore, global data are used to contextualise EU-level developments. This global-EU linkage is essential for understanding the structural conditions under which EU member states pursue decarbonisation pathways. Accordingly, this article focuses on the EU-level policy mechanisms as the primary institutional framework shaping the decarbonisation of the steel industry.

While incrementalism has traditionally been viewed as a practical and politically reasonable approach (Lindblom, 1959; Purdy, 2024), sustainability scholarship increasingly points to its shortcomings. The analysis illustrates the structural mismatch between the required technological transformation and the EU's incremental policy preferences. Accordingly, the study aims to:

- Provide an overview of incrementalism and sustainability
- Provide a general overview of the iron and steel industry
- Review pathways for green transition in the industry
- Conclude on the theoretical limits of incrementalism and practical implications for the EU steel industry

2.2. Methodological Approach

The study combines a conceptual analysis and a qualitative case analysis of steel-sector decarbonisation pathways. The conceptual component consists of a critical review of incrementalism, analysing its theoretical foundations and limitations within the sustainability transition scholarship. The empirical component employs a desk-based qualitative analysis to evaluate the extent to which green-steel pathways can contribute to deep decarbonisation.

The qualitative case analysis focuses on the EU27 steel sector decarbonisation pathways, interpreted within the global technological and industrial context that shapes steel-making options. The study examines three broader categories of pathways: circular economy, CO_2 reduction possibilities and direct carbon avoidance. Each pathway is assessed for expected CO_2-reduction potential, technology maturity, infrastructure requirements and capital intensity.

The various EU policies were evaluated to determine whether they support incremental or structural transformations. The criteria are summarized in Table 1.

Table 1

Criteria for evaluating policy mechanisms

Incrementalism / Optimisation	Structural Transformation
Efficiency improvements	Shift to new production routes
Marginal abatement measures	Deep emissions reductions aligned with climate trajectories
Lifetime extension of incumbent assets	Phase-out of carbon intensive assets
No major new infrastructure required	Requires substantial new infrastructure
Politically feasible, low risk, aligned with incumbent interest	High capital intensity, long investment cycles, transformative investment
Reinforces existing socio-technical regime	Creates new institutional and market arrangements

Source: Constructed by the author

The desk-based research component used the following publicly available datasets:

- World Steel Association (WSA) – production statistics, technology shares
- EU ETS Data Viewer – installation-level emissions
- Green Steel Tracker – project-level information of green-steel projects
- European Commission policy documents - Fit for 55, Hydrogen Strategy, CBAM
- Corporate disclosures – project announcements

These sources provide the empirical basis for evaluating technological pathways and policy alignments.

1. Literature Review of Incrementalism and Sustainability

Charles Lindblom's article ''The Science of Muddling Through'' published in Public Administration Review in 1959 provided an alternative approach to decision-making, suggesting that decisions proceed step-by-step and by small degrees from the current situation, rather than through radical changes (Allison & Saint-Martin, 2011; Lindblom, 1959, 1979). Incrementalism refers to the implementation of small, incremental modifications which jointly lead to significant transformations rather than through drastic or cautiously planned big steps (Purdy, 2024).

Incrementalism has been widely debated by public administration, political science, and strategic management literature (Allison & Saint-Martin, 2011; Lindblom, 1979). While the idea of incrementalism has been mainly applied to political processes, it has been examined across various fields in healthcare, civil rights, education, foreign policy, and climate change (Purdy, 2024).

Sustainability policy often defaults to incremental changes; therefore, sustainability literature studies examine how incrementalism shapes environmental governance and prospects for systematic change. Across the studies, various frameworks in transition studies examine the conflict between incremental change and structural transformation required for sustainability.

Sustainability governance provides a conceptual foundation for transition management by integrating regulatory and planning tools. Sustainability governance tends to proceed through incremental adjustments because policy change is shaped by political disagreements, slow institutions and competing priorities. However, deep decarbonisation requires long-term, strategic political commitment rather than incremental policy adjustments (Meadowcroft, 2009).

Sustainable energy transition research highlights that choices are deeply political, influenced by incumbent interests that work to defend the existing socio-technical regime and often constrain more transformative pathways (Smith et al., 2005; Geels & Schot, 2007; Stirling, 2014). Brand further strengthens this argument by showing that incrementalism is a political choice, while green economy approaches frame sustainability as a technical and economic optimisation problem (Brand, 2012).

Scoones also raises the point that while green transition implies technology and market shifts, it is also fundamentally political. This transformation differs from changes we witnessed in the past, driven by economic, social, technological and cultural developments or geopolitical events. The green transformation aims to change the existing economic model towards sustainability (Scoones et al., 2015). Past changes were open-ended or driven by market or technological dynamics alone, whereas sustainability transitions have directionality. They are normatively orientated towards specific environmental outcomes, such as deep decarbonisation (Stirling, 2009).

Sustainable transition cannot be achieved by incremental improvements of the existing regime. These changes are not just technological transitions, but systematic "socio-technical transitions", as they involve reconfiguring technology, infrastructure, markets, policy frameworks and cultural understanding (Geels, 2002, 2011; Rotmans et al., 2001; Markard et al., 2012). Societies face multiple possible routes, reflecting the existence of multi-pathways for the kind of change required for sustainability (Scoones et al., 2015). Choices among these pathways are inherently political, and ignoring the directionality of sustainability transition leads to a form of incrementalism that reinforces incumbent socio-technical regimes (Stirling, 2009).

The literature also notes that more ambitious climate policies or targets can trigger political or social resistance. Such backlash can shape the politics of climate policy and the pace of transformation. To maintain support for transformative change, the emphasis is on fairness, transparent communication and inclusive governance (Patterson et al., 2026; Patterson, 2023; Scoones, 2016).

This process is embedded within broader multi-level interactions among technology, policy and politics, economic and market dynamics, and culture or discursive factors, which together shape shifts towards more sustainable production and consumption (Geels, 2002, 2011; Smith et al., 2005; Markard et al., 2012).

Transition studies frequently use the concept of "niche"; niche innovations gain momentum and can eventually compete with incumbent system. However, the growth of "green" niches requires support to reshape economic framework conditions (Geels et al., 2004; Smith, 2006; Markard et al., 2012).

Within the multi-level perspective, interaction occurs between regimes, which represent the dominant configuration; the landscape, which reflects broader societal system; and niches which include the non-conforming configurations (Avelino & Rotmans, 2009; Geels & Schot, 2007). These interactions are reinforced by technological, behavioural and institutional lock-ins that stabilise the dominant regime (Loorbach & Rotmans, 2010).

Consequently, established socio-technical systems undergo incremental rather than radical changes (Loorbach et al., 2017; Markard et al., 2012), and such incremental changes will not suffice to cope with the prevailing sustainability challenges; transformative change requires reconfiguration, not optimisation (Geels, 2002; Markard et al., 2012; Petrović, 2023).

Transformative change involves the deliberate phase-out of incumbent carbon-intensive technologies and creation of a new socio-technical configuration aligned with climate goals, because incremental changes cannot deliver the pace, scale and directionality required for deep decarbonisation. Furthermore, institutional change aligned with financial and political incentives is necessary to create a window of opportunity for such transformation (Westley et al., 2011).

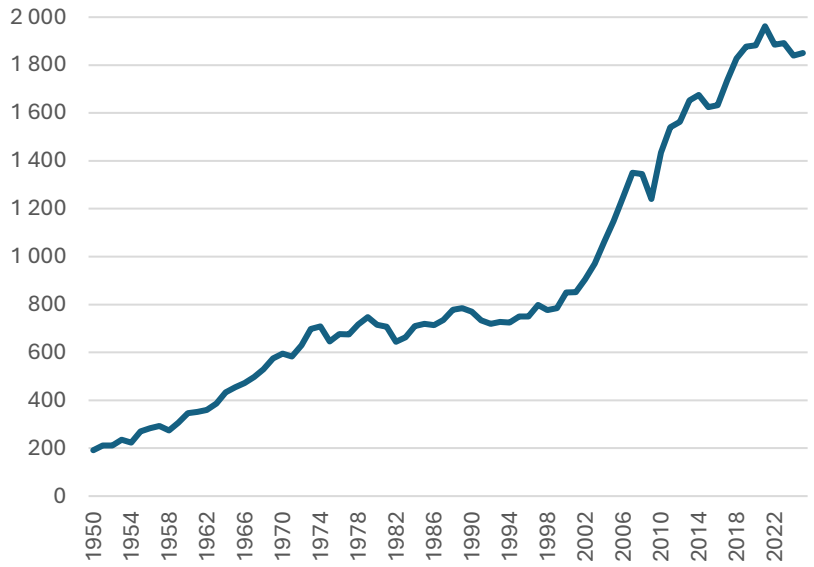
In contrast to political and socio-technical perspectives, the heavy-industry decarbonisation literature primarily adopts technology-centred and techno-economic approaches. A wide range of studies map mitigation pathways and assess the feasibility of low-carbon technologies using techno-economic assessments, life-cycle analysis, supply-chain optimisation and levelized cost modelling (e.g.: Devlin et al., 2023; Fischedick et al., 2014; Hasanbeigi et al., 2013; Mayer et al., 2019). Although Bataille and colleagues (2020) discuss policy instruments relevant to industrial transformation, this engagement with politics is largely limited to identifying policy instruments that enable technology deployment rather than analysing political dynamics shaping the pace and direction of change.

Based on the literature review, sustainability transition cannot be resolved through technology, markets or marginal optimisation alone; sustainability is fundamentally a political exercise. While existing governance tends to deliver incremental change, the scale of sustainability challenge requires structural transformation rather than incremental adjustment. This understanding provides a useful foundation for analysing the steel industry.

Accordingly, this article uses incrementalism as a conceptual perspective to analyse how EU industrial decarbonisation policies shape the pace and direction of change in the steel-sector. Rather than providing an analysis of political institutions and behaviour, the study focuses on macro-level pathways and EU policy instruments, investigating how incremental policy design and implementation contribute to regime stability. In doing so, the paper argues that policymakers must confront the urgency and difficulty of transformative change in the steel industry, rather than relying on incremental adjustments that delay decisions and undermine climate objectives.

2. Steel Sector overview and Environmental Challenges

Steel is one of the most important materials in the world. More than a hundred years ago, in 1900, the world crude steel production was only 37 million tons, now the annual production of crude steel reached 1,850 Mt in 2025 (WSA, 2025a). The total crude steel production growth since 1950's is shown in Figure 1.



Source: Constructed by the author using data from WSA

Figure 1: World crude steel production, Mt

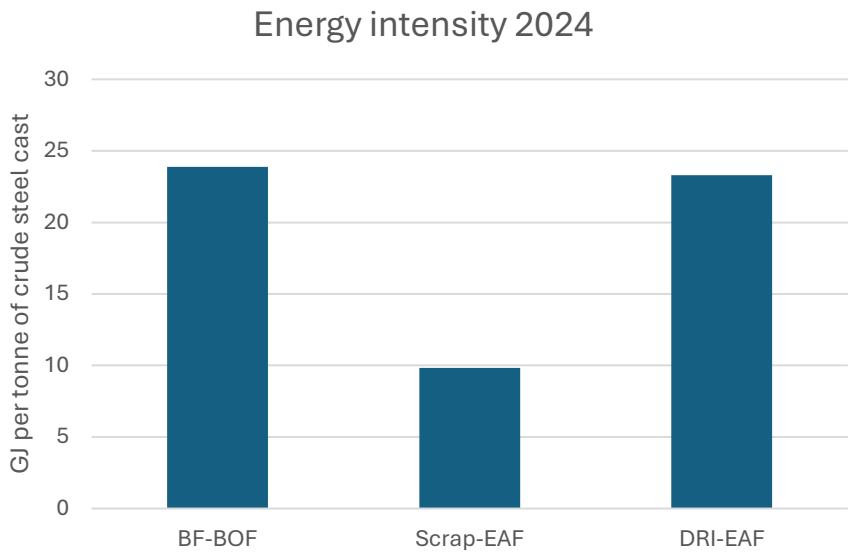
The steel industry is known for being cyclical and reflective of overall market conditions and for being sensitive to trends in cyclical industries, such as the automotive, construction, appliance, machinery, equipment and transportation industries (Frost & Sullivan, 2018). The level of per capita consumption of steel is treated as an important index of socioeconomic development, which gives the steel industry strong institutional and political influence.

The industry is characterized by a small number of large, established firms that dominate an industry with large-scale production facilities, heavy machinery, and significant capital investment. Therefore, the sector is deeply locked into socio-technical regime with dependence on fossil fuels, long-life capital stock, and strong reliance on infrastructure (OECD, 2024; Vogl, 2023).

Steel is one of the most highly recycled materials in use today; steel scrap is reused in Electric Arc Furnaces (EAF), but most of the steel is still produced via the integrated route, Blast Furnace and Basic Oxygen Furnace (BF-BOF). Globally the crude steel produced by BF-BOF process is over 70%.

During the BF-BOF process, iron ore is reduced in the blast furnace to hot metal with coal, coke and gas, which is subsequently refined to crude steel in the basic oxygen furnace. It is a hard-to-abate sector because the energy-intensive nature of the process and fossil fuels make it difficult to achieve significant emissions reductions with current technologies (IRENA, 2024; Kumar et al., 2024).

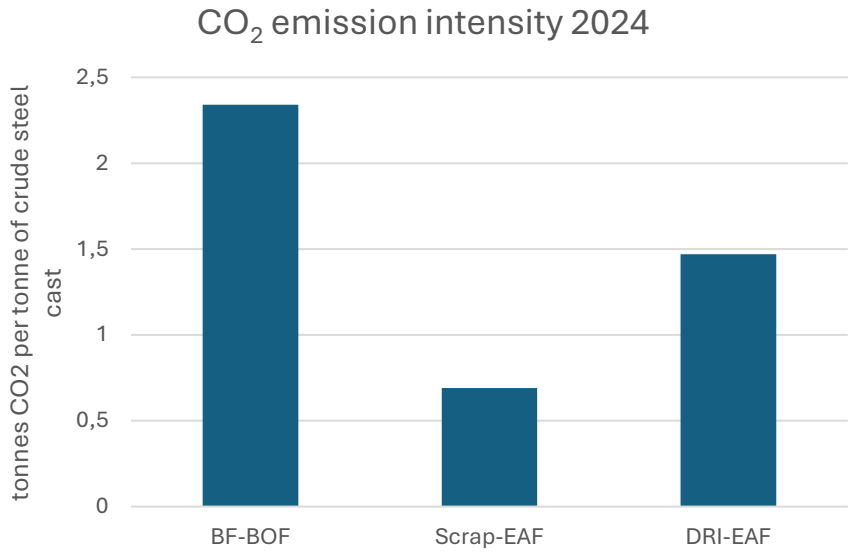
The BF-BOF process is the largest industrial consumer of coal, which provides around 75% of its energy demand, making it second in terms of energy consumption (IEA, 2020). The energy intensity of the industry is summarized in Figure 2.



Source: Constructed by the author from WSA data (WSA, 2025b)

Figure 2: 2021-2024 global energy intensity

The iron and steel sector has the largest CO_2 emissions among the heavy industries. The CO_2 emission intensity of the main process routes is summarised in Figure 3.



Source: Constructed by the author from WSA data (WSA, 2025b)

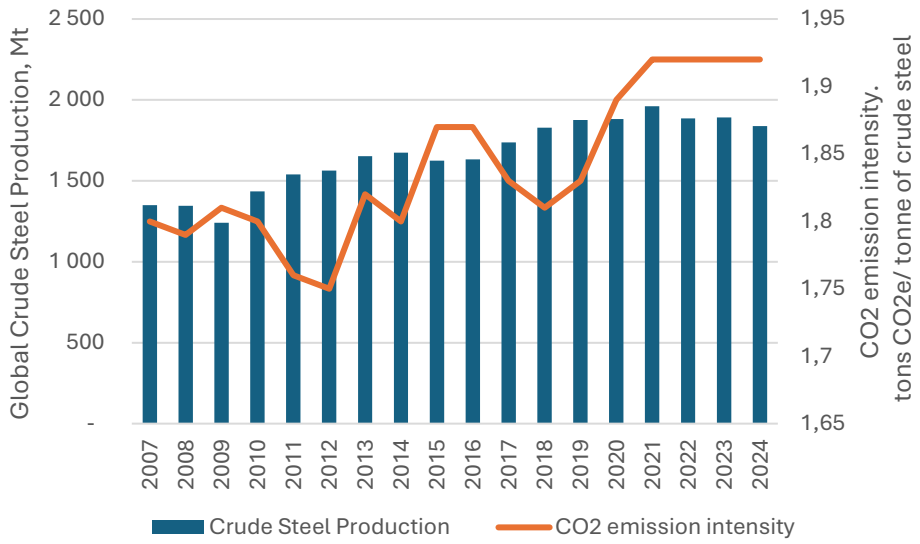
Figure 3: 2021-2024 global CO_2 emission intensity

The largest direct emissions originate from integrated BF-BOF plants, the global average CO_2 emission intensity was around 2.34 t of CO_2 per tons of steel in 2024 (Steelonthenet, 2012; WSA, 2025b).

It is estimated that 2-3 tons CO_2 per tons of steel is emitted if the direct reduction process is coal based, or 0.7-1.2 tons CO_2 per tons of steel if the process is gas-based (Morfeldt et al., 2015; Steelonthenet, 2012). The global average of CO_2 emission intensity for direct reduced iron with EAFs was around 1.47 t of CO_2 per tons of steel in 2024.

The remaining emissions in the iron and steel industry come mainly from power generation (indirect) to run Electric Arc Furnaces (EAF), and from rolling mills, which are for downstream processing of steel products. For the scrap-based EAF process the global average of CO_2 emission intensity was around 0.69 t of CO_2 per tons of steel.

Most of the countries and companies have committed to reducing CO_2 emissions, but while the sector-specific CO_2 emissions showed some decrease after the Paris Agreement in 2015, specific emissions figures have shown an increase since 2018-19 driven by the dominance of carbon-intensive BF-BOF route. Figure 4 shows the crude steel production and changes in CO_2 emission intensity over the years, highlighting the current gap between ambition and actual progress.



Source: Constructed by the author from WSA data, (WSA, 2025b)

Figure 4: Global crude steel production and CO_2 emission intensity 2007-2024

2.1. Future Steel Demand

In general, steel demand is sensitive to macroeconomic fluctuations in the global economy which are impacted by many factors ranging from trade and geopolitical tensions to global and regional monetary policy to specific disruptive events such as pandemics and natural disasters.

The total apparent steel consumption has almost doubled in the last 20 years. The total steel demand was approximately 1,773 Mt in 2025 (WSA, 2025c). It is expected that steel demand will continue to rise in the future with increased demand in end-user sectors. Various sources project the demand to be above 2,000 Mtpy and in some scenarios reaching 2,500 Mtpy by 2050, which is approximately 40% increase compared to today's level (Hasanbeigi et al., 2013; Hornby & Brooks, 2021; IEA, 2020; Material Economics, 2019; van Ruijven et al., 2016).

Figure 5 summarizes the steel production from 2012-2024 and the forecast for 2050. As discussed before, most of the production is still mainly coming from integrated technology route (BF-BOF) that creates the largest CO_2 emissions, thus without any changes the emissions would increase around 4.8 billion tons of CO_2 in 2050 with the increased production to meet demand. The CO_2 commitment level by the Paris agreement is also shown in Figure 5.

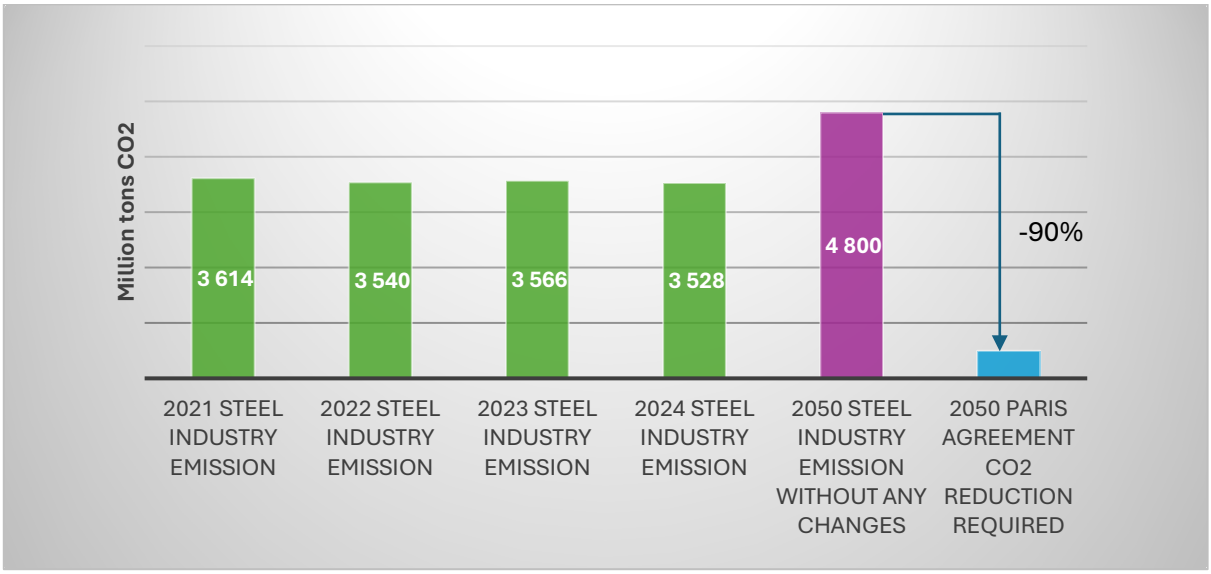
The scale of the challenge is substantial; the industry faces a CO_2 reduction requirement by approximately 90% (OECD, 2022). Consequently, the industry needs to undergo major transformation in order to reduce emissions.

2.2. Technologies - Decarbonization Strategies

There are many possible technological pathways for structural transformation currently under consideration by the industry, such as:

- Circular economy
- CO_2 reduction
- Direct Carbon avoidance

Each decarbonisation pathway is assessed by expected CO2-reduction potential, technology maturity, infrastructure requirements and capital intensity.



Source: Author's own compilation based on data from WSA, additional external sources (Hornby & Brooks, 2021), and the author's own 2050 calculation

Figure 5: CO_2 emission intensities and committed CO_2 level by Paris Agreement in 2050

2.2.1. Circular Economy

While some decarbonisation approaches focus on reducing primary steel demand and replacing by a higher degree of scrap-based production, material efficiency strategies, on the other hand, aim to reduce the need for additional steel production in the first place (Bataille, 2020; Kim et al., 2022; MPP, 2022).

Circular economy represents the integration of economic activities with environmental well-being (Murray et al., 2017); a move from linear business models, where products are manufactured from raw materials and then discarded at the end of their useful lives, to circular business models where intelligent design leads to products or their parts being repaired, reused, returned and recycled (WEF, 2014).

Although the steel industry is already an integral part of the global circular economy, as steel is one of the most recycled materials in the world, this form of circularity is described by some authors as a weak, incremental interpretation of circular economy (Broadbent, 2016; Murray et al., 2017). Circular economy practices in the steel industry can reinforce existing socio-technical regime, because they are politically attractive and safe incremental sustainability strategies. However, they represent incremental innovation within the stable regime rather than a pathway to structural transformation (Geels et al., 2004).

2.2.2. CO2 reduction possibilities

Using steel scrap reduces the virgin material input requirement, waste and emissions for the industry (Korhonen et al., 2018). However, impurity accumulations and limited scrap availability prevent completely scrap-based steel production, meaning that iron produced from iron ore will still be required in the future (Radloff et al., 2023).

The blast furnace is quite an efficient process in terms of energy use and productivity, but the use of coke generates the largest amounts of CO_2 (Sohn, 2020). One of the key options identified as the fastest way to slow emissions growth without considerable cost is to improve the energy efficiency of current BF processes (Holappa, 2020).

To optimize efficiency, diverse options are being investigated; the major technologies are summarized below:

- New burden of iron–carbon agglomerates,
- HBI use in BF,
- Hydrogen usage in BF: by injecting waste plastics, natural gas partially or pure hydrogen,
- Top gas recycling (Feiterna et al., 2014)

However, to achieve further reductions, carbon capture and utilization (CCU) and/or carbon capture and storage (CCS) are required (de Silveira Cachola et al., 2023). CCS cannot be regarded as a long-term solution though to reduce CO_2 emissions; it can only be used as a temporary mitigation method. A better way is carbon capture combined with utilization (CCU), where CO_2 can be chemically converted into other products such as plastics, concrete or biofuel, or without conversion used in enhanced oil recovery (EOR) (Holappa, 2020; WSA, 2023).

Nonetheless, there are some growing concerns arising regarding CCUS technologies. The only CCS project for the steel industry is the Al Reyadah project in UAE, serving a gas-based DRI plant, but only captures 19-26% of the plant emissions. It is even more difficult to integrate CCS with a coal-based iron and steelmaking facility which has several sources of carbon emissions, therefore this technology seems less likely to be utilized in the sector (Amand et al., 2024; Nicholas, 2025).

The emissions reduction potential using traditional energy-efficiency measures shows that to reduce emissions is limited (Muslemani et al., 2021). This reinforces the earlier argument from the literature review that incremental adjustments are unlikely to be sufficient. These measures optimise the existing BF-BOF regime but remain incremental improvements within the incumbent system and therefore cannot deliver the scale of change required in the steel sector.

2.2.3. Direct Carbon Avoidance

To achieve the required change, direct avoidance of CO_2 emissions will be required in the future. These emerging production routes, such as replacement of carbon by renewable electricity and/or fossil-free reductants to directly avoid CO_2 emissions, and using hydrogen, represent transformational change because they replace rather than optimise the incumbent BF-BOF technology (EUROFER, 2019).

There are many new breakthrough technologies that exist, such as:

- direct electrolysis: Hydrogen Plasma Smelting Reduction (HPSR), electrowinning (ULCOS, SIDEWIN, Electra), Molten Oxide Electrolysis (MOE),
- novel flash ironmaking,

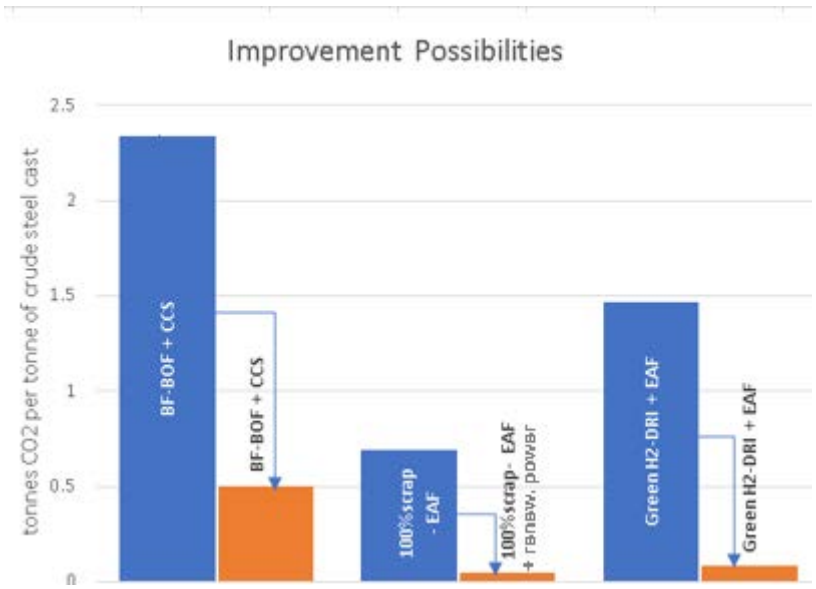
but many of these technologies remain at low technology readiness levels and have only been demonstrated at laboratory or pilot scale.

Smelting Reduction processes aim at overcoming the fundamental problems of the existing blast furnace route, however, most of these technologies only insignificantly reduce CO_2 emissions and they rely on the integration of CCS and CCUS technologies (Shahabuddin et al., 2023; Zhao et al., 2020).

The gas-based DRI process already has substantially lower greenhouse emissions and can operate economically. Hydrogen is already present in the process through the use of natural gas and increasing the ratio of it has been studied for many decades; replacing natural gas with green hydrogen (H-DRI) makes it technically possible to bring the iron and steel sector on a path to net zero emissions (MPP, 2022; World Economic Forum, 2022).

Hydrogen-based ironmaking being sensitivity to electricity price and availability, hence various studies investigating the potential for locating these facilities where low-cost renewable energy is available, preferably in locations with iron ore deposits, in order to develop green iron or steel as a value-added commodity (Bilici et al., 2024; Ellersdorfer et al., 2024; Lopez et al., 2023; Rhee et al., 2024; Trollip et al., 2022).

Various electric smelting furnaces concepts are also being explored, but commercial deployment is limited to EAF in ferrous industry, which can approach net-zero emissions with scrap and/or H_2-DRI when operated with renewable power. The estimated CO_2 reduction possibilities are summarized in Figure 6.



Source: Author's own compilation based on data from external sources (Material Economics, 2019; MPP, 2022; Amand et al., 2024)

Figure 6: Estimated CO_2 emissions for various technologies

The most promising technologies, however, require substantial investment in the associated renewable power generation, grid capacity and hydrogen infrastructure to supply green electricity and hydrogen at cost-competitive prices and sufficient volumes to meet the needs of the steel industry. At present, the required infrastructure is not readily available to completely avoid GHG emissions from the steel industry (Graupner et al., 2022).

The incumbent BF-BOF route remains constrained too, as it can only deliver incremental efficiency improvements. The marginal efficiency improvements are insufficient to achieve deep emissions reductions, mirroring the literature's conclusion that sustainability challenges demand structural transformation rather than marginal optimization.

Meeting climate targets requires substantial emissions reductions within the next decade, yet BF reinvestment cycles and long-lead infrastructure projects risk locking in carbon-intensive production until even the 2040s. As the largest industrial emitter, the steel industry is essential for achieving climate goals, particularly given the sector's role in supplying raw materials for renewable energy systems and the expected increase in steel demand.

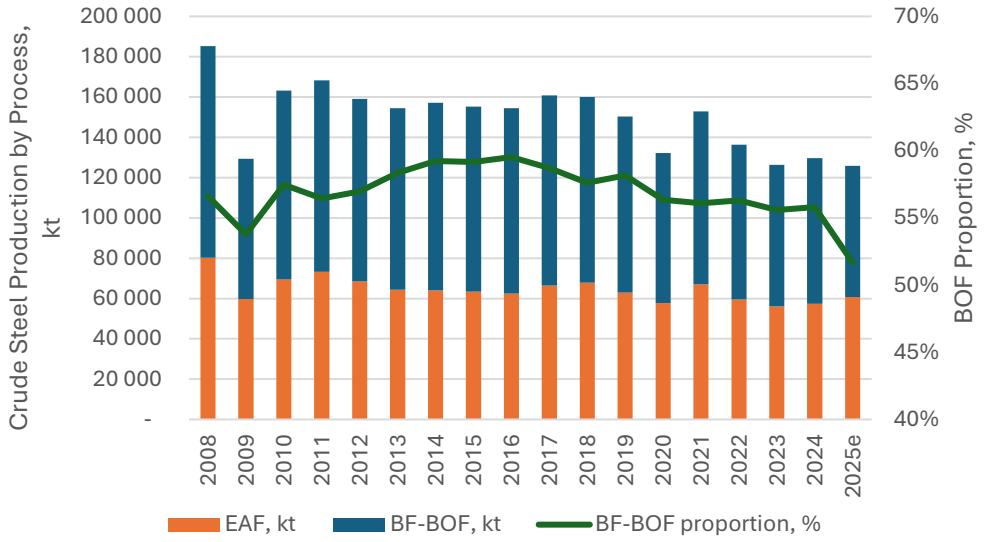
The transition away from incumbent regime depends not only on technological feasibility but also on the wider policy and political context that shapes industry decision making. The pace of progress will depend on the extent to which policy and company decisions can bring forward investments in low-emissions steelmaking (Lopez et al., 2023; MPP, 2022).

3. EU27 - Iron and Steel Sector

The EU has committed to a 55% reduction in the net greenhouse gas emissions level by 2030 (relative to 1990) and to achieve net zero emissions by 2050, in line with the Paris Climate agreement, the European Green Deal, and the Fit for 55 packages (European Commission, 2023, 2025; European Council, 2024).

Although European Union steel production has continued to decline from its peak over the past decade and in 2025 only produced 126 Mt., the industry plays a crucial role in driving economic growth, employment, and innovation.

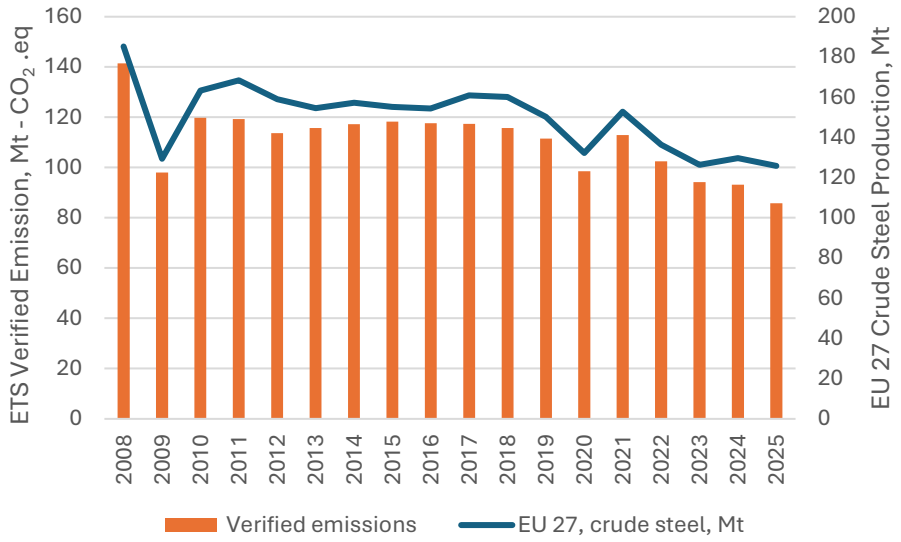
Europe traditionally has many coal-based blast furnaces; the share of the BF-BOF route is already lower than the global average, but it is still above 50% (Figure 7) (IEA, 2020). Most of the blast furnaces are approaching the end of their operating life, meaning that companies must decide between reinvestment in carbon-intensive assets or investing in low-carbon technologies. Considering long asset life, investment decisions will shape technology composition into the 2050s, therefore they are crucial for the decarbonization of the industry (MPP, 2022; Lopez et al., 2023; Choksey et al., 2025).



Source: Author's own compilation based on data from WSA

Figure 7: European Union Crude Steel Production by Process and BF-BOF Route Proportion

Despite the European Union being a global leader in decarbonisation efforts, CO_2 emissions reductions in the iron and steel industry have so far resulted mainly from lower production volumes rather than deployment of low-carbon technologies, as shown in Figure 8.



Source: Author's own compilation based on EU Emissions Trading System (ETS) Data Viewer, 2025

Figure 8: European Union Production of Pig Iron and Steel Historical Emissions

To achieve net-zero, the industry will require deployment of multiple available and emerging technologies. The main issue is not the lack of technological solutions, but the high cost associated with these solutions, affecting market share, trade and labour politics (Fan & Friedmann, 2021).

EU's steel companies have publicly committed to transformation, with integrated steel producers seeking to shift towards greener technologies such as hydrogen-based DRI and electric arc furnaces, maximizing scrap usage and secure partnerships with green iron producers and suppliers of green electricity to meet climate targets of the industry. None of the steel companies are currently considering commercial-scale CCUS with BF-BOF projects (Choksey et al., 2025).

Table 2 summarizes major green iron and steel projects in the EU. However, the initial momentum appears to have slowed, with many projects delayed, postponed or even cancelled (in red), and some of the largest companies reconsidering their low-carbon transformation pathways.

ArcelorMittal's Steel4Future DRI projects in Bremen and Eisenhüttenstadt, Germany, have been cancelled due to increasing steel imports, weak European demand, high energy costs and the lack of competitively priced green hydrogen. The company also suspended its plans for a DRI plant in Dunkirk, France because the investment was unprofitable with the given prices of natural gas and green hydrogen. ArcelorMittal has likewise put on hold its plan for a DRI plant in Gijon, Spain for reasons such as energy cost, political and market uncertainty (Laity, 2025; Yermolenko, 2025a, 2025b).

Table 2

Major Green Iron and Steel Projects in the EU27

Project name	Planned commissioning	Technology to be used	Company	Location
Complementing conventional steelmaking				
Sestao (DRI from Gijon)	2025	BF-BOF to EAF	ArcelorMittal	Spain
Oxelösund mini-mill	2026	BF-BOF to EAF	SSAB	Sweden
Greentec steel – Linz	2027	BF-BOF to EAF	Voestalpine Group	Austria
Greentec steel – Donawitz	2027	BF-BOF to EAF	Voestalpine Group	Austria
Luleå mini-mill	2028	BF-BOF to EAF	SSAB	Sweden
Phasing out BF				
Stegra Boden (formerly H2GreenSteel)	2025	H-DRI	Stegra (formerly H2 Green Steel)	Sweden
Bremen DRI (Steel4Future)	2026- withdrawn	NG-DRI to H-DRI	ArcelorMittal	Germany
Eisenhüttenstadt DRI (Steel4Future)	2026- withdrawn	NG-DRI to H-DRI	ArcelorMittal	Germany
Gijon DRI and EAF	2026 – postponed	H-DRI & EAF	ArcelorMittal	Spain
Hydnum Steel (Ph.1)	2026	H-DRI	Hydnum Steel	Spain
H-DRI Dunkirk	Withdrawn Now planned	NG-DRI to H-DRI EAFs in Dunkirk	ArcelorMittal	France
The Blastr Green Steel Project	2027	H-DRI	Blastr Green Steel	Finland
tkH2Steel	2026- curtailed 2028	NG-DRI to H-DRI NG-DRI	ThyssenkKupp	Germany
GravitHy	2028	H-DRI	GravitHy	France
ArcelorMittal Belgium DRI	2030	NG-DRI to H-DRI	ArcelorMittal	Belgium
SALCOS	2033 (delayed)	H-DRI	Salzgitter Group	Germany
Power4Steel (Pure Steel+ brand)	2045	NG-DRI to H-DRI + EAF	Stahl Holding Saar GmbH	Germany
Demo Plant				
HYBRIT	2026	H-DRI	LKAB, SSAB, Vattenfall	Sweden

Source: Author's own compilation based on data from Green Steel Tracker, 2026

ThyssenKrupp's tkH2Steel project has been curtailed to a natural gas-based process due to higher than expected hydrogen price and slow development of the hydrogen sector (Burgess, 2025). Salzgitter has also postponed the next stages of its SALCOS project for three years, again due to hydrogen market conditions and lack of promised regulatory changes by governments (Yermolenko, 2025b).

Even though BF-BOF conversion to EAF is technically proven and already occurring in the EU and other jurisdictions, the current landscape in the EU does not provide sufficient support to deploy or accelerate these transitions at the necessary scale. The EU is already a global leader in green innovation such as Hybrit and Stegra, demonstrating technical feasibility (LeadIT, 2026). However, firms cite similar constraints across projects. Policy and market uncertainty is linked to EU ETS and CBAM reforms; weak market demand for premium-priced green steel reflects the limited scope of public procurement; and high energy and hydrogen prices, combined with slow infrastructure development connected to gaps in renewable expansion, hydrogen strategies and permitting processes.

Taken together, these developments reveal a structural mismatch between the scale of technological transformation required for steel industry decarbonisation and the EU's predominantly incremental policy preferences.

4. EU Policies Supporting Low-Emitting Technologies

The EU relies on policy instruments designed to promote low-emitting technologies and exert pressure on the incumbent BF–BOF regime. This section presents the relevant policies and examines the potential issues with their effectiveness, helping to explain why these measures have not translated into lower specific emissions in the steel sector.

4.1. Carbon Pricing

Carbon pricing, such as the EU ETS, is one of the policy tools aimed at incentivising the shift towards lower-emitting technologies and support carbon reduction technologies, to create a viable business case for low-CO_2 steelmaking technologies.

The EU ETS works on the principle of a "cap and trade" system. It sets benchmark values of emitted carbon, above which the companies must pay a proportion of the additional pollution generated. (EU, n.d.) EU Allowances (EUAs) are a type of carbon allowance that permits companies covered by the EU ETS to emit a certain amount of CO_2 equivalent. The cap on the total number of available allowances guarantees their value. The price of EUAs should encourage emissions reductions and promote investment in innovative, low-carbon technologies.

While Europe is leading the way in regulatory reform, the steel industry enjoys free ETS allowances for most of its production volumes. Concerns about losing competitiveness on global markets, as well as carbon leakage, have been the main reasons behind carbon price exemptions observed for the steel sector (OECD, 2022).

Although rising carbon costs would impose significant pressure on incumbent processes, the continued use of free allocation dampens these incentives and slows structural change, reflecting a gradual, step-by-step compromise that embodies Lindblom's incrementalism argument and protects the competitiveness of the incumbent industry.

4.2. CBAM

As carbon prices increase, shipping steel products from non-EU countries could become attractive despite transport costs (Lehne & Sartor, 2020). Exporting emissions would undermine climate change initiatives and cause economic damage. Therefore, the EU became the first to introduce measures to address the issue with the Carbon Border Adjustment Mechanism (CBAM).

The CBAM equalises the price of carbon between domestic products and imports to ensure their equal treatment by applying a tariff on emissions embedded in goods produced outside the EU ETS. Since the ETS currently assigns free allowances to protect industrial competitiveness, these must be phased out as the CBAM is phased in to comply with World Trade Organization rules.

The CBAM phase-in plan gradually ends the free allocation of EU ETS allowances over a nine-year period, with CBAM applying only to the proportion of emissions not covered by free allocation during this transition (EC, 2025; Tiseo, 2024).

This considerably long transitional phase reflects a deliberate, step-by-step political compromise, consistent with Lindblom's incrementalism argument, and continues to protect incumbent technologies.

4.3. Green Public Procurement

Changing customer requirements and growing demand for low-carbon steel products can be observed already in various industries. Customers' willingness to recognise the value of green steel products and pay for decarbonization through "green premiums" can drive the shift to more sustainable production technologies. There is a need to strengthen "demand pull" for green steel from downstream industries and increase confidence that the premium can be passed to end consumers (Hoffmann et al., 2020; Åhman et al., 2023; Perez et al., 2025).

Green Public Procurement (GPP) is a process for public authorities to obtain products that have a lower environmental impact throughout their life cycle. However, existing GPP regulation rules are not unified and mainly voluntary at the present in the EU, so they do not provide enough to stimulate demand (EC, n.d.).

The EU is proposing minimum mandatory GPP criteria in sectoral regulation, but for effective changes well-coordinated policies, such as material-efficiency building codes, design & recyclability policies are needed at national and international levels (Bataille, 2020; Åhman et al., 2023; EC, n.d.).

4.4. Steel Scrap

Recycling steel generates significantly fewer emissions than primary production; therefore, steel scrap is a strategic source of low-carbon raw material with significant economic value. The EU is the biggest exporter of steel scrap, but with the transition to EAFs a steady supply of large amounts of high-quality scrap will be required (JRC, 2025; Lee et al., 2026).

Regulations are planned to 'onshore' the supply of scrap and incentivise domestic consumption, but non-EU buyers often offer better prices, causing high-quality scrap to leave the EU. Hence, there is an ongoing debate about restrictions, as conflicting interests between steel producer and the recycling industry have delayed any decision-making (Hansen, 2025; Pickens, 2023).

The quality of the steel scrap is also important, as products from the BF-BOF process route have traditionally higher quality, hence clearer classification and harmonised waste regulations are required to improve sorting and treatment (EUROFER, 2020; JRC, 2025). While the legislative framework is evolving, the shifts are only incremental and so far achieved modest results (Grabbe & Moffat, 2024).

4.5. Renewable Power

To deploy low-carbon technologies of the iron and steel industry, policies are required to support the development of renewable power generation capacity, such as wind, solar and biomass, as well as nuclear power (Toktarova et al., 2022; Superchi et al., 2023; Fuhrlaender et al., 2025).

It is a significant challenge to match variable electricity supply from renewable energy sources with the demand from electric arc furnaces and electrolysers. Renewable energy deployment is also limited by grid connection issues, permitting can take a long time causing delays in grid capacity required for both EAFs and H_2 electrolysers (Superchi et al., 2023; Toktarova et al., 2022).

Beyond availability, low energy cost is also essential for supporting the green transition. The EU is preparing the EU Electrification Plan and AccelerateEU packages as a response to energy-price volatility, presenting measures to improve system efficiency, replace fossil fuels and stimulate investment in clean energy (Bolotova et al., 2026; EC, 2026). However, due to repeated delays, deadlines are being missed, creating a situation where these initiatives are losing momentum.

4.6. Hydrogen Economy

Hydrogen infrastructure is an emerging alternative energy infrastructure that includes green H_2 production, storage, transportation and utilizing gases rich in hydrogen. (Johnson et al., 2025). Most hydrogen developments are in their early stages. Although the EU laid out a roadmap ensuring the scaling up of renewable hydrogen production, establishing the logistical infrastructure and storage facilities in 2020, lawmakers approved only around 100 hydrogen projects in April 2026, including electrolysers and pipelines. As a result, the infrastructure rollout remains slow and fragmented (IEA, 2023; OECD, 2025; Hydrogen Infrastructure, 2026).

Also, it should be noted that before hydrogen can be widely adopted, robust safety measures must be developed to ensure secure and reliable utilization (Sun et al., 2024).

Today's hydrogen production technologies operating at commercial scale do not yet deliver affordable green hydrogen. Nonetheless, hydrogen needs to be cost-competitive, sustainable and available at scale in order to be used widely in the steel industry (Shahabuddin et al., 2023; Sun et al., 2024). This challenge is linked back to the price and availability of renewable energy, reinforcing existing sectoral lock-ins that continue to slow transformative change.

5. Conclusions

The analysis shows that the existing BF-BOF regime remains the dominant configuration in the EU iron and steelmaking. Although climate and sustainability targets create momentum for change, specific policy instruments intended to exert pressure on the incumbent regime remain insufficient.

Circular economy and CO_2-reduction measures largely deliver incremental improvements within the existing system. By contrast, only niche pathways such as direct carbon-avoidance innovations have the potential to challenge the incumbent regime. However, the way policy instruments are implemented to support niches still reflects the broader pattern of policy incrementalism.

Carbon pricing, CBAM, green procurement, steel scrap developments, renewable and hydrogen infrastructure plans are designed to exert pressure on high-emission technology routes. However, across the EU policy landscape, a consistent pattern of political compromise is visible, such as free allocation under EU ETS, the nine-year CBAM phase-in, voluntary GPP rules, delayed scrap regulations and slow permitting processes for renewables and hydrogen infrastructure.

Together, these reflect political constraints that slow the pace of change. More ambitious sustainability measures can provoke resistance, shape the politics of climate policy and slow transformation. These political dynamics help explain why policy instruments may signal a shift in expectations, while their slow and incremental implementation, combined with exemptions and transitional arrangements, often reinforces lock-ins rather than destabilise the regime.

As a result, EU policy instruments reshape expectations without yet enabling structural transformation. This illustrates how the myth of incrementalism obscures the transformative change required for viable green decarbonisation pathways in the steel sector. This interpretation is conceptual, because the study examines policy instruments and sectoral pathways, not political behaviour. In conclusion, stronger and more transformative policy interventions, aligned with long-

term strategic frameworks, are required to enable a meaningful shift away from the incumbent regime. This is especially urgent because current investment decisions carry long-term lock-in effects that will shape the emissions trajectories for decades to come.

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Generative AI Declaration Statement

If AI was used:

During the preparation of this manuscript, the author(s) used CoPilot for the purpose of identifying related sources for the literature review, refining the academic tone, and correcting grammar and punctuation. The author(s) subsequently reviewed and edited the content as necessary, maintained full human oversight of the process, and assume full responsibility for the accuracy and integrity of the published work.

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Data availability statement

The data that support the findings of this study are available from the corresponding author (Beáta Buró, burobea@hotmail.com) upon reasonable request.

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The Relationship between Financial Structure and Accounting Performance: A Benchmark Study of a Sample of Companies Listed on the Algiers Stock Exchange during the Period 2017–2024

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SUMMARY

This study aimed to examine the impact of financial structure—measured by the equity ratio, the debt-to-equity ratio, and the long-term assets ratio—on accounting performance measured by the return on assets. The study relied on (panel data) comprising 40 observations obtained from the financial statements of a sample of five (05) companies listed on the Algerian stock market over an eight (08)-year period from 2017 to 2024. To analyze the data and test the study's hypotheses, the study relied on descriptive and inferential statistical analysis methods using Eviews 14.SV software. The results showed that the equity ratio, the debt-to-equity ratio, and the long-term assets ratio have a statistically significant inverse relationship with accounting performance, as measured by the return on assets. In light of these results, the study recommends that the companies under study adopt a specific policy to maintain a balanced financial structure.

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1. INTRODUCTION

The financial structure, or capital structure, refers to how a company finances its assets and operations through debt, equity, or a combination of both. The financial structure is one of the most important strategic decisions in an organisation because it is linked to its fundamental purpose: maximising its value to ensure its survival and continuity (Priyanka & Singh, 2022). Financial performance is also considered one of the most important indicators of a company's success, as it reflects its ability to generate profits and financial returns and to utilise its resources efficiently. Capital structure decisions affect a company's ability to finance growth and its efficiency in dealing with economic uncertainty (Gautam et al., 2025).

The theoretical framework for financial structure and financial performance is based on the idea that financing decisions are central to corporate finance; firms must choose how to finance their operations and growth through debt, equity, and related instruments, making financial structure both a financing choice and a risk choice for the firm (Oluwaleye et al., 2021).

The theoretical importance of this topic lies in the fact that financing decisions are typically made to maximize wealth; thus, the quality of a company's financing choices is often evaluated based on their impact on the company's value and financial performance, Consequently, many studies use concepts such as profitability, revenue generation, and optimal asset utilization to assess performance and determine whether the chosen financing mix benefits or harms the company (Gharaibeh & Sarea, 2015).

Numerous researchers have conducted studies on this topic in both developed and developing countries, such as Algeria, to determine the relationship or impact between financial structure and financial performance, using various samples and time periods and applying multiple statistical methods. Given the varied and conflicting results of these studies, this research aims to shed light on this aspect by conducting a benchmark study on a sample of companies listed on the Algerian Stock Exchange from 2017 to 2024. Accordingly, the research question was formulated as follows:

To what extent does financial structure affect the financial performance of companies listed on the Algerian Stock Exchange during the period 2017–2024?

2. Theoretical Framework and Previous Studies

2.1. Financial Structure

2.1.1. The Concept of Financial Structure

Numerous definitions have emerged due to differing opinions among authors and researchers in financial management regarding the concept of "financial structure". Fabozzi and Peterson Drake (2009) define it as the process of combining debt and equity to finance a company's projects; In other words, it encompasses all sources of long-term and short-term financing, which are known in accounting as liabilities on the balance sheet—representing the total obligations incurred by the company in exchange for its total assets.

Moyer et al. (2006) also defined it as how a company finances its assets using all available resources. Generally, companies finance only a portion of their assets with equity capital (common stock, preferred stock, retained earnings, and reserves). In contrast, the remainder is financed by debt and other short-term liabilities.

Ali et al. (2015) identified five important factors that determine a company's optimal capital structure: cost, risk, control, flexibility, and timing. The financial planning process is one of the key aspects in shaping the capital structure; it determines whether these needs will be met from internal resources or through external financing sources, such as long- or short-term debt, the issuance of preferred or common stock, or other sources of financing.

2.1.2. Theories of Capital Structure

Capital structure is one of the most controversial issues in business; consequently, various theories have been proposed to explain it. Some theories acknowledge the existence of an optimal capital structure, while others reject this notion. Among the most important of these theories are:

2.1.2.1. The Traditional Theory

The traditional theory is based on the premise that there is a relationship between a company's capital structure and its value. In other words, the way a firm finances its operations through debt and equity affects its total value. This theory advocates the rational use of debt to increase the firm's value on the one hand and minimise the risks resulting from increased debt on the other. Therefore, corporate decision-makers must consider how to balance capital structure, firm value, and dividend policy (Lumby & Jones, 2015).

2.1.2.2. Modigliani and Miller's Theory

In 1958, Modigliani and Miller published their theory, known as the "irrelevance of capital structure" theory, This theory is based on a set of assumptions: that all internal and external parties to the company have access to the same information (information symmetry); that the cost of debt equals the cost of equity; and that the company's earnings before interest and taxes (EBIT) are not affected by the method of debt financing, In other words, increasing debt in the capital structure will lead to a decrease in the weighted average cost of capital (WACC) due to the lower cost of borrowing; and as equity increases, that increase will be exactly equal to the extent to which the lower cost of borrowing is offset, thereby keeping the WACC constant.

Following numerous criticisms of the theory, Modigliani and Miller announced a modification to their previous hypothesis in 1963, in which the two scholars took tax benefits into account as determinants of the financial structure; since increased leverage allows a company to enhance its value and performance thanks to the tax deductibility of interest payments (Lawal et al., 2014).

2.1.2.3. Equilibrium Theory

In 1984, Myers and Majluf addressed this theory, which advocates prioritising a company's own resources (internal financing) when funding new projects; if retained earnings are insufficient for financing, borrowing (such as issuing bonds) is preferred to issuing new equity shares. According to this theory, the cost of capital structure is a key factor, with priority given to internal sources of financing, followed by the lowest-cost financing (debt), while issuing new common stock is the last resort due to its high cost (Muritala, 2012).

2.2. Financial Performance

Financial performance is considered one of the most important indicators used to measure a company's success, as it reflects its ability to generate profits and financial returns and to utilize its resources efficiently; it serves as a mirror that reflects the company's activities and achievements, Financial performance also represents the narrow concept of corporate performance, as it focuses on using financial indicators to measure the extent to which objectives are achieved. It serves as the primary driver of the various business activities carried out by the company and contributes to making financial resources available and providing the company with investment opportunities in different areas of performance, which help meet the needs of stakeholders and achieve their objectives (Kim et al., 2021); Consequently, it reflects the company's financial position over a specific period, including the raising and use of funds—aspects that can be measured through various indicators such as return on assets, return on equity, capital adequacy ratio, and solvency ratio (Van Horne & Wachowicz, 2008).

Based on the above definitions, we conclude that financial performance is a tool used to assess and understand a company's financial condition over a specific period of time—that is, to determine its efficiency in utilising available resources, on the one hand, and the extent to which it achieves its objectives, on the other.

2.3. Review of Previous Studies

Previous studies serve as the scientific foundation upon which the researcher relies to enrich the study and distinguish it from prior research; the researchers reviewed numerous studies relevant to the topic, which will be presented in chronological order from oldest to most recent:

- ✓ **Study (Vo & Ellis, 2017):** This study examined the relationship between capital structure and shareholder value in Vietnam, using accounting data from companies listed on the Ho Chi Minh City Stock Exchange during the period 2007–2013. It reached a number of conclusions, the most notable of which was the existence of an inverse relationship between leverage and shareholder value, indicating that the cost of debt financing exceeds the expected return for Vietnamese companies.
- ✓ **Study (Le & Phan, 2017):** This study used unbalanced cross-sectional data for all non-financial listed companies during the period 2007–2012 to examine the impact of capital structure on corporate performance in Vietnam. The results showed a strong negative relationship between all debt ratios and firm performance. This finding is inconsistent with most studies conducted in developed countries, which assume a positive relationship between capital structure and firm performance; however, it is consistent with some studies in the context of emerging markets.
- ✓ **Study (Siddik et al., 2017):** This study examined the impact of financial structure on the profitability of 22 banks in Bangladesh during the period (2005–2014) using panel data models, and the study reached a set of findings, the most important of which is that the ratios of domestic assets (SLA) and long-term domestic assets (LLA) have a significant negative effect on return on assets (ROA). Furthermore, the long-term local asset ratio (LLA) has a significant positive effect on return on equity (ROE), while the short-term local asset ratio (SLA) has a significant negative effect. Meanwhile, the control variables—size, growth rate, and inflation—have a positive effect on the dependent variables, whereas liquidity and real GDP growth have a negative effect.
- ✓ **Study (Nguyen & Nguyen, 2020):** This study aimed to investigate the variation in the impact of capital structure on performance between state-owned and non-state-owned firms listed on the Vietnamese stock market, and relied on panel data for a sample of 488 non-financial firms listed on the Vietnamese stock market over a six-year period (2013–2018). The results showed that capital structure has a statistically significant negative effect on firm performance, and also indicated that this effect is stronger in state-owned companies compared to non-state-owned companies in Vietnam.
- ✓ **Study (Dinh & Pham, 2020):** This study examines the impact of capital structure on the financial performance of pharmaceutical companies listed on the. Data was collected for the period from 2015 to 2019 for all 30 pharmaceutical companies listed on the Vietnamese stock market. A simple linear regression model was used to test the impact of capital structure on the companies' financial performance. The results of the analysis showed that the

leverage ratio, the ratio of long-term assets, and the debt-to-assets ratio are positively correlated with company performance, while equity financing has a negative effect on return on equity.

- ✓ **Study (Ngoc et al., 2021):** This study examined the impact of capital structure on the operating performance of 25 real estate companies listed on the Ho Chi Minh City Stock Exchange (HOSE) during the period from 2011 to 2018. The results showed that capital structure has a negative effect on operating performance. In addition, the study revealed that tangible assets (TANG) have a positive effect on the performance of real estate companies, a result that is consistent across the three regression models used using the applicable generalized least squares (FGLS) method; this suggests that as the tangible fixed assets of listed real estate companies increase, the efficiency of their operational performance improves. As for the control variables—which included firm size (SIZE), liquidity (LIQ), asset growth (GROWTH), economic growth (GDP), and the inflation rate (INF)—the study did not find sufficient evidence to conclude that there is a relationship between these variables and operational performance.
- ✓ **Study (Arhinful et al., 2023):** The study aimed to examine the impact of capital structures (represented by capitalization ratios and debt-to-EBITDA ratios —EBITDA—on the financial performance of Ghanaian financial institutions. The study selected 15 financial institutions in Ghana using a purposive sampling strategy; ten (10) of these institutions were listed on the Ghana Stock Exchange, while the remaining five (5) were unlisted. Data were collected from the audited annual reports of these institutions and analyzed using the "Stata" software in accordance with the fixed-effects and random-effects models. The Hausman test was also used to determine the most appropriate method for presenting the study's results, and it was found that the random-effects model was the most suitable. The results showed that the capitalization ratio has a negative effect on the net interest margin, the loan-to-assets ratio, and the return on assets. With regard to the debt-to-EBITDA ratio, it was found to have a negative effect on the net interest margin and return on assets, while having a positive effect on the loan-to-assets ratio; it was also found that this ratio has a statistically significant effect on both the net interest margin and return on assets.
- ✓ **Study (Javaid et al., 2024):** This study aims to explore the impact of ownership structures on corporate performance and, consequently, on the country's overall economic prosperity; for it is undeniable that well-performing commercial banks play a role in promoting economic growth. A company's ownership structure is responsible for defining and distributing authority among management. Given that the relationship between ownership structure and the performance of commercial banks in Pakistan has not been studied previously, this study seeks to fill this gap by examining data from 20 banks listed on the Pakistan Stock Exchange during the period from 2010 to 2021, using a panel regression model with fixed effects. The results confirmed that ownership structure has a significant positive impact on performance. The study emphasizes the importance of prioritizing and achieving an optimal ownership structure to enable banks to achieve their strategic objectives and enhance their resilience, thereby ensuring their sustainability, through improved governance practices.

2.4. What Distinguishes the Current Study from Literature Review

A review of the existing literature reveals that the relationship between financial structure and accounting performance has received extensive research attention, both in developed economies and emerging markets. Furthermore, many studies have used data from listed companies and panel data models to analyze this relationship. Therefore, the research gap does not lie in the absence of previous studies on the subject, but rather in the limited number of studies that have examined this relationship in the context of companies listed on the Algiers Stock Exchange, particularly given the limited number of listed companies and the diversity of the sectors to which they belong.

Furthermore, a review of the literature reveals clear differences in the indicators used to measure financial structure, financial and accounting performance, and the standard models employed, as well as inconsistent results in previous studies regarding the direction of the relationship between financial leverage and performance indicators. Accordingly, the present study seeks to provide additional empirical evidence from the Algerian context, while clarifying the limits of the generalizability of the results given the characteristics and size of the sample.

3. RESEARCH METHODOLOGY

3.1. Study Design and Methodology

This study falls within the category of applied quantitative studies aimed at analyzing the relationship between the financing structure and the accounting performance of companies listed on the Algiers Stock Exchange during the period from 2017 to 2024. The study relied on a standard analytical approach, utilizing panel data, which allows for the simultaneous utilization of both the cross-sectional and time-series dimensions of the data.

It should be noted that the study does not treat all observations as statistically independent, since consecutive years for the same firm represent partially correlated observations. Consequently, the basic unit of analysis is the firm-year, rather than the firm as an independent observation in each instance. Furthermore, the results are interpreted within the context of the five firms included in the sample and are not generalized absolutely to all Algerian firms.

3.2. Study Population and Sample

The study population consists of companies listed on the Algiers Stock Exchange for which financial data were available during the study period. According to the data used in the study, the study population comprised eight (08) companies, three (03) of which (Mestashir, the Algerian People's Bank, and the Local Development Bank) were excluded due to their recent listing and the lack of a complete time series that would allow for the construction of a balanced data set for the period under study.

The following (Table 1) is an overview of the companies comprising the study sample:

Table 1

Companies Representing the Study Sample

ISIN Code	Stock Exchange Ticker	Company Name	Sector / Category	Nominal Value (DZD)	Number of Shares
DZ0000010037	ALL	Alliance Assurances	Insurance	380	13,930,826
DZ0000010029	AUR	EGH El Aurassi	Hospitality	250	6,000,000
DZ0000010003	SAI	Saidal	Pharmaceutical Industry	250	10,000,000
DZ0000010052	BIO	Biopharm	Pharmaceutical Industry	200	25,521,875
DZ0000010060	AOM	AOM Invest	Tourism	100	4,596,030

Source: Prepared by the researchers based on the Algiers Stock Exchange website, available at: https://www.sgbv.dz/ar/ Accessed on April 5, 2026.

This resulted in the creation of a balanced data panel consisting of five companies × eight years, i.e., 40 company-year observations; however, this number does not imply the existence of 40 independent units, but rather represents 40 observations distributed across five cross-sectional units over eight years.

3.3. Study Variables and How They Are Measured

Based on the existing literature and the nature of the data available for the companies under study, accounting performance was identified as the dependent variable, while financial structure was represented by a set of financial ratios extracted from the financial statements.

A. Dependent Variable: Accounting Performance

Financial performance is not viewed in this study as a one-dimensional concept, but rather as a concept that can be measured using a set of accounting indicators. Given the nature of the available data and the study's objective regarding the efficient use of resources and assets, the return on assets (ROA) was adopted as an indicator of accounting performance.

This indicator reflects a company's ability to generate profits from the resources it possesses; therefore, it is appropriate for measuring accounting efficiency in the use of assets. However, the use of ROA does not imply that it is a comprehensive measure or a substitute for market performance, as market performance can, in turn, reflect investor expectations and changes in the company's market value.

Accordingly, the use of ROA in this study should be understood as an accounting performance indicator rather than a comprehensive measure of the company's value or its performance in the stock market.

B. Independent Variables: Financial Structure

Financial structure was measured using three indicators: the self-financing ratio, the leverage ratio, and the long-term assets ratio.

• **Self-Financing Ratio (SF):** This ratio measures the extent to which a company relies on its own resources to finance its assets;

• **Leverage Ratio (LR):** Leverage reflects the degree to which a company relies on debt financing relative to its equity; for the purposes of this study, the formula should conform to the theoretical definition used in the literature and the source of the variable, and the formula should be standardized for all companies and years.

• **Long-Term Assets Ratio (LTR):** This ratio measures the relative weight of long-term assets within the company's total assets.

Table 2 illustrates the method used to measure the study variables.

Table 2

Method of Measuring Study Variables

Variable Nature	Code	Name	Calculation Method	Source
Independent Variable	SF	Self-Financing Ratio	Equity / Total Assets	(Trinh et al., 2022)
	LR	Leverage Ratio	Total Debt / Equity	(Bhullar & Gupta, 2017)
	LTR	Long-Term Asset Ratio	Fixed Assets / Total Assets	(Ngoc Minh, 2020)
Dependent Variable	ROA	Return on Assets	Net Income / Total Assets	(Alshammari et al., 2024)

Source: Prepared by the researchers based on relevant previous studies.

3.4. Hypotheses and Research Model

To achieve the study's objectives and address its research question, the following main hypothesis was formulated:

H1: There is a statistically significant positive relationship between the financing structure and the accounting performance of companies listed on the Algiers Stock Exchange during the period 2017–2024.

The following sub-hypotheses stem from this main hypothesis:

There is a statistically significant positive relationship between the equity financing ratio and the return on assets for companies listed on the Algerian stock market;

There is a statistically significant positive relationship between the financial leverage ratio and the return on assets for companies listed on the Algerian stock market;

There is a statistically significant positive relationship between the long-term asset ratio and the return on assets for companies listed on the Algerian stock market.

Based on the theoretical framework and previous studies, a standard model was formulated to test the relationship between financial structure indicators and the accounting performance of the companies under study.

The basic equation takes the following form:

$$ROA = \beta 0 + \beta 1*SF + \beta 2*LR + \beta 3*LAR + \varepsilon$$

Where:

ROA: Return on Assets

SF: Equity Ratio

LR: Leverage Ratio

LTR: Long-Term Assets Ratio

β0, β1, β2, β3: Estimation coefficients

ε: Random error

3.5. Statistical Analysis Tools Used in the Study

After completing the analysis of the companies' annual financial reports as outlined in the study model, the data was processed to extract the study variables using Excel. The panel data method, which is suitable for this type of study, was applied using the statistical software Eviews 14.SV. The following is an explanation of the statistical methods used in the study:

- Descriptive statistics, calculated by determining the arithmetic mean, standard deviation, maximum value, and minimum value for all study variables, where:
  Mean: to calculate the average values of the financial structure and accounting performance variables across the companies under study.
  Standard deviation: to measure the degree of variation of the data around the mean in order to assess the stability of the study variables.
- Normal distribution of the data, through the Skewness and Kurtosis tests and the Shapiro-Wilk test.
- Pearson's correlation coefficient to calculate the correlation among all study variables, determine the nature of the relationship between them, and assess its statistical significance.
- The Levin et al. (2002) unit root test to verify the temporal stability of the study data.
- Testing for linear multicollinearity among the study variables using the VIF and Tolerance tests to determine whether there is multiple linear correlation among the independent variables, which could affect the reliability of the model.
- The test for heteroscedasticity to determine whether the variances of the errors are constant or vary across segments.
- The Hausman test was conducted to select the appropriate model—whether a fixed-effects or random-effects model is most suitable for the analysis.
- Multiple linear regression was performed to examine the simultaneous effect of a set of independent variables on the dependent variable.

4. Results and Discussion

4.1. Descriptive Statistics Analysis

Table 3 shows that the return on assets ranges from 0.0665 (the minimum value) to 0.1359 (the maximum value), with an arithmetic mean of 0.0334 and a standard deviation of 0.0469, The results indicate variation in the ROA values, reflecting differences in the financial performance of the companies in the study sample. The standard deviation also indicates significant dispersion in the results, reflecting heterogeneity in the financial performance of these companies.

Table 3

Results of the Descriptive Analysis

Variables	Minimum	Maximum	Mean	Standard Deviation
ROA	-0.0665	0.1359	0.0334	0.0469
SF	0.2712	0.6138	0.4274	0.0974
LR	0.3702	2.6458	1.0042	0.4479
LTR	0.0959	0.9205	0.5554	0.2253

Source: Prepared by the researchers based on the output of the Eviews 14 program

As for the self-financing ratio, it ranges from a minimum of 0.2712 to a maximum of 0.6138, with an arithmetic mean of 0.4274 and a relatively low standard deviation of 0.0974. Based on the results, we can conclude that the companies under study are similar in their external financing policies, as indicated by the relatively low standard deviation, while the arithmetic mean shows that reliance on self-financing was moderate.

The leverage ratio ranges from a minimum of 0.3702 to a maximum of 2.6458, with an arithmetic mean of 1.0042 and a standard deviation of 0.4479. This indicates a variation in reliance on internal and external financing, with a balance between the sources of financing; given the large standard deviation, this suggests that financing policies are not uniform among the companies under study.

As for the ratio of long-term assets, it ranges from 0.0959 as the minimum value to 0.9205 as the maximum value, with an arithmetic mean of 0.5554 and a standard deviation of 0.2253. The results show diversity in investment among the companies, with a preference for long-term assets.

4.2. Test of Normal Distribution

A test of normal distribution was conducted for the study variables, which are presented in the following table.

Table 4

Test of Normal Distribution for the Study Variables

Variables	Skewness	Kurtosis	Shapiro–Wilk	Significance (p-value)
ROA	0.2017	3.1749	0.9522	0.0905
SF	0.4336	2.2727	0.9478	0.0636
LR	1.2763	6.1860	0.8979	0.0017
LTR	-0.5390	2.2979	0.9428	0.0431

Source: Prepared by the researchers based on the output of Eviews 14.

Table 4 shows that the skewness coefficient for the ROA variable recorded a value of 0.2017, which is close to zero, reflecting a slight right-skewness, while the SF variable recorded a value of 0.4336, indicating a limited degree of positive skewness. The LR variable recorded the highest skewness value of 1.2763, indicating a clear positive skew in its distribution, while the LTR variable recorded a negative value of-0.5390, reflecting a limited negative skew.

As for the kurtosis coefficient, its value was 3.1749 for ROA, 2.2727 for SF, 6.1860 for LR and 2.2979 for LTR. It should be noted that the kurtosis value for LR is relatively high compared to the reference value for a normal distribution, which is consistent with the high skewness coefficient and indicates that the distribution of this variable is more concentrated and has sharper tails compared the normal distribution.

As for the Shapiro-Wilk test, the p-value for the ROA variable was approximately 0.0905, and for the SF variable, approximately 0.0636; both are greater than 0.05, allowing us to accept the null hypothesis of a normal distribution at the 5% level.

As for the LR variable, it recorded a p-value of 0.0017, which is less than 0.01, confirming that it does not follow a normal distribution.

As for LTR, its p-value was 0.0431, which is slightly less than 0.05, leading to the rejection of the null hypothesis of normal distribution for this variable.

In general, the results of the normality test do not pose an obstacle to estimating the panel data model used in the study, as the normal distribution of the variables is not a necessary condition for obtaining consistent estimates of the panel model coefficients. However, given the small sample size and the presence of some deviations from the normal distribution—particularly in the LR variable—the reliability of the statistical inference was enhanced by using robust standard errors in the final model.

4.3. Testing the Correlation Among Study Variables

It is evident from the matrix of correlation coefficients among the study variables shown in Table 5 as follows:

There is a strong inverse correlation between the return on assets and the ratio of long-term assets, with a correlation coefficient of 0.7156—which indicates that an increase in investment in long-term assets is accompanied by a decrease in the efficiency of asset utilization in generating profits.

There is a weak negative correlation between the return on assets and the leverage ratio, with a correlation coefficient of 0.1595—indicating that reliance on debt leads to increased costs and thus has a negative impact on performance results.

As for equity financing and return, there is a moderate inverse relationship (0.4124). This indicates that companies' excessive reliance on their own funds to finance their activities may cause them to miss out on the opportunity to generate significant profits.

There is no statistically significant correlation between the independent variables, as the P-values are greater than 0.05.

Table 5

Results of the Correlation Test

		ROA	SF	LR	LTR
ROA	Pearson	1			
	Sig				
SF	Pearson	-0.4124	1		
	Sig	0.000			
LR	Pearson	-0.1595	-0.4519	1	
	Sig	0.001	0.005		
LTR	Pearson	-0.7156	0.4041	0.1536	1
	Sig	0.076	0.000	0.003	

Source: Prepared by the researchers based on the output of Eviews 14

4.4. Testing the Stationarity of the Study Data

Before using cross-sectional time-series data, it is necessary to ensure that the time series used in the model are stationary by testing for the unit root using the statistical test (Levin et al., 2002). Table 6 shows that most of the variables in the study are stationary at the first level, as the P-value is less than 0.05, which supports their direct use in the panel model. However, the LLC results should be interpreted with caution due to the small sample size.

Table 6

Stability Test Results

Variables	Test Statistic	Significance Level (p-value)
ROA	-7.3902	0.0243
SF	-6.6142	0.0074
LR	-3.5314	0.0002
LTR	3.8033	0.0000

Source: Prepared by the researchers based on the output of Eviews 14

4.5. Testing for Linear Interaction Among Independent Variables

Table 7 shows the results of the linear multicollinearity test, indicating that all independent variables fall within statistically acceptable limits, with VIF values ranging from 1.4393 to 1.7661. Consequently, the variance inflation factor (VIF) values are less than 10, and all tolerance values are greater than 0.3055, which confirms that there is no multicollinearity among the independent variables.

Table 7

Results of the Linear Interdependence Test

Independent Variables	Variance Inflation Factor (VIF)	Tolerance
SF	1.7661	0.4338
LR	1.5134	0.3392
LTR	1.4393	0.3055

Source: Prepared by the researchers based on the output of Eviews 14

4.6. Test for Heteroskedasticity

The results of the test for heteroskedasticity across firms, as shown in Table 8, indicate that the p-value for the test was 0.021734, which is less than the significance level of 0.05. This indicates that the null hypothesis—which states that variances are homogeneous across firms—is rejected, and thus there is heteroscedasticity among firms. Meanwhile, the results of the test for heteroscedasticity over time showed that the p-value was 0.002392, which is also less than the significance level of 0.05, indicating the presence of heteroscedasticity across time periods.

Table 8

Results of the Test for Heteroscedasticity

Test Type	Test Statistic	Probability (Prob.)
Modified Wald Test (Groupwise)	13.1816	0.021734
Breusch–Pagan Test	18.4892	0.002392

Source: Prepared by the researchers based on the output of Eviews 14

Given the presence of heteroscedasticity across units (companies), the model was adjusted during estimation using robust standard errors to address this issue, thereby obtaining more accurate results and ensuring the reliability of the significance tests within the study model.

4.7. Estimation Results for the Fixed-Effects Model and the Random-Effects Model

The Table 9 below shows the estimation results for the two models.

Table 9

Estimation Results for the Fixed-Effects and Random-Effects Models

Variable	Fixed-Effects Model			Random-Effects Model		
	Coefficient	t-value	p-value	Coefficient	t-value	p-value
SF	-0.2135	-2.590	0.0143	-0.1701	-2.627	0.0126
LR	-0.0558	-3.402	0.0018	-0.0441	-3.120	0.0035
LTR	-0.1496	-2.078	0.0458	-0.1136	-2.925	0.0059

Source: Prepared by the researchers based on the output of Eviews 14

4.8. Hausman Test

To choose between the two models:

The results in Table 10 show that the chi-square (Chi-Sq) value is estimated at 4.9401, and the p-value (P-value) is 0.1762, which is greater than 0.05. Therefore, we accept the null hypothesis and reject the alternative hypothesis, which states that the fixed-effects model is the most appropriate for analyzing the study data, which is consistent with the study by Arhinful et al. (2023), which relied on the "Stata" software in accordance with the fixed-effects and random-effects models, and also used the "Hausman test" to determine the most appropriate method for presenting the study's results, where it was found that the random-effects model was the most suitable for this purpose.

Table 10

Selection of the Most Appropriate Regression Model

Test Type	Chi-Square (Chi-Sq)	Degrees of Freedom (df)	Probability (Prob.)
Hausman Test	4.9401	3	0.1762

Source: Prepared by the researchers based on the output of Eviews 14

4.9. Final Random Effects Model with Robust Standard Errors

Since the random effects model was found to be the appropriate model, and referring to Table 11, the following can be observed:

- The proposed model is formulated as follows:

$$ROA = 0.2134 - 0.1701*SF - 0.0441*LR - 0.1136*LTR$$

- The Wald test shows that its p-value is 0.0000, which is less than 0.05, indicating that the model as a whole is statistically significant;
- The explanatory power of the estimated model is high, with a coefficient of determination (R^2) of 0.733, indicating that the independent variables collectively explain 73% of the variation in accounting performance;
- The results indicated that all independent variables under study have a negative and statistically significant effect. The independent variables were ranked according to their impact on accounting performance as follows:

✓ **Equity financing ratio (X1):** For every 1% increase in the equity financing ratio, the return on assets decreases by 0.1701 at a 5% significance level, suggesting that an increase in companies' reliance on equity financing may lead to a decline in accounting performance; This can be explained by the failure to take advantage of the benefits of external financing and financial leverage in maximizing returns. The results of the current study are consistent with the study by Vo & Ellis (2017), which indicated that heavy reliance on internal resources may reflect poor utilization of investment opportunities and inefficient liquidity management, leading to a lower return on assets. A study by Dao and Ta (2020) also supported this argument by confirming that excessive retention of internal funds without effective deployment negatively affects accounting performance;

✓ **Long-Term Assets Ratio (X3):** For every 1% increase in the volume of long-term assets, the return on assets decreases by 0.1136 at a 5% significance level, indicating that an expansion in long-term assets may lead to reduced efficiency in asset utilization and lower returns in the short term. Consequently, the current findings are consistent with a study (Alipour et al., 2015), which showed that an increase in the volume of fixed assets may lead to a decline in operational efficiency and return on assets in the event of underutilization of production capacity. A study by Siddik et al. (2017) also noted that expansion in long-term investments without achieving sufficient returns negatively affects companies' financial performance;

✓ **Leverage ratio (X2):** For every 1% increase in the leverage ratio, the return on assets decreases by 0.0441 at a 5% significance level, indicating that increased reliance on debt leads to a lower return on assets due to increased financial burdens and borrowing costs. The findings of the current study are consistent with a study (Nguyen & Nguyen, 2020), which concluded that high indebtedness leads to a decline in financial performance due to higher financing costs and the risks associated with borrowing. This is also consistent with Le and Phan (2017), which found that excessive debt use negatively affects corporate profitability because it increases financial burdens and reduces financial flexibility.

Table 11

Results of the Random Model Estimation

Variable	Coefficient	Robust S.E	t-Statistic	Probability (p-value)
C	0.21342	0.03360	6.351	0.0000
X1	-0.1701	0.05248	-3.241	0.0026
X2	-0.0441	0.01409	-3.130	0.0035
X3	-0.1136	0.03607	-3.149	0.0033
Model Test / Statistic	Statistic		Probability (p-value)	
Wald $\chi^2(3)$	25.033		0.0000	
R^2	0.733		/	
Number of Observations	40		/	

Source: Prepared by the researchers based on the output of EViews 14

5. Conclusion and Recommendations

Based on 40 panel observations for five companies listed on the Algerian Stock Exchange during the period 2017–2024, the study concluded that the random effects model is the most appropriate according to the Hausman test (χ^2=4.940; p=0.176). After addressing heteroskedasticity with robust standard errors, the model as a whole was found to be statistically significant (Wald χ^2=25.033; p<0.001). Furthermore, the SF, LR, and LTR coefficients were negative and statistically significant, which contradicts the study by Javaid et al. (2024), which concluded that ownership structure has a significant positive effect on performance. This implies that improved accounting performance in the firms under study is not only linked to increased sources funding, but also to the efficiency of their use, asset structure, and the cost of liabilities; the results remain limited by the small sample size and the short time period.

Based on the findings, the study's hypotheses can be tested as follows:

- ✓ The negative sign of the equity financing coefficient indicates that a higher ratio of equity to assets does not necessarily translate into a direct improvement in return on assets. This may reflect lower efficiency in the use of equity or a higher proportion of non-income-generating assets;
- ✓ The negative effect of leverage suggests that increased reliance on liabilities relative to equity may raise the cost of financing and financial risk, thereby putting pressure on accounting profitability. This result is consistent with the traditional interpretation of leverage, whereby the cost of borrowed funds exceeds the return generated by their use;
- ✓ Furthermore, the negative effect of the long-term asset ratio implies that a higher proportion of long-term assets is associated with a lower return on assets, which can be explained by the slow turnover of these assets, higher depreciation and maintenance costs, or the inefficient utilization of investment capacity during the study period.
- ✓ Consequently, the main hypothesis—which posits a direct relationship with statistical significance between the capital structure and the accounting performance of the firms under study; furthermore, the three sub-hypotheses are rejected, with the emphasis that the direction of the estimated relationship was negative for all independent variables, which is consistent with the study by Ngoc et al. (2021), which concluded that capital structure has a negative effect on operating performance. These results suggest that the effect of financing structure on accounting performance is not merely linked to an increase in sources of financing or the volume of long-term investments, but rather depends to a large extent on the efficiency of resource allocation resources, the cost of financing, and the extent to which companies are able to convert their financial and investment resources into accounting returns.

In light of these findings, the following recommendations can be made:

- Companies listed on the Algerian financial market must focus on the efficient allocation of resources when making decisions regarding their capital structure; an imbalance in the capital structure results in exorbitant financing costs, which in turn leads to a significant decline in both operating profits and net profits for these companies;
- These companies must adopt a specific policy to maintain a balanced financial structure; a balanced capital structure allows for strong control over financing costs, which has a positive impact on the companies' performance indicators; it is essential to adopt an appropriate strategy that ensures this balance; for example, if the debt ratio in the capital structure rises, the company can use the profits earned in a given year to repay creditors; that is, the company may choose to repay debt rather than distribute dividends to shareholders, which leads to a reduction in the debt ratio to some extent and makes the capital structure more balanced. Companies should take such measures periodically to ensure that the capital structure remains balanced and to control the cost of capital, which ultimately leads to improved performance and increased profits;
- Work to improve the efficiency of long-term asset utilization within companies, because poorutilization negatively affects accounting performance even if the financing structure is sound;
- Paying greater attention to the periodic analysis of financial indicators and adopting accurate evaluation tools that help make sound financial decisions supporting improved return on assets and enhancing the efficiency of accounting performance.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement

The data that support the findings of this study are available from the corresponding author, (Aboubaker Khoualed, aboubaker.khoualed@univ-annaba.dz), upon reasonable request.

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Author contributions

Belkacem Mimouni: Conceptualization 90%, Methodology 80%, Data curation 100%, Formal analysis 85%, Investigation 100%, Software 100%, Visualization 90%, Writing – original draft 90%.
Zine Elabidine Othmani: Methodology 20%, Data curation 80%, Validation 85%, Investigation 80%, Writing – review & editing 70%.
Aboubaker Khoualed: Conceptualization 80%, Supervision 100%, Methodology 100%, Validation 100%, Project administration 80%, Writing – review & editing 80%.
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Generative AI declaration statement

The authors declare that no generative artificial intelligence (AI) tools or services were used in the research, writing, analysis, or any other aspect of this work.

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Assessing the Effect of Competitive Insight on Organizational Agility: Evidence from Tuyil Pharmaceutical Company

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SUMMARY

In emerging economies, manufacturing firms operate in volatile environments shaped by intense competition, institutional gaps, and shifting consumer demands. This study examines the effect of competitive insight, operationalised as competitor analysis, industry comparisons, and strategic intelligence, on organizational agility, using a single-firm case study of Tuyil Pharmaceutical Company in Nigeria's pharmaceutical manufacturing sub-sector. Using a survey design and PLS-SEM, data were collected from 174 employees of Tuyil Pharmaceutical. Results show that industry comparison ($\beta = 0.302$, $p < 0.001$), competitor analysis ($\beta = 0.275$, $p = 0.002$), and strategic intelligence ($\beta = 0.246$, $p = 0.005$) each significantly and positively influence organizational agility. The combined predictive power of these consists of 53.8% ($R^2 = 0.538$) of the variance of organizational agility. The results are a single firm case study and so not generalisable to Nigeria's manufacturing sector until a multi-firm replication of this study has been conducted. Finally, the study identifies pharmaceutical firms' need to build a structured competitive insight dimension on which to build their business and aggregate their agility and competitive advantage.

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1. INTRODUCTION

Manufacturing enterprises in emerging economies operate within a fluctuating environment typified by stiff competition, institutional flaws, and shifting customer needs, making strategic information and market-oriented learning resources essential to survival and differentiation (Eniola et al., 2019). In Nigeria, a study on the topic of small and medium enterprises shows that strategic management practices regarding the product quality and organisational culture significantly enhance the performance of organisational structure, meaning that the companies that scan the environment in which they are operating with a systematic approach and subsequently restructure their internal processes enjoy benefits over the competitors that are not so adaptive (Eniola et al., 2019). The dynamics reflect the importance of comprehending the application of strategic intelligence in the Nigerian manufacturers' actions to assert their position in the already crammed markets, safeguarding their firms within the masses (Ashiru et al., 2022).

In highly competitive and heavily examined markets, the companies are putting more emphasis on the internal responsiveness ability to ensure their continued performance (Meng et al., 2023). The revealed firms confirm that MESG performance is conducive to firm-level response to stakeholders' focus, especially during periods of high-level investor attention (Meng et al., 2023). On the other hand, research on CSR in manufacturing indicated that changeability of

organizations is positively correlated with visible activities of responsible behavior which also have downstream effects (Meiryani et al., 2023). Knowing how the competitors and market information are translated into agile internal reactions of manufacturers in Nigeria is therefore very essential in accounting for the performance heterogeneities in regional & global value chains (Ashiru et al., 2022).

The effects of globalisation, technological advances, and the aftermath of the pandemic, have led companies in Nigeria to place high value on access to information in real time and the need for a timely response to it in the form of a strategy to deal with it (Orji & Ojadi, 2021). From the findings of the studies, the role of dynamic capabilities in relation to the Nigerian SMEs during the period of crisis, it is noted that through relationship-based governance and adaptability in decision making it is possible to describe reconfiguration of the resources and maintain stakeholders' trust during the execution process of a radical uncertainty situation (Ashiru et al., 2022). Meanwhile, the national studies reported that there is a need for strategic entrepreneurship to intertwine with strategic management to achieve sustainable growth and the ownership of the temporary legitimacy of a business in the market (Olusegun et al., 2025). All these overlapping pieces of evidence point to the importance of targeting a standalone research effort to investigate managerial actions and how manufacturing firms in Nigeria would leverage competitive information and awareness of general environment in a rather competitive environment to influence and sustain their competitive advantage (Orji & Ojadi, 2021).

This study makes an important contribution to literature by shedding light on the complex link between strategic intelligence in the context of manufacturing companies in Nigeria and organizational agility. It shows the importance of competitor analysis and market analysis, highlighting how firms use those to react in the environments in which they operate, and therefore offers a way to understand the process firms use to become responsive from the inside of the organization in emerging markets. This contribution fills a gap in previous research concerning the economies under study, as many research studies ignore the different problems particular to manufacturers in these economies, and hence it accorded valuable opportunity for discussing various issues to both academics and practitioners in the field of strategic management. The general research problem in this study is thus, “How does the competitive insight as a tool (competitor analysis, industry comparisons, and strategic intelligence) impact the agility of organizations within the manufacturing industry in Nigeria”?

So specifically, the objectives of the study will include: to determine the effect competitor analysis on organizational agility, to investigate the influence of industry comparisons on organizational agility and to examine the influence of strategic intelligence on organizational agility.

2. Conceptual Review

2.1. Concept of Competitive Insight

Competitive insight is defined in this study as a dynamic, knowledge-based capability involving the systematic collection, analysis, and application of information on competitors, industry standards, and market trends to inform strategic decision-making (Golshan et al., 2025; Nassou & Kamar, 2025). In addition to the data collection, this capability includes organised environmental scan, analysis, and sharing of data, through which disintegrated data regarding competitors, customers and technologies are converted into decision-based knowledge (Golshan et al., 2025). Such interpretive focus aligns with the resource-based and dynamic capabilities paradigms, which consider such knowledge to be an intangible asset allowing the company to adapt products and services, reorganize markets, and maintain a competitive edge in the face of change (Nassou & Kamar, 2025; Radko & Temchenko, 2025).

In the era of big data, the competitive understanding is increasingly mediated by advanced analytics, artificial intelligence and decision support systems, which enhance the rate, amount and granularity of information available to strategic effect (Pu et al., 2025). These technological facilitators enable organisations to shift to be a retrospective reporting entity to be a predictive and prescriptive entity like predicting the strategic path of rivals or simulating market responses to different strategic plans (Adewusi et al., 2024). In conceptual terms, hence, competitive insight is best regarded as a socio-technical system that brings analytical infrastructures and managerial interpretation together, thus allowing firms to transform external signals into timely and consistent strategic decisions, so as to be perceived (Nassou & Kamar, 2025; Pu et al., 2025).

2.2. Concept of Organizational Agility

Organizational agility is defined here as a firm-level dynamic capability enabling rapid sensing of, and response to, environmental and competitive shifts through fast adjustment, learning from experience, and reflective practice (Tallon & Pinsonneault, 2011). It refers to an organisation's ability to respond to or even shape the market disruption by reorganising their resources and processes before or alongside a disruption (Nguyen et al., 2025). This construct is captured by capturing internal responsiveness and learning routines thus the most appropriate instrument to measure this construct

is from internal employees who are the key informants best suited to assess the ability of organizational adjustments and organizational learning potential (Desalegn et al., 2024).

2.3. Effect of Competitive Insight on Organizational Agility

Conceptual models of competitive intelligence show that more sophisticated understanding of a competitor and market situation correlates with the ability of a firm to sense the changes and realign operations accordingly (Adenuga et al., 2025; Flaig et al., 2021). Highly efficient firms that systematically process what happens outside into their strategic choices tend to have better ability to program value propositions and processes in line with market shifts (Radko & Temchenko, 2025). Therefore, competitive insight is considered to be upstream capacity that facilitates agile reconfiguration, which might become a downstream consequence, but an outcome that needs to be measured and captured as part of this study is not. Thus, a possible downstream outcome of this study (measured outcome) is a reputation standing as a result of competitive insight capability, which is considered to be upstream capacity that makes agile reconfiguration possible.

The theoretical and empirical literature on each of CSR and competitive behaviour highlights that organisations that are timely and systematic to operate their CSR activities based on market intelligence tend to develop high adaptive capacities, which may over time shape the perception of the organisations' stakeholders (Lin, 2023; Bianchi et al., 2019). It points to the importance of this study of the interplay between these dimensions, which are mutually related: competitive intelligence, ethical strategy, and organisational responsiveness (Nassou & Kamar, 2025; Bianchi et al., 2019).

2.4. Effect of Competitor Analysis on Organizational Agility

Competitor analysis creates awareness of the relative performance in service quality, innovation and customer experience which is used to understand how rapidly the firms can be responsive to adjust their operations (Gao et al., 2018; Kim et al., 2025). This additional information, derived from comparing the data from the reviews and social media, helps companies know what to adjust as soon as possible so that they can develop an effective strategy (Taherdoost & Madanchian, 2023). Sentiment systems processed on text, for example, or machines that perform sentiment analysis, also provide real-time signals of comparison, aiming at aiding agile decisions, and any impact on perception of the brand is a potential secondary effect (Ingole et al., 2024; Taherdoost & Madanchian, 2023); Competitor related analytics can therefore be used as an internal responsiveness tool to guide strategic responses to eliminating the performance gaps (Adenuga et al., 2025; Ingole et al., 2024). Thus, we propose the first hypothesis as follows:

H1: *competitor analysis has a positive influence on organizational agility*

2.5. Effect of Industry Comparisons on Organizational Agility

Industry comparisons orient a firm within a wider categorical context, prompting it to benchmark against sector standards and adjust accordingly (Gomez-Trujillo et al., 2020; Havryliuk, 2025). Systematic reviews show that firms benchmarking against industry peers are better able to reconfigure practices in step with sector expectations, with reputational capital as one possible longer-term effect (Gomez-Trujillo et al., 2020). Comparative positioning studies also indicate that companies with better positioning towards desired industry reference points are more likely to be able to adapt their actions in response to the requirement of industry adaptation than those less favourably positioned (Liu et al., 2020; Creevey et al., 2021). Industry-level benchmarking, therefore, acts as a mechanism for internal adjustment, consequently the focus of this study is not the credibility of the program, which is explored downstream from the activity, rather it is composed of program-specific gains (Gomez-Trujillo et al., 2020; Havryliuk, 2025). Therefore, we would like to propose the second hypothesis:

H2: *Industry comparisons have a positive influence on organizational agility*

2.6. Effect of Strategic Intelligence on Organizational Agility

It is a thought process of collecting and analysing market, technology and stakeholder information systematically, with a connection to more informed and timely decision making that ensures organisational responsiveness (Nwaiwu, 2018; Adenuga et al., 2025). The study on digital transformation' indicates that the implementation of data-driven intelligence systems can assist firms in predicting change and being responsive to it early on in the process, which boosts responsiveness over time (Nwaiwu, 2018; Taherdoost & Madanchian, 2023). Sophisticated intelligence tools, such as AI sentiment analysis, similarly generate finer data that support faster internal adjustment (Kayakuş et al., 2024). When applied ethically and transparently, strategic intelligence supports sustained organisational adaptability, with any reputational benefit treated here as a possible downstream implication (Adenuga et al., 2025; Kayakuş et al., 2024). Thus, we propose the third hypothesis as follows:

H3: *Strategic intelligence has a positive influence on organizational agility*

3. Theoretical Review

3.1. Resource-Based View (RBV) Theory

The Resource-Based View has been developed based on the previous work of Penrose and is formalised by Wernerfelt (1984) and Barney (1991), putting forward the firms as productive resources bundles, instead of industry participants (Lockett et al., 2009). It is based on the assumption that disparities in performance are caused by heterogeneous, non-mobility resources and capabilities that are valuable, rare, inimitable, and non-substitutable and create long-term competitive advantage (Ferreira & Ferreira, 2024). RBV shifts the emphasis of external positioning to internal resources that include knowledge, routines, brands, and relational capabilities, and integrates the associated approaches including dynamic capabilities, knowledge based view, and all of which describe the consistent performance heterogeneity.

RBV is based on a few assumptions: resource heterogeneity, i.e., being the firm with various bundles of resources; resource immobility, i.e., the strategic resources cannot be easily transferred, therefore, creating persistent advantage; and the erosion of the unprotected advantages creating superior performance by resources that meet VRIN/VRIO criteria only (Kraaijenbrink et al., 2010; Ferreira & Ferreira, 2024). The framework assumes that rational managers strategically identify, develop and deploy strategic resources in order to earn rents. The lack of conceptual clarity of the concepts of resource and value, overfocus on fixed internal resources, inadequate definition of the limits of the firm, a lack of focus on stakeholders and dynamism of the environmental forces are among the criticisms (Nagano, 2020; Freeman et al., 2021).

To the Nigerian manufacturing sector, RBV entails competitive insight capabilities (used to collect, analyze, and act on market and competitor data) as strategic, knowledge-based assets that can be valuable, rare and difficult to replicate when integrated into routine, culture and analytics systems (Pereira & Bamel, 2021). Other companies that have better insight have the ability to foresee moves by competitors, cope with stakeholders expectations and build stronger brand names as an intangible value whereas those who do not have the same react more slowly, and have lower reputational strength, which strengthens industry heterogeneity. RBV then suggests that competitive insight should be operationalised as internal resources and organizational agility as a path-dependent intangible, analyse the capability in relation to the requirements of VRIN/VRIO, and the capability development in an over-time perspective to gain a sustained reputational and performance advantage (Komakech et al., 2025; Ferreira & Ferreira, 2024).

4. Empirical Review

Empirical work in this stream converges on the idea that competitive intelligence drives reputational outcomes when it is channelled through a credible, monitored, and interpretable signal, but weakens where that channel is noisy or unmonitored. As noted by Taherdoost and Madanchian (2023), sentiment analysis is a prevalent method for firms to utilize the unstructured information they get from their stakeholders to gain operational intelligence about positioning and reputation, reflecting a new trend towards leveraging AI for competitive insight which is becoming prominent. Meng et al. (2023) apply this argument to a structure context, and find that the reputational value of consistent ESG performance is moderated by investor attention, where competitive insight means reputational benefit is contingent on a credible external audience that pays attention to the firm. Pan et al.'s (2024) meta-analysis, by contrast, identifies source credibility and identification as boundary conditions: competitive/comparative communication (via influencers) enhances brand outcomes only when the source is perceived as credible, and can fail to do so otherwise. Read together, these studies suggest competitive intelligence succeeds in driving organizational outcomes when it is analytically well-processed, channelled through a credible source, and received by an attentive audience, and is more likely to fail where any one of these conditions is absent.

5. Methodology

5.1. Research Design

This study adopts a quantitative, cross-sectional survey design, appropriate for measuring causal relationships between defined constructs across a target population at a single point in time.

5.2. Research Questions and Hypotheses

The study is guided by the following research question: To what extent does competitive insight influence organizational agility in Nigeria's manufacturing sector? Three hypotheses are tested:
H1: Competitor analysis has a positive influence on organizational agility.
H2: Industry comparisons have a positive influence on organizational agility.
H3: Strategic intelligence has a positive influence on organizational agility.

5.3. Population and Sampling

The target population comprised 388 employees of Tuyil Pharmaceutical Company, Nigeria. Purposive sampling technique was used to select the respondents who have direct interactions on strategic and market related decisions. Using Taro Yamane's formula [$n = N / (1 + N(e^2))$, $e = 0.05$], the required sample size was calculated as 196. A total of 174 valid responses were returned, yielding a response rate of 88.8%. It is acknowledged that the use of a single firm limits the generalisability of findings; this is addressed in the limitations section.

5.4. Measurement Instruments (Operationalisation)

Data were collected using a structured, five-point Likert-scale questionnaire (1 = Strongly Disagree, 5 = Strongly Agree). Each construct was measured using two indicators:

- Competitor Analysis: Data Analytics (DA), Performance Metrics (PM)
- Industry Comparisons: Intelligence Gathering (IG), Strategy Modification (SM)
- Strategic Intelligence: Embracing Change (EC), Resource Redeployment (RR)
- Organizational agility: measured using items adapted from validated scales in the literature

The full questionnaire is provided in Appendix A. Construct validity was assessed through pilot testing and expert review. Internal consistency was confirmed via Cronbach's Alpha. Partial Least Squares Structural Equation Modelling (PLS-SEM), executed using SmartPLS software, was used to analyse the data given its suitability for predictive modelling with small-to-medium samples.

5.5. Model Specification

Organizational Agility (OA) is the dependent variable; competitive insight components are the independent variables:

OA [FA + LL + RL] = f (Competitor Analysis [DA + PM] + Industry Comparisons [IG + SM] + Strategic Intelligence [EC + RR])

Where:
OA = Organizational Agility
FA = Fast Adjustment
LL = Lessons Learned
RL = Reflection and Learning
DA = Data Analytics
PM = Performance Metrics
IG = Intelligence Gathering
SM = Strategy Modification
EC = Embracing Change
RR = Resource Redeployment

6. RESULTS

6.1. Response Rate

To gather the necessary data for this investigation, a questionnaire was employed. In total 174 responses were recorded representing 88.8% of the anticipated sample (22 less responses than required). Hence, the authentic responses make up the data used in this analysis.

6.2. Descriptive Analysis of Responses and Normality Test

Table 1

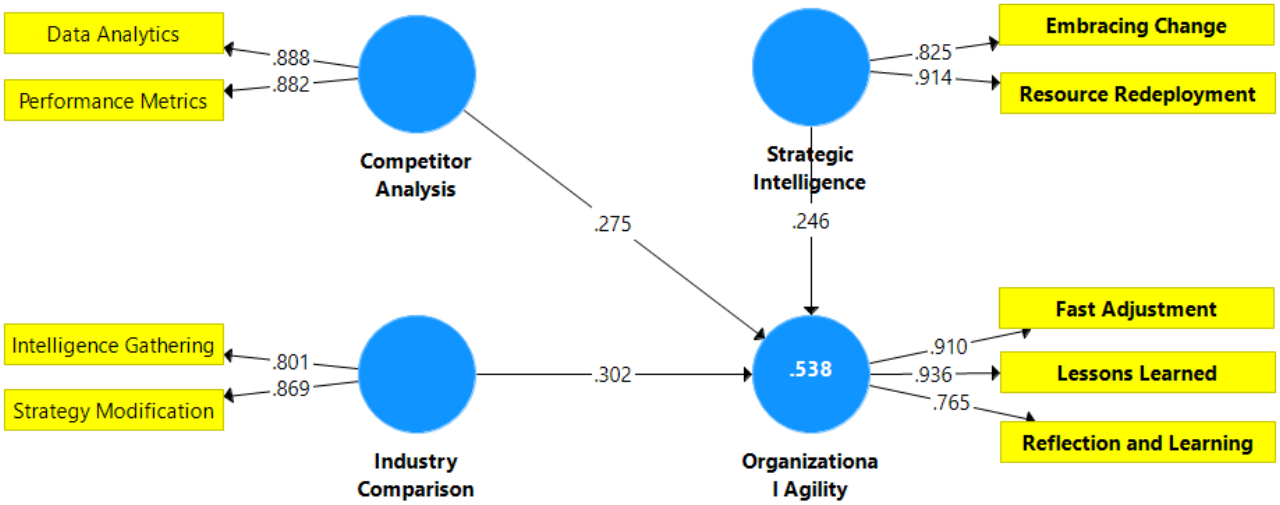
Descriptive Analysis and Normality Test

	Mean	Standard Deviation	Excess Kurtosis	Skewness	Number of Observations Used
Data Analytics	3.322	1.213	-0.802	-0.308	174.000
Embracing Change	2.626	1.224	-0.981	0.235	174.000
Fast Adjustment	3.598	1.334	-0.766	-0.665	174.000
Intelligence Gathering	2.891	1.215	-0.921	0.037	174.000
Lessons Learned	3.580	1.233	-0.964	-0.419	174.000
Performance Metrics	3.103	1.318	-1.170	-0.238	174.000
Reflection and Learning	3.080	1.288	-1.072	-0.070	174.000
Resource Redeployment	3.190	1.238	-1.007	-0.183	174.000
Strategy Modification	3.460	1.333	-1.119	-0.375	174.000

Source: SmartPLS Output, 2026

The results of Table 1 are a descriptive analysis and normality test that offer an overview of the responses with regard to the strategic variables of sensitivity at Tuyil Pharmaceutical Company. The mean descriptive statistics show that Data Analytics (3.322), Embracing Change (2.626), Fast Adjustment (3.598), Intelligence Gathering (2.891), Lessons Learned (3.580), Performance Metrics (3.103), Reflection and Learning (3.080), Resource Redeployment (3.190), and Strategy Modification (3.460) all indicate moderate to high levels of strategic sensitivity overall. The standard deviations of 1.213 (Data Analytics) to 1.334 (Fast Adjustment) represent moderate variability of the responses, and hence, there is a reasonable agreement between respondents. The skewness values, which are ranging between-0.665 (Fast Adjustment) and 0.235 (Embracing Change) are within the accepted range of-1 to +1, and this suggests that the responses are approximately normally distributed, Fast Adjustment, however, exhibits a slight negative skew meaning that they are more inclined to score high. The values of excess kurtosis are all negative, with the range of-1.170 (Performance Metrics) to-0.766 (Fast Adjustment), and this explains how the distribution could be platykurtic, that is, the responses are widespread in shape with fewer restrictive values and this further supports the fruitfulness of the data in the process of parametric analysis. The use of 174 observations across all variables represents a sufficient sample size to provide adequate statistical power to statistically analyze the results. These results suggest that Tuyil Pharmaceutical exhibits a moderate performance in strategic sensitivity especially in quick response and in drawing on experience and that they are essential to sustain competitive edge in the dynamism within the pharmaceutical market. The fact that the mean of Embracing Change (2.626) is relatively lower presents a prospective aspect of improvement and this implies that the organization might have to increase the flexibility to external change to support its competitive advantage.

6.3. Assessment of Measurement Model



Source: SmartPLS Output, 2026

Figure 1: A path model of Competitive Insight and Organizational agility

The relationships that are tested in the structural model, which are illustrated in Figure 1, are those comprising the path model Competitive Insight and Organizational agility. The figure probably indicates arrows of Competitor Analysis, Industry Comparison, and Strategic Intelligence to Organizational agility with a path coefficient of the intensity and direction of the relationships. According to Table 5, the paths are not insignificant since the coefficients of Competitor Analysis 0.275, Industry Comparison 0.302, and Strategic Intelligence 0.246 all have a p-value that falls below 0.05 which indicated positive and statistically significant impacts. The model graphically displays the impact of these elements of competitive insights in total on the Organizational agility with Industry Comparison displaying the highest route, then Competitor Analysis, and lastly Strategic Intelligence. The multicollinearity (Table 4) is nonexistent thus this guarantees the presented paths are unique contributions. The research implication is that the path model will help in better understanding how strategic sensitivities contribute to better organizational agility in Tuyil Pharmaceutical with special consideration to the multifactorial approach to competitive insight. This diagram demonstrates the strategic significance of these elements in motivation of competitive advantage in terms of enhanced organisational responsiveness or agility in the pharmaceutical sector.

Table 2

Construct Reliability and Validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Organizational agility	0.843	0.906	0.763
Competitor Analysis	0.722	0.878	0.783
Industry Comparison	0.771	0.822	0.698
Strategic Intelligence	0.788	0.862	0.758

Source: SmartPLS Output, 2026

Table 2 gives the values of reliability and validity of the constructs of competitive insight and organizational agility. The organizational agility presents Cronbach's alpha 0.843, Composite Reliability 0.906, and Average Variance Extracted 0.763, which are good to indicate that the construct has a high internal consistency and convergent validity since the AVE exceeds the 0.5 level, which means that the indicators integrate an excellent part of the variance in the construct. Competitor Analysis the Cronbach's Alpha is 0.722, Composite Reliability is 0.878, and AVE is 0.783, which represents a sufficient reliability and high convergent validity. The Cronbach's Alpha of Industry Comparison is 0.771, Composite Reliability is 0.822 and AVE is 0.698, which suggests good reliability, but mediocre convergent validity. Strategic Intelligences have the Cronbach's Alpha of 0.788, Composite Reliability of 0.862, and an AVE value of 0.758 which affirm good reliability and convergent validity. Those findings indicate that the measuring model is sound and valid, the constructs reflect the intended facets of competitive insight and organizational agility. The study implications are great,

since high reliability and validity of the constructs give a solid basis on the measurement of the effects of competitive insight on organizational agility in Tuyil Pharmaceutical. This strength increases confidence on the structural model to test the hypothesis hence justifying the goal of establishing the effects of competitive insight on organizational agility in pharmaceutical industry.

Table 3

Discriminant Validity

	Organizational agility	Competitor Analysis	Industry Comparison	Strategic Intelligence
Organizational agility	**0.873**			
Competitor Analysis	0.653	**0.885**		
Industry Comparison	0.677	0.747	**0.836**	
Strategic Intelligence	0.623	0.618	0.685	**0.871**

Source: SmartPLS Output, 2026

Table 3 evaluates discriminant validity using the Fornell-Larcker criterion, in which the square root of each construct's AVE should exceed its correlation with every other construct. AVE of Organizational agility is 0.873, correlates of 0.653(Competitor Analysis), 0.677 (Industry Comparison) and 0.623 (Strategic Intelligence) are less than square root, which is the confirmation that AVE is discriminant valid. The AVE of Competitor Analysis is also adequate, with correlations to Industry Comparison (0.747) and Strategic Intelligence (0.618) both meeting the criterion. Industry Comparison square root of AVE = 0.836, with a correlation of 0.685 to Strategic Intelligence, and Strategic Intelligence square root = 0.871; both are satisfactory on the discriminating validity criteria. These findings suggest that the constructs are independent of each other and they do not interact with their measurement of different areas of competitive insight and organizational agility. This means that the constructs of the study are clear and therefore the analysis of the effect of competitive insight on the organizational agility is not clouded by other overlapping measures. This immediacy reinforces the research to control the particular impacts of the elements of competitive insight on organizational agility which is in line with the objective of knowing their impact in the competitive advantage of Tuyil Pharmaceutical.

6.4. Multicollinearity

This assesses the correlation between the independent variable. It is to know if two independent variables are not correlated and producing the same result. The variance inflation factor (VIF) is used in this study to assess likely correlation between the independent variables.

Table 4

Inner VIF Values

	Organizational agility
Organizational agility	
Competitor Analysis	2.377
Industry Comparison	2.769
Strategic Intelligence	1.980

Source: SmartPLS Output, 2026

Table 4 is used to indicate the Value of Variance Inflation Factor (VIF), which measures the presence of multicollinearity between the independent variables that affect Organizational agility. The values of VIF are Competitor Analysis 2.377, Industry Comparison 2.769 and Strategic Intelligence 1.980 which are much lower than the value of 5, are not indicative of any serious cases of multicollinearity. The low values of VIF indicate that the independent variables are distinct enough and do not cause repeated effects on Organizational agility and hence the stability and significance of the results obtained through the structural model. This is an important finding as it indicates that the influence of Competitor analysis on organizational agility is measurable without the confounding effect of high relationships between these two variables because of the high correlation between them. This means that Tuyil Pharmaceutical would be able to target an improvement in all the competitive insights components without the fear that they are interconnected, which would

strengthen the strategic decision-making process supporting organizational agility and competitive advantage within the pharmaceutical industry.

Table 5

Bootstrapping Results Showing Path Coefficient for Structural Model

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Competitor Analysis -> Organizational agility	0.275	0.272	0.090	3.048	**0.002**
Industry Comparison -> Organizational agility	0.302	0.319	0.093	3.250	**0.001**
Strategic Intelligence -> Organizational agility	0.246	0.237	0.087	2.834	**0.005**

Source: SmartPLS Output, 2026

Table 5 indicates the bootstrap estimates of the structural model, which looks at the role of Competitor Analysis, Industry Comparison, and Strategic Intelligence on Organizational agility. The statistical significance of the relationship between Competitor Analysis and Organizational agility (b =0.275) has a sample mean of 0.272, a standard deviation of 0.090, a T-statistic of 3.048 and a p-value of 0.002 thus confirming a statistical significance of the relationship between Competitor Analysis and Organizational agility. Likewise, the relationship between Industry Comparison and Organizational agility has a pathway that is defined as: b= 0.302, mean=0.319, SD=0.093, T=3.250 and p= 0.001, which is significant positive. The correlation between Strategic Intelligence and Organizational agility gives the correlation of b=0.246 with a sample mean=0.237, standard deviation=0.087, T-statistic=2.834 and p-value= 0.005, which is also a big positive influence. Taken together, these have all showed that the three components of competitive insight play important roles in promoting organizational agility in Tuyil Pharmaceutical. These findings support the study objective by showing that the competence development of competitor analysis, industry comparison, and strategic intelligence is significantly associated with organizational agility and thus provides the organisation a competitive edge in the pharmaceutical industry by making strategically informed decisions and market positioning.

Table 6

Coefficient of Determination Score

	R Square	R Square Adjusted
Organizational agility	0.538	0.530

Source: SmartPLS Output, 2026

Table 6 records the coefficient of determination of the Organizational agility; it has a R 2 of 0.538 as well as adjusted R 2 of 0.530. These statistics show that Organizational agility as a variable can be explained by Competitor Analysis, Industry Comparison, and Strategic as its total variance, with the adjusted value accounting for the number of predictors. Based on Chin's (1998) benchmarks for PLS-SEM (R^2 ranges between 0.19- weak, 0.33- moderate, 0.67- substantial), this implies that the R^2 of 0.538 represents moderate-to-substantial level of explanatory power. The moderately strong explanatory power justifies the supposition that competitive insight had a significant influence on organizational agility at Tuyil Pharmaceutical. This subsequently effects the organisation's ability to respond to market change being significantly influenced by the strategic sensitiveness framework. By capitalising on these insights, Tuyil Pharmaceutical can strengthen its adaptive capacity and competitive position in the Nigerian pharmaceutical market; any resulting gains in brand standing are a possible longer-term implication rather than a measured outcome of this study.

Table 7

Assessment of the Effect Size (f^2)

	Organizational agility
Organizational agility	
Competitor Analysis	0.069
Industry Comparison	0.071
Strategic Intelligence	0.066

Source: SmartPLS Output, 2026

Table 7 shows the effect size (f^2) of each independent variable when dealing with Organizational agility. The Competitor Analysis results in $f^2 = 0.069$, Industry Comparison $f^2 = 0.071$ and Strategic Intelligence $f^2 = 0.066$. Following Cohen's (1988) benchmarks ($f^2 \geq 0.02$ small, ≥ 0.15 medium, ≥ 0.35 large), all three predictors fall within the small-effect range. Although statistically significant, their individual practical contributions are modest. The effect size of Industry Comparison is the greatest; and makes it the most prominent predicting factor amongst the three compared, with Competitor Analysis and Strategic Intelligence coming in at close. The implications of these findings are that although Competitive Insight on all fronts contributes to Organizational agility, Industry Comparison with a marginally greater impact probably because of its interest in benchmarking against industry is an absolute necessity as far as a highly competitive sphere such as pharmaceuticals is concerned. As such, Tuyil Pharmaceutical must focus on benchmarking the industry to be in a position to promote organizational agility and continue developing a sound competitor analysis and strategic intelligence to retain and develop its competitive advantage in a reputation-driven market.

7. Discussion of Findings

The findings support all three hypotheses. Industry Comparison is the strongest predictor of organizational agility ($\beta = 0.302$, $p < 0.001$), followed by Competitor Analysis ($\beta = 0.275$, $p = 0.002$) and Strategic Intelligence ($\beta = 0.246$, $p = 0.005$). Together these predictors explain 53.8% of the variance in organizational agility ($R^2 = 0.538$), which represents a moderate level of variance.

As per the Resource Based View, the notion of the primacy of Industry Comparison aligns with systemic comparisons conducted by firms with their sectors leading on a standard, which involve aligning the use of resources with external expectations, giving a sense of perceived credibility and stakeholders' trust (Gomez-Trujillo et al., 2020). This aligns with Havryliuk (2025), who states that the benchmarking of industry-level is a multiplier of respect. This study however, takes the argument to the pharmaceutical manufacturing environment in Nigeria where institutional legitimacy is salient to the stakeholders in the environment.

The impact of the Competitor Analysis is consistent with Kim et al. (2025) who found that a systematic approach to competitor monitoring helps to gain product differentiation and make consumers feel superior. In case of Tuyil, firms which monitor other firms' actions can reliably distinguish their products further, something that is correlated to the agility of a firm.

The relatively weak but higher value is for Strategic Intelligence, which could be due to some of the manufacturing companies in Nigeria, having inadequate data analytics infrastructures (Nwaiwu, 2018). While industry comparison mechanisms need to have relational awareness, strategic intelligence requires technological investment and this may not be universally available. This is slightly different from Adenuga et al. (2025) who saw strategic intelligence as the top influence on reputation, given the nascent-adopting economy in which this study takes place.

Combined these results confirm the findings of Radko and Temchenko (2025), which unfolded that competitive intelligence leads to positive enhancement of brand equity, and add to them by disintegrating the concept of competitive intelligence into its various aspects and by testing each one of them separately.

8. Conclusion

8.1. Answering Research Goals

This study set out to examine the effect of competitive insight on organizational agility in Nigeria's manufacturing sector. All three hypotheses were supported: competitor analysis (H1), industry comparisons (H2), and strategic intelligence (H3) each positively and significantly influence organizational agility at Tuyil Pharmaceutical.

8.2. Theoretical Contribution

The study extends the Resource-Based View by empirically demonstrating that competitive insight, as a knowledge-based, intangible capability, functions as a strategic asset that drives organizational agility in an emerging economy context. It further contributes by disaggregating competitive insight into three measurable dimensions, providing a replicable framework for future research.

8.3. Managerial Implications

Nigerian manufacturers should institutionalise competitive intelligence functions. In particular, businesses should be looking for quarterly competitor benchmarking of and against sector leaders, more structured competitor monitoring systems and the development of data analytics skills to inform better strategic decisions and brand positioning.

8.4. Social Implications

A stronger organizational agility among Nigerian manufacturers can improve consumer trust, attract investment, and contribute to sector credibility, all of which have broader economic implications for Nigeria's industrial development.

8.5. Limitations

This study is limited by its single-firm, cross-sectional design, reliance on self-reported data, and focus on the pharmaceutical sub-sector of Tuyil Pharmaceutical Company. As a single-firm case study, the findings cannot be generalised to Nigeria's broader manufacturing industry without multi-firm replication across other sub-sectors.

8.6. Future Research Directions

Future studies should replicate this framework across multiple firms and sectors, adopt a longitudinal design, and explore potential mediating variables such as organisational culture or digital capability maturity.

8.7. Takeaway

Competitive insight is not merely an operational tool; it is a driver of organisational agility or responsiveness. Firms that invest in understanding their competitive environment are better positioned to adapt quickly in Nigeria's dynamic manufacturing landscape, with stronger stakeholder standing as a possible downstream benefit.

8.8. Recommendation

The study suggests that Tuyil Pharmaceutical should focus on developing its competitive insight resources to strengthen organizational agility and remain competitive. In particular, the organisation needs to invest in strong industry comparison behaviours, as the factor had the greatest impact on the organizational agility; benchmarking frequently against the industry leaders will help the organisation adhere to best practices and respond more quickly to market shifts. To conduct competitor analysis, Tuyil needs to develop its surveillance systems in order to sift strategic moves of rivals hence differentiating through innovative product offerings and specialized marketing strategies that are unique to the pharmaceutical industry. The advanced data analytics and intelligence-gathering instruments need to be invested in to augment strategic intelligence so that strategic decisions are made, hence allowing agility in the dynamism of a business market environment. In order to correct the relatively low scores attributed to Embracing Change (as shown in Table 1), Tuyil must institute a culture of adherence to change through specific training and change-management programs and therefore ensure that employees have the capacity to react to changes in the market. These are action measures that will

superbly improve the sensitivity level of the strategic orientation of Tuyil as a company, and consequently strengthen its organizational agility and competitive stance in the Nigerian pharmaceutical sector.

Declaration of competing interests

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author, (Oluwayomi Omotayo Olota  , olota.oo@unilorin.edu.ng) upon reasonable request.

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Writing – original draft: Opeyemi Emmanuel Babawale, 70%; Ebenezer Oluwadamilare Balogun, 30%.
Writing – review & editing: Oluwayomi Omotayo Olota, 60%; Ebenezer Oluwadamilare Balogun, 20%; Opeyemi Emmanuel Babawale, 20%.

Generative AI declaration statement

The authors declare that no generative artificial intelligence (AI) tools or services were used in the research, writing, analysis, or any other aspect of this work

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APPENDIX

QUESTIONNAIRE

Questions relating Competitive Insight and Organizational agility: A study of Tuyil Pharmaceutical, Ilorin

Instruction: Please tick (✓) in front of statements that correspond with the degree of your answer.

Note the following contraction: Strongly Agree SA; Agree = A; Undecided- U; Disagree D; and Strongly Disagree = SD.

COMPETITIVE INSIGHT						
S/N	Competitor Analysis					
		SA	A	U	D	SD
1.	Our organization uses data analytics tools to systematically monitor and evaluate competitor strategies.					
2.	We track performance metrics to benchmark our position against competitors.					
Industry Comparisons		SA	A	U	D	SD
3.	Our organization actively engages in intelligence gathering to stay informed about industry trends and competitor actions.					
4.	Insights from industry comparisons regularly lead to modification of our strategies and business practices.					
Strategic Intelligence		SA	A	U	D	SD
5.	Our organization readily embraces change in response to strategic intelligence gathered from the competitive environment.					
6.	We effectively redeploy resources based on insights derived from strategic intelligence.					
S/N	Organizational agility	SA	A	U	D	SD
7.	Our brand makes fast adjustments to its market positioning whenever competitive intelligence signals a shift.					
8.	We consistently incorporate lessons learned from past market experiences to improve our organizational agility.					
9.	Regular reflection on brand performance outcomes enables us to enhance how we are perceived by stakeholders.					

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Paper submission

For information on our paper admission and peer reviewing policies please contact the T(heory) M(ethodology) P(ractice) website at:

https://ojs.uni-miskolc.hu/index.php/tmp/index

Formatting guidelines for submitted papers
All submitted papers should include the following sections

- Title of the paper
- Author(s) details – Please note: Author details should not be included in the submitted article, and are only required when completing relevant sections of the online submission form.

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- Abstract of the paper
- Keywords
- Journal of Economic Literature (JEL) codes
- Introduction, Research question
- Literature review
- Materials and/or methods
- Discussion of main findings and their relation to the reviewed literature
- Conclusion
- References
- Author contributions (in case of multiple authors)

Further formatting details

- An original article would normally consist of 4,500-7,000 words
- **Authors are encouraged not to use any special text formatting at all**
- The **text** should be single-spaced, using Times New Roman 12-point font, no blank lines between paragraphs, no pagination
- The **abstract** should be 70-150 words long, in a single paragraph
- For library indexing and on-line searching you are encouraged to provide up to 5 **keywords**, separating them with semicolons (e.g. apple; pear; grapes)
- TMP uses the **APA 7.0 format for in-text citations and references lists**. Please, use a citation tool or read the detailed description of this style by following this link: https://bit.ly/APA70description
- **Figures and tables** are to be inserted in the text, and are numbered consecutively; sources are also to be provided; when preparing the figures please consider that the final copy will be published in black and white format
- Please do not use **footnotes**; you can include all peripheral remarks in the text within parentheses, or, if you absolutely need notes, please use endnotes
- Only black and white **photographs** can be published in the proceedings
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  - Authors should check if a **DOI is available** for the cited work (using http://search.crossref.org/); if yes, it should be put in the references in the following format: https://doi.org/xxxxxxxxxxxxxxxxxxxx
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  - The list of references may only contain items cited in the text; an English translation of the title of non-English papers in the references must be added
- In case of multiple authors please specify the **contribution of each author** by using the following 5 categories, and also give an estimate about the share of work (e.g. Author1 55%; Author2 45%)
  - Possible contribution categories: Conceived and designed the study; Collected the data; Performed the analysis; Wrote the paper; Other (pls., specify)
- You may use an Appendix (no longer than 5 pages); this section should come after the References