Politická ekonomie

Volume 74
Forthcoming articles
https://doi.org/10.18267/j.polek.1523
Open Access

VŠE / PRAGUE UNIVERSITY OF ECONOMICS AND BUSINESS

Do Potential Interactions Between Firms Have an Impact on Profitability? The Case of Manufacturing Industry in Turkey

Ruya Karci, Ilkut Elif Kandil Goker, Ceren Dirik Ayvaz, Bahadır Uysal

Ruya Karci (email: ruyakarci@kku.edu.tr), Department of Econometrics, Kirikkale University, Kirikkale, Turkey

Ilkut Elif Kandil Goker (*corresponding author*, email: egoker@ankara.edu.tr), Department of Real Estate Development and Management, Ankara University, Ankara, Turkey

Ceren Dirik (email: cerendirik@kku.edu.tr), Department of Quantitative Methods, Kirikkale University, Kirikkale, Turkey

Bahadır Uysal (email: bahadiruysal@kku.edu.tr), Department of Accounting and Finance, Kirikkale University, Kirikkale, Turkey

Abstract

This study examines the determinants of firm profitability in the Turkish manufacturing industry by incorporating spatial interaction among firms in the same sub-sector. Using quarterly data from 119 Borsa Istanbul (BIST)-listed firms between 2014–2023, we employ spatial panel models to assess whether a firm's profitability is influenced by both its own characteristics and the performance of neighboring firms. The Spatial Durbin Model emerges as the best-fitting specification. Findings indicate significant positive spillover effects: profitability is affected by peers' financial metrics, particularly working capital turnover, firm size, and debt to equity ratio. Spatial autocorrelation suggests sectoral externalities. Results highlight that traditional profitability drivers gain additional explanatory power when inter-firm dependencies are considered. The study underscores the importance of incorporating sectoral dynamics and spatial linkages into firm strategy and policymaking, offering novel empirical evidence for emerging market contexts.

Keywords: Emerging economy, manufacturing industry, profitability, spatial panel analysis

JEL Classification: C23, G30, L60

Citation: Karci, R., Goker, I. E. K., Dirik Ayvaz, C., Uysal, B. Do Potential Interactions Between Firms Have an Impact on Profitability? The Case of Manufacturing Industry in Turkey. *Politická ekonomie,* 74, Forthcoming articles, https://doi.org/10.18267/j.polek.1523

1. Introduction

From Kaldor's (1966) statement that "manufacturing is the engine of growth" to the present day, the manufacturing industry continues to play a critical role in the economic development of countries. For this reason, numerous studies in literature aim to identify the factors that affect the continuity and sustainability of profitability in this sector. However, the most significant shortcoming in the existing literature is the neglect of potential interaction effects between firms operating in the same sub-sector. Such interactions between firms reveal the existence of both positive and negative externalities, which are closely related to the theoretical propositions of the Endogenous Growth Theory. Economic growth can also be fueled by internal processes like the spread of knowledge and the accumulation of human capital, according to Romer (1986) and Lucas (1988). Even though businesses might seem to function as distinct entities, the actions and output of other businesses in the same industry can have a significant impact on their productivity. An important research question arises in this context: Is it possible for businesses in the same sub-sector to experience both positive and negative externalities?

In Turkey, the manufacturing industry still constitutes the most important driving force of economic growth. For example, according to TUIK data (2023), the manufacturing industry's contribution to GDP rose from 15% in 2010 to 17% in 2022, while export volume in this sector constitutes 94.5% of Turkey's total exports. Akbulut (2019) explained the positive effect of industrialization on economic growth with opportunities such as increased export volume and export income, thanks to high value-added products, efficiency in the allocation of labor resources, external economy, learning by doing, and stimulating technological change. In addition, the development of the manufacturing industry in a country enables the development of new technologies, mechanization, efficient use of pharmaceuticals, communication, and progress in information technologies, thus increasing the productivity of other sectors such as the agricultural sector or the service sector (Taymaz and Suiçmez, 2005).

While the Turkish economy used to be agriculture-based, the manufacturing industry has become the leading indicator of economic growth over time. Increased productivity and innovation in production have been achieved thanks to a young and educated workforce. Low labor costs compared to Europe, along with tax reductions, financial support, and government-provided investment incentives, have further contributed to the rapid growth of the sector. The manufacturing industry in Turkey has 23 sub-sectors, according to the NACE Rev. 2 two-digit divisions. However, manufacturing firms listed on Borsa Istanbul (BIST) are grouped under nine sub-sectors by combining some sub-sectors under the same

heading. The sub-sectors in BIST are (i) Food, Beverages, and Tobacco, (ii) Textiles, Clothing, and Leather, (iii) Forest Products and Furniture, (iv) Paper and Paper Products Printing, (v) Chemicals, Pharmaceuticals, Petroleum, Rubber, and Plastic Products, (vi) Stone and Earth-Based, (vii) Basic Metal Industry, (viii) Metal Goods, Machinery, Electrical Equipment, and Transportation Vehicles, and (ix) Other Manufacturing Industry. According to the most recent statistics, the value-added by the manufacturing industry is expected to account for approximately 17% of GDP by 2022 (TUIK, 2023). With a strategic location connecting Europe, Asia, and the Middle East and a well-developed manufacturing infrastructure, especially in automotive, textiles, white goods, machinery, and food, the manufacturing industry accounts for 94.5% of Turkey's exports (TUIK, 2023).

Table 1 presents the proportion of the manufacturing industry within all sectors and its contribution to GDP between 2010 and 2022. It provides detailed figures that highlight the consistent growth and significant role of manufacturing within the Turkish economy during this period. According to the most recent statistics released by TUIK (2024), the manufacturing sector has the highest production value in Turkey, with a production worth 10 trillion 312 billion Turkish Liras. The manufacturing industry also indirectly supports the contribution of other sectors to the economy by providing their essential inputs. Additionally, Turkey's manufacturing industry has been targeting a structural transformation for the past decade. In particular, it is aimed at producing high-value-added products. As stated in the report titled "Structural Analysis of the Turkish Manufacturing Industry", published by the Ministry of Industry and Technology of the Republic of Türkiye (2023), the fact that the parameter with the highest increase among the parameters taken into account in the development of the manufacturing industry in Turkey since 2015 is R&D expenditures in USD and that employment, productivity, value-added, number of entrepreneurs, exports, imports, and the ratio of exports to imports have increased compared to 2015 are the indicators that concrete steps have been taken towards this goal.

Table 1: Key statistics for the Turkish manufacturing sector 2010–2022 (%)

Years	Manufacturing/Total Sectors	Manufacturing/GDP
2010	17.31	15.26
2011	18.69	16.50
2012	18.15	16.09
2013	18.46	16.29
2014	18.51	16.39
2015	18.56	16.36
2016	18.69	16.47
2017	18.92	16.74
2018	18.54	16.46
2019	17.93	15.93
2020	18.35	16.15
2021	19.31	17.19
2022	18.97	16.98

Source: Central Bank of the Republic of Türkiye (2024)

Since profitability is an important determinant in ensuring the continuity of businesses, it is essential to identify firm-specific factors affecting profitability. The literature on firm profitability is quite extensive, primarily exploring factors such as firm size, liquidity, leverage, and working capital. However, there remains a gap in examining how potential interactions between firms' impact profitability, which this study aims to address. Incorporating the interaction between firms within manufacturing industry sub-sectors is anticipated to contribute to the literature in two keyways. Since firms operating in the same sector are very likely to create an interaction effect, this study will eliminate the limitations of previous studies in terms of "not taking interaction into account". In other words, it is aimed to provide a more explanatory and policy-guiding framework by modeling, rather than abstracting, the inter-firm relationships within the manufacturing industry. What sets this study apart from the existing literature is its application of spatial econometric analysis, which allows for the identification of profitability determinants while accounting for inter-firm interaction effects. Secondly,

a statistically significant effect of one firm's profitability on another firm's profitability within the same sector indicates the presence of a positive or negative externality among firms in that sector. Indeed, this study reveals that an increase in the profitability of a firm in Turkey has a positive impact on the profitability of other firms operating within the same sub-sector.

The remainder of the paper is structured as follows: Section 2 presents a review of the relevant literature. Section 3 describes the variables used in the analysis and presents the spatial econometric model formulations. Section 4 provides a detailed discussion of the empirical findings. Section 5 concludes by providing a general overview, discussing possible underlying reasons for the findings, and highlighting opportunities for further research.

2. Literature Review

A considerable body of literature has investigated firm profitability using various methodological approaches. These studies focus mainly on determining the factors that may affect profitability, such as tangibility (Pratheepan, 2014), firm size (Alarussi and Alhaderi, 2018), investment (Panda and Nanda, 2018), risk (Odusanya *et al*., 2018), working capital (Deloof, 2003; Ukaegbu, 2014), liquidity (Goddard *et al*., 2005), sales growth (Demirgunes and Ucler, 2015), research and development (Isik and Tasgin, 2017; Huang and Hou, 2019), open innovation (Noh, 2015), managerial efficiency and location (Agiomirgianakis *et al*., 2006), technical efficiency (Camino-Mogro and Bermúdez-Barrezueta, 2019), firm age and capital structure (Sivathaasan *et al*., 2013), lagged profitability (McDonald, 1999; Margaretha and Supartika, 2016), labor productivity (Margaretha and Supartika, 2016), inflation and exchange rate (Spitsin *et al*., 2020), competition and interest rate (Bolarinwa *et al*., 2021), labor cost and capital intensity (Pervan *et al*., 2019), import/export activity and market concentration (Bennenbroek and Harris, 1995; Fuertes-Callén and Cuellar-Fernandez, 2019), and intangible assets and leverage (Alarussi and Goa, 2023). It is noteworthy that the most commonly used variables in related studies are firm size, liquidity, sales growth, firm age, leverage, and working capital.

Although econometric modeling is mainly employed to determine the determinants of profitability, it is seen that the approach used varies, such as stepwise regression (Agiomirgianakis *et al*., 2006), multiple regression analysis (Sivathaasan *et al*., 2013), pooled ordinary least squares regression (Alarussi and Alhaderi, 2018; Alarussi and Goa, 2023), data envelopment analysis based approaches (Camino-Mogro and Bermúdez-Barrezueta, 2019; Zhao *et al*., 2021), event study (Noh, 2015), and generalized model of moments estimation (Goddard *et al*., 2005; Demir, 2009; Ozmen *et al*., 2012; Isik *et al*., 2017; Panda and Nanda, 2018; Odusanya *et al*., 2018; Pervan *et al*., 2019; Bolarinwa *et al*., 2021).

The literature on profitability determinants often exhibits sectoral variation. For example, the determinants of profitability are identified in the sector of banking (Menicucci and Paolucci, 2016; Sayilgan and Yildirim, 2009), tourism (Agiomirgianakis *et al*., 2013), healthcare (Tyagi and Nauriyal, 2017), energy (Morina *et al*., 2021), insurance (Malik, 2011), agricultural (Vržina and Dimitrijević, 2020), while a considerable amount of the remaining studies are conducted in the manufacturing sector.

Studies on the determinants of profitability in the manufacturing sector also differ in terms of the countries in which they are conducted, like Bennenbroek and Harris (1995) in New Zealand, McDonald (1999) in Australia, Goddard *et al*. (2005) in Belgium, France, Italy, and the United Kingdom, Agiomirgianakis *et al*. (2006) in Greece, Sivathaasan *et al*. (2013) and Pratheepan (2014) in Sri Lanka, Ukaegbu (2014) in Egypt, Kenya, Nigeria, and South Africa, Margaretha and Supartika (2016) in Indonesia, Bockova and Zizlavsky (2016) in Czech Republic, Alarussi and Alhaderi (2018) in Malaysia, Panda and Nanda (2018) in India, Odusanya *et al*. (2018) in Nigeria, Pervan *et al*. (2019) in Croatia, Huang and Hou (2019) in Taiwan, Fuartes-Callén and Cuellar-Fernandez (2019) in Spain, Tao *et al*. (2020) in China, Spitsin *et al*. (2020) in Russia, Bolarinwa *et al*. (2021) in 27 African countries, and Alarussi and Goa (2023) in China.

Ensuring sustained profitability in the manufacturing industry is crucial, as it plays a significant role in the Turkish economy. For this reason, many studies with a sample of Turkey have been addressed to determine the determinants of profitability. For example, Demir (2009) examined how macroeconomic uncertainty and financialization affect profitability in Turkish manufacturing firms, revealing that increased speculative activities negatively impact profitability, whereas higher levels of financial investments significantly buffer these adverse effects. Using firm-level data, Ozmen *et al*. (2012) investigated the factors that affected corporate profitability in Turkey from 1996 to 2008. The empirical results indicate that the real exchange rate, leverage ratio, asset tangibility, and public debt have a negative impact, whereas firm size, real output growth, and financial development have a positive impact on nonfinancial firms' profitability. Cakir and Kucukkaplan (2012) analyzed 122 manufacturing firms traded on BIST between 2000 and 2009 using panel data analysis and found that the quick ratio, stock turnover ratio, and asset turnover ratio are positive, while the current ratio and leverage ratio are negative determinants of firm profitability. Agca *et al*. (2012) investigated the relationship between intrapreneurship dimensions and firm performance in Turkish manufacturing firms, finding that innovativeness and risk-taking are positively associated with profitability, while self-renewal shows a negative relationship. Their findings highlighted that environmental factors, particularly munificence,

significantly influence intrapreneurial activities, which in turn affect financial outcomes such as profitability.

Dogan's (2013) study on 200 firms for the years 2008–2011 is also one of the studies that showed that larger firm size is associated with higher profitability. In Demirgunes and Ucler's (2015) study, on the other hand, the authors analyzed the possible relationship between profitability, growth, and size in the Turkish manufacturing industry by constructing two different models, first with profitability as the dependent and growth as the independent variable, and then with profitability as the dependent and size as the independent variable, they found an inverse relationship between profitability and size. Isik and Tasgin (2017) used a dynamic panel data model to identify the factors in the Turkish manufacturing sector from 2005 to 2012. The authors revealed that firms' profitability is positively affected by lagged profitability, firm size, net working capital, and economic growth while negatively affected by financial risk and research and development costs. Using two-way panel data analysis for the period 1996–2015, Demirci (2017) found that accounts receivable turnover and the real volume of assets have a positive effect, while the tangible assets-to-total assets ratio and leverage ratio have a negative effect on return on assets in the Turkish manufacturing industry. In another study on the Turkish manufacturing industry, Isık *et al*. (2017) found that firm size indicators (assets, sales, and number of employees) affect the profitability of the firm positively. Kurt and Derekoy (2020) investigated the effects of foreign exchange rates on firm profitability for 37 Turkish manufacturing companies between 1999 and 2019. As a result of the analysis, which tested the effects of independent variables on return on assets and return on equity in two separate models, the authors concluded that changes in foreign exchange rates, foreign sales, and asset size do not significantly impact firm profitability determinants.

The literature review reveals that existing studies primarily concentrate on identifying the factors influencing profitability. Therefore, potential interaction effects between firms on profitability are ignored. This situation may lead to misleading results. This study seeks to address these gaps in two key aspects. Initially, it is investigated whether interaction effects between firms have an impact on profitability. Secondly, the analysis examines whether the factors influencing a firm's profitability also impact on the profitability of another firm within the same sub-sector. In addition, it aims to evaluate whether there is competition or clustering among firms in the Turkish manufacturing sector in line with the empirical findings.

3. Data and Methodology

This article examines the impact of firm-specific micro variables on the profitability of companies in the Turkish manufacturing sector, which alone accounts for approximately 20% of production in Turkey, constitutes nearly 35% of listed companies, and is expected to have interaction among companies based on their areas of activity. We also focus on whether the interaction effects between firms affect profitability. It is important to note that neglecting to consider these potential impacts may result in erroneous assessments of the impact of implemented policies, incomplete analyses of micro-level production dynamics, and inaccurate modelling of competitive advantages. Econometric models that take into account neighborhood structures based on sectoral networks represent progression beyond classical approaches and facilitate a more accurate analysis of firm-level strategic behaviors and sectoral relations. The study aims to contribute to the development of economic analyses and the design of effective policies for the Turkish manufacturing sector through the econometric modelling of interactions.

The sample consists of 119 firms in eight sub-sectors of the nine sub-sectors of the Turkish manufacturing industry listed on the BIST. One sub-sector is excluded from the analysis as it has data from only one company, and the analysis is conducted by over eight sub-sectors. It is based on quarterly data for the period 2014–2023. The firm-specific data[1] (profitability, liquidity situation, financial structure, operating efficiency, and firm size) are drawn from the Finnet database. Information on the variables is given in Table 2. Return on assets is calculated by the ratio of net profit to total assets for profitability. The liquidity of the firm is measured by the current ratio. The current ratio is calculated by dividing current assets by short-term liabilities. For financial structure, the ratio of total liabilities to total equity is used. Operating efficiency is measured by working capital turnover, and firm size[2] is expressed in terms of total assets.

1 Tables A2 and A3 present the descriptive statistics and correlation matrix, respectively. The Panel Unit Root Test (CIPS), developed by Pesaran (2007), is employed to ascertain the stationarity of the variables. The findings from these analyses are not presented here, but they can be requested directly from the authors.

2 Firm size series are in natural logarithms.

Table 2: Information on the variables

Variables	Proxy	Calculation
Return on Asset	Financial Performance	Net Profit/Total Assets
Current Ratio	Liquidity	Current Assets/Short-Term Liabilities
Working Capital Turnover Ratio	Liquidity	Net Annual Sales/Average Working Capital
Inventory Turnover Ratio	Operating Efficiency	Total Cost of Sales/Average Value of Inventory
Debt-Equity Ratio	Financial Structure	Total Liabilities/Total Equity
Firm Size (Total Assets)	Size	Total Assets

Source: Authors' own elaboration

Panel data specifications are generally used in the existing literature on the determinants of profitability (see *e.g.*, Arora and Sharma, 2016; Zhou *et al*., 2024; Nuseva *et al*., 2024). Conventional econometric models assume that there are no interaction effects between units. It is argued that ignoring the interacting effects leads to omitted variable bias (Greene, 2005: 133–134). These neglected effects are of particular interest for spatial econometric models (Anselin, 2001).

Spatial econometric models are of importance in ensuring that parameters that could be compromised due to the disregard of dependencies between units are estimated in an unbiased and consistent manner, taking into account interaction effects. The emergence of these dependencies can be attributed to a variety of mechanisms, ranging from the spillover effects of public policies to social interactions, externalities, and spatial strategic behavior (Case *et al*., 1993; Bramoullé *et al*., 2009). Furthermore, spatial econometrics facilitates a more realistic analysis of spatial interactions by enabling the separation of direct and spillover effects. Given the considerations, it is hypothesized that spatial econometrics may have the capacity to facilitate the attainment of results in regional and social data analysis that are both theoretically consistent and empirically reliable. This is predicated on the utilization of a formal representation of interaction effects.

Spatial econometrics uses the weight matrix, usually based on geographical proximity, to capture potential interaction effects between neighboring specifications (Anselin, 2002; Kelejian and Prucha, 1998). Moreover, Case *et al*. (1993: 287) state that "*neighborliness does not necessarily connote geographic proximity*". It is reasonable to hypothesize that the basis of the phenomenon under investigation is likely to be units that are linked by non-geographical characteristics, such as socio-economic similarity (Elhorst, 2014: 1).

The paper focuses on inter-firm interactions and defines the concept of "neighborhood" based on sectoral similarity and production technology proximity. This concept is predicated on the supposition that enterprises operating within analogous sub-sectors may be impacted by the resolutions and actions of other enterprises exhibiting analogous characteristics with regard to their production preferences, level of innovation, pricing strategies, productivity performance, and labor utilization. Consequently, to account for interactions arising from dependency relationships shaped by sectoral and technological proximity, modelling is carried out using weight matrices defined through network structures in the spatial econometrics' literature.

The following five-panel data model specification with interaction effects is adopted:

- Spatial Autoregressive Regression (SAR) Model

$$\boldsymbol{Y_t} = \rho \mathbf{W} Y_t + \mathbf{X_t}\boldsymbol{\beta} + \boldsymbol{\mu} + \gamma_t \boldsymbol{\iota_N} + \boldsymbol{u_t} \tag{1}$$

- Spatial Durbin Model (SDM)

$$\boldsymbol{Y_t} = \rho \mathbf{W} Y_t + \mathbf{X_t}\boldsymbol{\beta} + \theta \mathbf{W} X_t + \boldsymbol{\mu} + \gamma_t \boldsymbol{\iota_N} + \boldsymbol{u_t} \tag{2}$$

- Spatial Error Model (SEM)

$$\begin{aligned} \boldsymbol{Y_t} &= \mathbf{X_t}\boldsymbol{\beta} + \boldsymbol{\mu} + \gamma_t \boldsymbol{\iota_N} + \varepsilon_t \\ \varepsilon_t &= \lambda \mathbf{W} \varepsilon_t + \boldsymbol{u_t} \end{aligned} \tag{3}$$

- Spatial Autocorrelation Model (SAC)

$$\begin{aligned} \boldsymbol{Y_t} &= \rho \mathbf{W} Y_t + \mathbf{X_t}\boldsymbol{\beta} + \boldsymbol{\mu} + \gamma_t \boldsymbol{\iota_N} + \varepsilon_t \\ \varepsilon_t &= \lambda \mathbf{W} \varepsilon_t + \boldsymbol{u_t} \end{aligned} \tag{4}$$

- Generalized Spatial Panel Random-Effects Model (GSPRE)

$$\begin{aligned} \boldsymbol{Y_t} &= \mathbf{X_t}\boldsymbol{\beta} + \boldsymbol{\mu} + \gamma_t \boldsymbol{\iota_N} + \varepsilon_t \\ \varepsilon_t &= \lambda \mathbf{W} \varepsilon_t + \boldsymbol{u_t} \end{aligned} \tag{5}$$

where $\boldsymbol{Y_t}$ is a $N \times 1$ vector for the dependent variable (*Return on Assets*) of every firm i ($t - 1, ..., N$) at time t ($t - 1, ..., T$). The response parameters for the variables that are spatially lagged ($\mathbf{W}\boldsymbol{Y_t}$, $\mathbf{W}\mathbf{X_t}$, $\mathbf{W}\varepsilon_t$ and $\mathbf{W}_\mu$) are represented by ρ, θ, λ and ϕ. $\mathbf{W}$ spatial weight matrix[3] shows the linkages among the firms. $\mathbf{X_t}$ denotes an $N \times k$ matrix of exogenous explanatory

3 The assumption is made that $\mathbf{W}$ remains constant over time.

variables (*Current Ratio, Working Capital Turnover Ratio, Inventory Turnover Ratio, Debt-Equity Ratio* and *Firm Size (Total Assets))* that are assumed to affect firm profitability. $\boldsymbol{\beta}$ is defined as a $K \times 1$ vector that is associated with the response parameters. $\boldsymbol{\mu} = (\mu_1 - ..., \mu_N)'$ is a vector with firm fixed effects. γ_t $(t - 1, ..., T)$refers time-specific effects, and $\boldsymbol{\iota_N}$ is a $N \times 1$ vector of ones. It is asserted that $\boldsymbol{u_t}$ is an $N \times 1$ vector of independent and identically distributed disturbance terms, having a mean of zero and a variance of σ^2, in which $N = 119$ and $T = 39$.

In Equation (1), the dependent variable with spatial lag can be expressed as:

$$WY = (\mathbf{I_T} \otimes \mathbf{W_N})Y \tag{6}$$

In Equation (2), the independent variable with spatial lag can be represented as:

$$WX = (\mathbf{I_T} \otimes \mathbf{W_N})X \tag{7}$$

In Equations (3.b, 4.b, 5.b), the error term variable with spatial lag can be expressed as:

$$W\varepsilon = (\mathbf{I_T} \otimes \mathbf{W_N})\varepsilon \tag{8}$$

In Equation (5.c), the unit-specific interaction effects can be written as:

$$W\mu = (\mathbf{I_T} \otimes \mathbf{W_N})\mu \tag{9}$$

In this context, $\mathbf{I_T}$ is defined as the identity matrix of size $T \times T$, and $\mathbf{W}_\mathrm{N}$ is an $N \times N$ spatial weight matrix composed of w_{ij} . $(\mathbf{I_T} \otimes \mathbf{W})Y$ refers to the endogenous interaction effects, that is, the profitability of a particular firm depends on the profitability of other firms. $(\mathbf{I_T} \otimes \mathbf{W})X$ refers to the exogenous interaction effects among the independent variables. Such effects may be observed when the behaviour of the *Return on Assets* is contingent upon the decisions of independent explanatory variables, which are taken by other firms. $(\mathbf{I_T} \otimes \mathbf{W})\boldsymbol{\varepsilon}$ denotes the interaction effects between the disturbance terms of various units, which means that similar unobserved sub-sector features lead to similar behaviors. The interaction effects, represented by$(\mathbf{I_T} \otimes \mathbf{W})\mu$, indicate that the panel effects are related.

Subsequently, the element w_{ij} of the $\mathbf{W}$ matrix is calculated using the following expression:

$$w_{ij} = \begin{cases} 1/S_i & \text{if two firms are in the same subsector} \\ 0 & otherwise \end{cases} \tag{10}$$

where s_i = the number of firms in the same sub-sector i. The weight matrix is defined as being row-normalized.

The utilization of the ordinary least squares (OLS) method within spatial econometric models has the capacity to yield estimates that are biased and inefficient. This phenomenon can be attributed to the infringement of the model's fundamental assumptions by the spatial data structure. In spatial autoregressive models, the incorporation of the spatially lagged version of the dependent variable as an independent variable in the model gives rise to a simultaneity problem. This is due to the correlation of this variable with the error term, which results in biased and inconsistent OLS estimates (Anselin, 1988). Conversely, in the context of spatial error dependence, the OLS estimates are not biased but are not efficient, as the variance-covariance matrix of the error terms will no longer be diagonal, resulting in the standard error estimates becoming unreliable. This finding calls into question the validity of statistical tests such as *t* and *F*-tests (Kelejian and Prucha, 1998). Furthermore, the failure to explicitly incorporate geographic, sectoral, and/or network-based interactions within the model can result in the introduction of omitted variable bias, thereby compromising the reliability of estimation results. Consequently, in spatial econometric models, it is advisable to consider alternative estimation approaches that are more suited to the nature of spatial structures, such as maximum likelihood estimation (MLE), instrumental variables (IV), generalized moments (GMM), or two-stage extended OLS (S2SLS) (LeSage and Pace, 2009). This study employs the MLE method.

4. Empirical Estimates

To study the determinants of firm profitability, we apply five spatial panel models that consider the interaction effects. To the best of our knowledge, no study has allowed for the interaction effects between firms in the Turkish manufacturing sector; in this study, a weighting matrix is used to link firm profitability.

Table 3: Estimated coefficients of the non-spatial models (Dependent variable is "*Return on Assets*")

Panel A: OLS	
Current Ratio	1.538*** (22.42)
Working Capital Turnover Ratio	3.213*** (20.67)
Inventory Turnover Ratio	−0.084 (−0.91)
Debt-Equity Ratio	−0.028*** (−4.55)
Firm Size (Total Assets)	0.748*** (−11.75)
Panel B: Statistics for testing interaction effects	
Moran I	0.143***
Geary C	0.855***
LM_ρ	114.037***
LM_λ	584.665***

Notes: *t*-values are given in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively. The OLS (Ordinary Least Squares) results presented in Panel A of Table 3 are provided to examine interaction effects by obtaining residuals. It should be noted that the model does not incorporate firm-specific and year -fixed effects.

Source: Authors' own calculations

Firstly, in order to ascertain the existence of interaction effects, the Moran's I and Geary's C test statistics, as reported in Panel B of Table 3[4], are calculated. The null hypothesis for Moran's I and Geary's C posits the absence of such effects. The estimated test statistics (Moran's I = 0.143, $p < 0.000$; Geary's C = 0.855)) are statistically significant[5]. Furthermore, the LM test statistics are calculated to examine the structure of interaction effects. The null hypothesis of LM_ρ and LM_λ are the absence of spatial autoregressive and spatial error interaction effects, respectively. The estimated LM test statistics (LM_ρ = 114.037, $p < 0.000$; LM_λ = 584.665, $p < 0.000$) are statistically significant. Overall, the results suggest that interaction effects should be considered through spatial models.

4 The coefficients estimated for the non-spatial model are presented in Table 3.

5 Unless stated otherwise, the significance level, α, is set to 0.10.

Table 4: Estimated coefficients of the spatial panel models (Dependent variable is "*Return on Assets*")

	SAR	SDM	SEM	SAC	GSPRE
Current Ratio	0.482*** (7.67)	0.478*** (7.61)	0.484*** (7.77)	0.477** (2.20)	0.521* (1.91)
Working Capital Turnover Ratio	2.649*** (17.26)	2.504*** (11.51)	3.299*** (17.28)	2.516*** (4.74)	3.147*** (4.94)
Inventory Turnover Ratio	−0.083 (−1.25)	−0.073 (−1.09)	−0.087 (−1.29)	−0.082 (−1.10)	−0.085 (−0.96)
Debt-Equity Ratio	−0.021*** (−4.57)	−0.021*** (−4.58)	−0.022*** (−4.84)	−0.020** (−1.93)	−0.022 (−1.64)
Firm Size (Total Assets)	1.775*** (13.94)	1.411*** (4.42)	2.670*** (14.17)	1.661*** (3.64)	2.014 (1.56)
W × Current Ratio		−0.120 (−0.61)			
W × Working Capital Turnover Ratio		0.299 (1.02)			
W × Inventory Turnover Ratio		−0.454* (−1.92)			
W × Debt-Equity Ratio		0.057*** (3.68)			
W × Firm Size (Total Assets)		0.371 (1.07)			
ρ	**0.444***** (21.35)	**0.428***** (18.60)		**0.487***** (4.28)	
λ			**0.462***** (20.27)	−0.090 (−0.40)	0.485*** (8.87)
φ					−0.314* (−1.73)

Notes: *t*-values are given in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively. SAR: Spatial Autoregressive Regression Model; SDM: Spatial Durbin Model; SEM: Spatial Error Model; SAC: Spatial Autocorrelation Model; GSPRE: Generalized Spatial Panel Random-Effects Model.

Source: Authors' own calculations

The interaction effects of 119 firm are analyzed using the spatial panel models[6]. The estimates are presented in Table 4. The coefficients for the spatially lagged dependent variables are positive and statistically significant, with values of $\rho_{SAR} = 0.444$, $\rho_{SDM} = 0.428$, and $\rho_{SAC} = 0.487$, respectively. These results indicate the existence of endogenous interaction effects. Therefore, the profitability of firms in the same sub-sector is affected by each other. Furthermore, the coefficients for the spatially lagged error term variables are both positive and statistically significant, with $\lambda_{SEM} = 0.462$ and $\lambda_{GSPRE} = 0.485$, respectively. This finding indicates the presence of interaction effects between the residuals of different units. Finally, the coefficient *phi* in the GSPRE model is statistically significant, thereby indicating a correlation between firms. Overall, the results indicate that interaction effects are also effective on profitability.

Table 5: Tests for optimal model selection

Panel A: Tests for model selection between SDM, SAC, and GSPRE			
	SDM	**SAC**	**GSPRE**
AIC	27,880.58	27,891.22	29,161.27
BIC	27,927.26	27,942.34	29,225.43

Panel B: Test statistics of SAR and SEM versus SDM				
Model	**Hypotheses**	**Wald Statistics**	***p*-value**	**Decision**
SAR	$H_0 : \theta = 0$	$\chi^2_{(5)} = 20.21^{***}$	0.001	H_0 Rejected
SEM	$H_0 : \theta = -\rho\beta$	$\chi^2_{(5)} = 69.51^{***}$	0.000	H_0 Rejected

Panel C: The Hausman specification test for SDM		
Test	**Statistics**	***p*-value**
Spatial Hausman	20.21^{***}	0.000

Note: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Authors' own calculations

6 All analyses in this study are conducted using the STATA statistical software, version 17.

The results of the tests conducted to identify the optimal model are presented in Table 5. Firstly, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) values reported in Panel A of Table 5 are employed to evaluate the most optimal model between the SDM, SAC, and GSPRE. The results indicate that the SDM, which exhibits the lowest AIC and BIC values, is the most optimal model for the data set in question. Panel B of Table 5 presents the Wald test results for SAR and SEM versus SDM. In order to ascertain the most suitable model, two Wald tests are performed, comparing the following: SDM, SAR, and SEM. For the first case, the null hypothesis is that the SAR is optimal versus the alternative SDM. In the second case, the null hypothesis posits that the SEM is the optimal model, while the alternative hypothesis proposes SDM as the superior option. The rejection of the null hypotheses for both SAR and SEM provides evidence that SDM is an optimal model. Subsequently, the Hausman specification test is applied to assess models with fixed effects and random effects. The result indicates that the fixed effects model provides a more precise data representation. Overall, the results indicate that the SDM with fixed effect is the most appropriate functional form among the five considered.

The utilization of point estimates for spatial model specifications has the potential to engender fallacious inferences, a consequence of an unidentified feedback effect. (Elhorst, 2010: 18). Therefore, it is suggested to calculate both the direct effects and spillover effects (LeSage and Pace, 2009: 74). Direct effects represent the impact of alterations in firm-specific micro variables on firm profitability. Spillover effects are defined as the influence of changes in the independent variable of one firm on the dependent variable of another (Seldadyo *et al*., 2010: 633). In contrast to more traditional models of analysis, the application of spatial models allows for the estimation of both direct and spillover effects. The partitioned effects (direct and spillover) of our model are presented in Table 6.

Table 6: Direct and spillover effects from the SDM

Variable	Direct	Spillover
Current Ratio	0.486*** (7.17)	0.163 (0.49)
Working Capital Turnover Ratio	2.571*** (12.60)	2.327*** (6.62)
Inventory Turnover Ratio	−0.093 (−1.40)	−0.834** (−2.20)
Debt-Equity Ratio	−0.018*** (−3.95)	0.083*** (3.22)
Firm Size (Total Assets)	1.468*** (4.83)	1.658*** (4.51)

Notes: Direct and spillover effects are based on the partial derivatives. *p*-values are given in parentheses. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

Source: Authors' own calculations

The estimated coefficients of the direct effects of the *Current Ratio* are positive and statistically significant. In accordance with economic theory, an increase in the current ratio is a factor that enhances the profitability of firms (Padachi, 2006; Sharma and Kumar, 2011; Azam and Haider, 2011). A higher current ratio indicates a greater degree of liquidity for the firm in question. The high level of liquidity among these firms permits the uninterrupted continuity of their activities, which in turn increases profitability. A further crucial indicator of a firm's liquidity position is the working capital turnover rate. The coefficient of the *Working Capital Turnover Ratio* is positive and statistically significant, suggesting that an increase in this ratio positively affects the profitability of the firm (Lazaridis and Tryfonidis, 2006; Karaduman *et al*., 2010). In light of the substantial proportion of working capital represented by total assets among manufacturing enterprises, the working capital turnover rate is regarded as a crucial metric for gauging the efficacy of firms' liquidity management strategies. An increase in liquidity is associated with enhanced profitability. On the other hand, the estimated coefficient of the *Debt-Equity Ratio* is negative and statistically significant (Negash, 2001; Myers, 2001; Cassar and Holmes, 2003; Gedajlovic *et al*., 2003; Philips and Sipahioglu, 2004; Akman *et al*., 2015). This result demonstrates that the financial liabilities incurred by firms through the utilization of financial leverage cannot be employed effectively in the context of asset investment. The positive and statistically significant coefficient of *Firm Size (Total Assets)* indicates that an increase in firm size has a positive effect on profitability. The direct effects obtained regarding the variables assumed to affect firm profitability are in accordance with the findings of previous studies in this field, thus corroborating the existing literature.

A further output of spatial analysis is the consideration of indirect effects between units, in addition to the potential results that can be obtained through traditional econometric methods. Such effects are referred to as spillover effects. In other words, this method considers the possibility that a firm's profitability may be influenced not only by the firm's own dynamics but also by the dynamics of other firms operating within the same sub-sector. The empirical findings suggest that increases in *Working Capital Turnover, Debt-to-Equity Ratio,* and *Firm Size (Total Assets)* in other companies in the same sub-sector have a significantly positive effect on the profitability of the company in question. This finding can also be interpreted as an increase in the speed of access to finance, represented by a company's *Working Capital Turnover* and *Debt-to-Equity Ratio*, leading to an increase in the profitability of other companies. It also suggests that companies operating in the same sub-sector purchase raw materials or labor from each other and that the increase in the speed of access to finance has a positive effect on each other's profitability. *Firm Size* enables faster development in areas such as R&D, human resources, and supply chain management due to the budget, market share, and corporate structure that come with size. Large companies create a spillover effect, positively impacting other companies as well. However, the negative and statistically significant coefficient of the *Inventory Turnover Ratio* indicates that an increase in the ratio of other firms in the same sub-sector is associated with a reduction in profitability. An increase in a company's inventory turnover rate indicates that it is rapidly converting its inventory into sales, which in turn accelerates its sales and reduces the sales and profitability of its competitors. This finding points to competition between companies. It is noted that there is a difference between the slope parameters of the SDM model presented in Table 4 and those presented in Table 6. This result provides further evidence in support of the existence of the feedback effect.

5. Conclusion

This study investigates the determinants of firm profitability in the Turkish manufacturing industry using a spatial econometric approach that accounts for potential interaction effects across firms. Quarterly data of 119 manufacturing firms registered in 8 sub-sectors of the manufacturing industry in BIST for the period 2014–2023 are used. The main limitation of this study is related to the data. Although there are 242 companies in the BIST manufacturing sector, 119 companies whose data are available constitute the sample of this study. The Spatial Durbin Model (SDM) is used to investigate whether a firm's profitability is affected by the performance and characteristics of other firms in the same sub-sector. The main findings demonstrate that firm-specific variables such as liquidity (current ratio), working capital turnover, debt-equity ratio, and firm size significantly affect profitability.

More importantly, statistically significant spillover effects are observed especially for working capital turnover, firm size, and debt-to-equity ratio, confirming that firm profitability is not only determined by internal factors but also shaped by inter-firm dynamics across sub-sectors. Although the literature indicates that the current ratio (Padachi, 2006; Sharma and Kumar, 2011; Azam and Haider, 2011) and working capital turnover ratio (Lazaridis and Tryfonidis, 2006; Karaduman *et al*., 2010) have a positive and statistically significant effect on profitability, and the debt-equity ratio (Negash, 2001; Myers, 2001; Cassar and Holmes, 2003; Gedajlovic *et al*., 2003; Philips and Sipahioglu, 2004; Akman *et al*., 2015) has a negative and statistically significant effect on profitability, none of these studies accounts for statistically significant spillover effects. To the best of our knowledge, this is the first study to determine whether these firm-specific variables have a statistically significant spillover effect on profitability.

This study reveals that the increased profitability of a firm in the Turkish manufacturing industry positively influences other firms in the same sub-sector. When a general evaluation is made regarding the various factors that may be the reason for this situation, it is thought that the government's public policies (tax incentives, state support, *etc.*) for the relevant sub-sectors may have a positive effect on all firms. Firms in the same sub-sector often use similar raw materials and cost elements. In developing countries like Turkey, the widespread use of imported raw materials means firms encounter similar challenges and opportunities in accessing these resources. Nevertheless, since firms operate in the same sub-sector, they may have the opportunity to reduce their costs by using the same supply chain. Thus, decreasing costs have an impact on increasing profitability.

The positive image or brand created by a firm may drive increased profitability for other firms in the same sub-sector. The brand or positive image created by a firm operating in the same sub-sector may increase the demand for the product subject to that brand and allow other firms to increase their sales. In this sense, the brand has the potential to be an important intermediary for the profitability of firms in the same sub-sector to act together. Since increased demand will lead new investors to focus on these sub-sectors, new investments will contribute positively to the profitability of firms in the sub-sector through increased sales volume. Similarly, the use of high technology by a firm operating in the same sub-sector may have been an incentive for other firms to use this technology with the increase in the speed of information dissemination today. Thus, falling costs may have resulted in an increase in profitability for all firms. In fact, the increased profitability of firms in the same sub-sector is expected to contribute to the sector's growth by providing the necessary auto financing.

In addition to the above-mentioned factors that are likely to be effective, the existence of enterprises in the same sub-sector with different business policies may also be the reason for the profit interaction between firms. In other words, the diversification of firms that sell raw materials, engage in production, and directly trade goods prevents the loss of profits due to the competition caused by operating in the same sub-sector. Although the factors that are thought to justify the empirical findings are interpreted based on literature, it is an important research question for future studies to test the effect of these factors on the interaction with hypotheses.

This study shows that the use of spatial econometrics is not limited to the geographical neighborhood, but it can also consider that firms may be in a neighborhood relationship in terms of the sub-sectors in which they operate. In today's interconnected economy, firms are rarely independent; they are often influenced by the activities and strategies of others. In this context, using spatial econometrics in planning corporate finance strategies is expected to contribute to the literature. Future studies can investigate the interaction channels between the profitability of firms operating in the same sub-sector. In this study, financial statement-based variables that have an impact on profitability are used; in future studies, the direct and spillover effects of non-financial variables on profitability can also be tested. In addition, the interaction effect can be tested for other sectors, and comparative analyses can be made.

Acknowledgement

Availability of Data and Materials: The data is available on https://www.kap.org.tr.

Competing Interests: The authors declare that they have no competing interests.

Funding: Not applicable.

Authors' Contributions: All authors read and approved the final manuscript.

References

Agca, V., Topal, Y., Kaya, H. (2012). Linking intrapreneurship activities to multidimensional firm performance in Turkish manufacturing firms: an empirical study. I*nternational Entrepreneurship and Management Journal*, 8, 15-33. https://doi.org/10.1007/s11365-009-0132-5

Agiomirgianakis, G., Voulgaris, F., Papadogonas, T. (2006). Financial factors affecting profitability and employment growth: The case of Greek manufacturing. *International Journal of Financial Services Management*, 1(2–3), 232–242. https://doi.org/10.1504/IJFSM.2006.009628

Agiomirgianakis, G. M., Magoutas, A. I., Sfakianakis, G. (2013). Determinants of profitability in the Greek tourism sector revisited: The impact of the economic crisis. *Journal of Tourism and Hospitality Management*, 1(1), 12–17.

Akbulut, H. (2019). Türkiye'de imalat sanayi sektörünün ekonomik etkileri: Girdi çıktı modeli analizi. *Sosyoekonomi*, 27(42), 241–253. https://doi.org/10.17233/sosyoekonomi.2019.04.13

Akman, E., Gökbulut, R. İ., Nalın, T., Gökbulut, E. (2015). Capital structure in an emerging stock market: The case of Turkey. *Çankırı Karatekin İktisadi ve İdari Bilimler Fakültesi Dergisi*, 5(2), 639–660. DOI: 10.18074/cnuiibf.240

Alarussi, A. S., Alhaderi, S. M. (2018). Factors affecting profitability in Malaysia. *Journal of Economic Studies*, 45(3), 442–458. https://doi.org/10.1108/JES-05-2017-0124

Alarussi, A. S., Gao, X. (2023). Determinants of profitability in Chinese companies. *International Journal of Emerging Markets*, 18(10), 4232–4251. https://doi.org/10.1108/IJOEM-04-2021-0539

Anselin, L. (1988). *Spatial econometrics: Methods and models*. Springer. ISBN 978-9024737354

Anselin, L. (2001). Spatial econometrics, in B. H. Baltagi, ed., *A companion to theoretical econometrics*. Blackwell, pp. 310–330.

Anselin, L. (2002). Under the hood: Issues in the specification and interpretation of spatial regression models. *Agricultural Economics*, 27(3), 247–267. https://doi.org/10.1111/j.1574-0862.2002.tb00120.x

Anselin, L., Bera, A. (1998). Spatial dependence in linear regression models with an introduction to spatial econometrics. In: A. Ullah, D. E. A. Giles, eds., *Handbook of applied economic statistics*. CRC Press, pp. 237–289.

Arora, A., Sharma, C. (2016). Corporate governance and firm performance in developing countries: Evidence from India. *Corporate Governance*, 16(2), 420-436. https://doi.org/10.1108/CG-01-2016-0018

Azam, M., Haider, S. I. (2011). Impact of working capital management on firms' performance: Evidence from non-financial institutions of KSE-30 index. *Interdisciplinary Journal of Contemporary Research in Business*, 3(5), 481-492.

Bennenbroek, N., Harris, R. I. D. (1995). An investigation of the determinants of profitability in New Zealand manufacturing industries in 1986–87. *Applied Economics*, 27(11), 1093-1101. https://doi.org/10.1080/00036849500000092

Bockova, N., Zizlavsky, O. (2016). Innovation and financial performance of a company: A study from Czech manufacturing industry. *Transformations in Business & Economics*, 15(3), 156-176.

Bolarinwa, S. T., Akinlo, A. E., Onyekwelu, U. L. (2021). Determinants of firm profitability in Africa. *Global Business Review*. https://doi.org/10.1177/09721509211046336

Bramoullé, Y., Djebbari, H., Fortin, B. (2009). Identification of peer effects through social networks. *Journal of Econometrics*, 150(1), 41-55. https://doi.org/10.1016/j.jeconom.2008.12.021

Cakir, H. M., Kucukkaplan, İ. (2012). Analyzing effects of working capital component on profitability and valuation at manufacturing firm in ISE for 2000–2009 period. *The Journal of Accounting and Finance*, (53), 69-86.

Camino-Mogro, S., Bermúdez-Barrezueta, N. (2019). Determinants of profitability of life and non-life insurance companies: Evidence from Ecuador. *International Journal of Emerging Markets*, 14(5), 831-872. https://doi.org/10.1108/IJOEM-07-2018-0371

Case, A. C., Rosen, H. S., Hines Jr, J. R. (1993). Budget spillovers and fiscal policy interdependence: Evidence from the states. *Journal of Public Economics*, 52(3), 285-307. https://doi.org/10.1016/0047-2727(93)90036-S

Cassar, G., Holmes, S. (2003). Capital structure and financing of SMEs: Australian evidence. *Accounting & Finance Journal*, 43(2) 123-147. https://doi.org/10.1111/1467-629X.t01-1-00085

Central Bank of the Republic of Türkiye (2024). Data set. [Retrieved 2025-02-17] Available at: https://evds2.tcmb.gov.tr/index.php?/evds/serieMarket/collapse_21/6004/DataGroup/turkish/bie_gsyhifkhe/

Deloof, M. (2003). Does working capital management affect profitability of Belgian firms?. *Journal Of Business Finance & Accounting*, 30(3-4), 573-588. https://doi.org/10.1111/1468-5957.00008

Demir, F. (2009). Financialization and manufacturing firm profitability under uncertainty and macroeconomic volatility: Evidence from an emerging market. *Review of Development Economics*, 13(4), 592-609. https://doi.org/10.1111/j.1467-9361.2009.00522.x

Demirci, N. S. (2017). The determinants of profitability in manufacturing industry sector: Panel data analysis with CBRT sectoral balance sheets (1996–2015). *Ege Academic Review*, 17(3), 381–394. DOI: 10.21121/eab.2017328404

Demirgunes, K., Ucler, G. (2015). Inter-relationship between profitability, growth and size: Case of Turkey. *Journal of Business Economics and Finance*, 4(4), 659–678. DOI: 10.17261/Pressacademia.2015424534

Dogan, M. (2013). Does firm size affect the firm profitability? Evidence from Turkey. *Research Journal of Finance and Accounting*, 4(4), 53–59.

Elhorst, J. P. (2010). Applied spatial econometrics: Raising the bar. *Spatial Economic Analysis*, 5(1), 9–28. https://doi.org/10.1080/17421770903541772

Elhorst, J. P. (2014). *Spatial econometrics: From cross-sectional data to spatial panels*. Springer. ISBN 978-3642403392

Fuertes-Callen, Y., Cuellar-Fernandez, B. (2019). Inter-relationship between firm growth and profitability in a context of economic crisis. *Journal of Business Economics and Management*, 20(1), 86-106. https://doi.org/10.3846/jbem.2019.6928

Gedajlovic, E. R., Shapiro, D. M., Buduru, B. (2003). Financial ownership, diversification and firm profitability in Japan. *Journal of Management and Governance*, 7, 315–350. https://doi.org/10.1023/A:1025029601562

Goddard, J., Tavakoli, M., Wilson, J. O. (2005). Determinants of profitability in European manufacturing and services: Evidence from a dynamic panel model. *Applied Financial Economics*, 15(18), 1269–1282. https://doi.org/10.1080/09603100500387139

Greene, W. H. (2005). *Econometric analysis* (6th ed.). Pearson Prentice Hall. ISBN: 978-0135132456

Huang, C. H., Hou, T. C. T. (2019). Innovation, research and development, and firm profitability in Taiwan: Causality and determinants. *International Review of Economics & Finance*, 59, 385-394. https://doi.org/10.1016/j.iref.2018.10.004

Isik, O., Tasgin, U. F. (2017). Profitability and its determinants in Turkish manufacturing industry: Evidence from a dynamic panel model. *International Journal of Economics and Finance*, 9(8), 66–75. https://doi.org/10.5539/ijef.v9n8p66

Isik, O., Unal, E. A., Unal, Y. (2017). The effect of firm size on profitability: Evidence from Turkish manufacturing sector. *Journal of Business Economics and Finance*, 6(4), 301–308. https://doi.org/10.17261/Pressacademia.2017.762

Kaldor, N. (1966). *Causes of the slow rate of growth in the United Kingdom.* Cambridge University Press. ISBN: 978-0521054621

Karaduman, H. A., Akbas, H. E., Ozsozgun, A., Durer, S. (2010). Effects of working capital management on profitability: The case of selected companies in the Istanbul Stock Exchange (2005–2008). *International Journal of Economics and Finance Studies*, 2(2), 47–54.

Kelejian, H. H., Prucha, I. R. (1998). A generalized spatial two stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances. *Journal of Real Estate Finance and Economics*, 17, 99–121. https://doi.org/10.1023/A:1007707430416

Kurt, E., Derekoy, F. (2020). Analysis of the relationship between exchange rate changes and profitability in Turkey: Example of BIST manufacturing sector. *Journal of Business Economics and Finance*, 9(4), 304–319. https://doi.org/10.17261/Pressacademia.2020.1312

Lazaridis, D. I., Tryfonidis, D. (2006). Relationship between working capital management and profitability of listed companies in Athens Stock Exchange. *Journal of Financial Management and Analysis*, 19(1), 26–35.

LeSage, J., Pace, R. K. (2009). *Introduction to spatial econometrics.* Chapman & Hall/CRC. ISBN 978-0429138089

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7

Malik, H. (2011). Determinants of insurance companies profitability: An analysis of insurance sector of Pakistan. *Academic Research International*, 1(3), 315.

Margaretha, F., Supartika, N. (2016). Factors affecting profitability of small medium enterprises (SMEs) firm listed in Indonesia Stock Exchange. *Journal of Economics, Business and Management*, 4(2), 132–137. https://doi.org/10.7763/JOEBM.2016.V4.379

McDonald, J. T. (1999). The determinants of firm profitability in Australian manufacturing. *Economic Record*, 75(2), 115-126. https://doi.org/10.1111/j.1475-4932.1999.tb02440.x

Menicucci, E., Paolucci, G. (2016). The determinants of bank profitability: Empirical evidence from European banking sector. *Journal of Financial Reporting and Accounting*, 14(1), 86–115. https://doi.org/10.1108/JFRA-05-2015-0060

Ministry of Industry and Technology of the Republic of Türkiye (2023). *Structural analysis of the Turkish manufacturing industry.* Available at: https://www.sanayi.gov.tr/plan-program-raporlar-ve-yayinlar/suresiz-yayinlar/cr1304011103

Morina, F., Balomenou, C., Ergun, U. (2021). Determinants of profitability: Evidence of renewable energy companies. In: A. Horobet, L. Belascu, P. Polychronidou, A. Karasavvoglou, eds., *Global, regional and local perspectives on the economies of southeastern Europe: Proceedings of the 11th international conference on the economies of the Balkan and Eastern European countries (EBEEC) in Bucharest, Romania, 2019*. Springer International Publishing, pp. 243–256.

Myers, S. (2001). Capital structure. *Journal of Economic Perspectives*, 15(2), 81–102. https://doi.org/10.1257/jep.15.2.81

Negash, M. (2001). Debt, tax shield and bankruptcy costs: Some evidence from JSE. *Investment Analysis Journal*, 54(3), 114–128. https://doi.org/10.1080/10293523.2001.11082430

Noh, Y. (2015). Financial effects of open innovation in the manufacturing industry. *Management Decision*, 53(7), 1527-1544. https://doi.org/10.1108/MD-12-2014-0681

Nuseva, D., Dakić, S., Peštović, K., Hladika, M. (2024). The impact of sales growth on manufacturing companies' profitability in the Republic of Serbia – Panel data analysis. *Strategic Management*. https://doi.org/10.5937/StraMan2400009N

Odusanya, I. A., Yinusa, O. G., Ilo, B. M. (2018). Determinants of firm profitability in Nigeria: Evidence from dynamic panel models. *SPOUDAI-Journal of Economics and Business*, 68(1), 43–58.

Ozmen, E., Sahinoz, S., Yalçın, C. (2012). *Profitability, saving and investment of non-financial firms in Turkey*. Central Bank of the Republic of Turkey.

Padachi, K. (2006). Trends in working capital management and its impact on firms' performance: An analysis of Mauritian small manufacturing firms. *International Review of Business Research Papers*, 2(2), 45–58.

Panda, A. K., Nanda, S. (2018). Working capital financing and corporate profitability of Indian manufacturing firms. *Management Decision*, 56(2), 441–457. https://doi.org/10.1108/MD-07-2017-0698

Pervan, M., Pervan, I., Ćurak, M. (2019). Determinants of firm profitability in the Croatian manufacturing industry: Evidence from dynamic panel analysis. *Economic Research – Ekonomska Istraživanja*, 32(1), 968–981. https://doi.org/10.1080/1331677X.2019.1583587

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312. https://doi.org/10.1002/jae.951

Phillips, P. A., Sipahioglu, M. A. (2004). Performance implications of capital structure: Evidence from quoted U.K. organisations with hotel interests. *The Services Industry Journal*, 24(5), 1–21. https://doi.org/10.1080/0264206042000276829

Pratheepan, T. (2014). A panel data analysis of profitability determinants: Empirical results from Sri Lankan manufacturing companies. *International Journal of Economics, Commerce and Management*, 2(12).

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 1002–1037. https://doi.org/10.1086/261420

Sayilgan, G., Yildirim, O. (2009). Determinants of profitability in Turkish banking sector: 2002–2007. *International Research Journal of Finance and Economics*, 28, 207–214.

Seldadyo, H., Elhorst, J. P., Haan, D. J. (2010). Geography and governance: Does space matter? *Papers in Regional Science*, 89(3), 625–640. https://doi.org/10.1111/j.1435-5957.2009.00273.x

Sharma, A. K., Kumar, S. (2011). Effect of working capital management on firm profitability: Empirical evidence from India. *Global Business Review*, 12(1), 159–173. https://doi.org/10.1177/097215091001200110

Sivathaasan, N., Tharanika, R., Sinthuja, M., Hanitha, V. (2013). Factors determining profitability: A study of selected manufacturing companies listed on Colombo stock exchange in Sri Lanka. *European Journal of Business and Management*, 5(27), 99–107.

Spitsin, V., Ryzhkova, M., Vukovic, D., Anokhin, S. (2020). Companies profitability under economic instability: Evidence from the manufacturing industry in Russia. *Journal of Economic Structures*, 9, 1–20. https://doi.org/10.1186/s40008-020-0184-9

Tao, Q., Zahid, Z., Mughal, A., Shahzad, F. (2022). Does operating leverage increase firm's profitability and bankruptcy risk? Evidence from China's entry into WTO. *International Journal of Finance & Economics*, 27(4), 4705-4721. https://doi.org/10.1002/ijfe.2395

Taymaz, E., Suiçmez, H. (2005). *Türkiye'de verimlilik, büyüme ve kriz.* Milli Prodüktivite Merkezi.

TUIK (2023). *Yıllık sanayi ve hizmet istatistikleri 2022.* Available at: https://data.tuik.gov.tr/Bulten/Index?p=Yillik-Sanayi-ve-Hizmet-Istatistikleri-2022-49569

TUIK (2024). *Türkiye İstatistik Kurumu Haber Bülteni, Sayı 53450*. [Retrieved 2024-09-15] Available at: https://data.tuik.gov.tr/Bulten/Index?p=Yillik-Gayrisafi-Yurt-Ici-Hasila-2023-53450#:~:text=%C3%9Cretim%20y%C3%B6ntemine%20g%C3%B6re%20cari%20fiyatlarla,5%20ile%20imalat%20sanayi%20ald%C4%B1.

Tyagi, S., Nauriyal, D. K. (2017). Firm level profitability determinants in Indian drugs and pharmaceutical industry. *International Journal of Pharmaceutical and Healthcare Marketing*, 11(3), 271–290. https://doi.org/10.1108/IJPHM-03-2016-0016

Ukaegbu, B. (2014). The significance of working capital management in determining firm profitability: Evidence from developing economies in Africa. *Research in International Business and Finance*, 31, 1–16. https://doi.org/10.1016/j.ribaf.2013.11.005

Vržina, S., Dimitrijević, M. (2020). Determinants of profitability of the agricultural sector of Vojvodina: The role of corporate income tax. *The European Journal of Applied Economics*, 17(1), 1–19. https://doi.org/10.5937/ejae17-21368

Zhao, T., Pei, R., Pan, J. (2021). The evolution and determinants of Chinese property insurance companies' profitability: A DEA-based perspective. *Journal of Management Science and Engineering*, 6(4), 449-466. https://doi.org/10.1016/j.jmse.2021.09.005

Zhou, S., Noordin, B. A. A., Tunde, M. B. (2024). Innovation's influence on working capital management and profitability: A Chinese high-tech manufacturing perspective. *Accounting & Finance*. https://doi.org/10.1111/acfi.13315

Appendices

Table A1: Descriptive statistics

	Mean	Max.	Min.	Std. Dev.	Obs.
Return on Assets	4.990	72.141	−20.552	8.717	4522
Current Ratio	1.843	52.026	0.148	1.776	4522
Working Capital Turnover Ratio	1.111	12.874	0.026	0.772	4522
Inventory Turnover Ratio	−0.007	16.678	−35.306	1.274	4522
Debt-Equity Ratio	2.606	1173.735	0.017	18.892	4522
Firm Size (Total Assets)	20.471	26.333	15.841	1.804	4522

Source: Authors' own calculations

Table A2: Correlation matrix for the variables

	Return on Assets	Current Ratio	Working Capital Turnover Ratio	Inventory Turnover Ratio	Debt-Equity Ratio	Firm Size (Total Assets)
Return on Assets	1.00					
Current Ratio	0.246***	1.00				
Working Capital Turnover Ratio	0.270***	−0.113***	1.00			
Inventory Turnover Ratio	0.017	−0.000	0.107***	1.00		
Debt-Equity Ratio	−0.073***	−0.054***	0.003	−0.004	1.00	
Firm Size (Total Assets)	0.118***	−0.244***	0.145***	−0.003	0.029**	1.00

Note: ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Source: Authors' own calculations