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The Impact of Gender Diversity on the Board of Directors on Firm Performance: Evidence from the Global Automotive Industry

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ABSTRACT

This study explores the impact of board-level gender diversity on corporate outcomes, based on data gathered from 39 leading firms in the international automotive sector be-tween 2020 and 2024. The Blau Index was employed to measure gender diversity, whereas company performance was evaluated through indicators like ROA, ROE, and the Tobin's Q coefficient. Findings from the panel data analysis indicated that gender diversity had no statistically meaningful relationship with financial outcomes. On the other hand, the company size showed a statistically significant and positive effect, whereas the impact of leverage fluctuated based on the particular performance indicator used. Study results im-ply that although female board presence is often presumed to boost corporate perfor-mance, such an effect may not be universally applicable and depends on contextual fac-tors. While certain academic works report a notable link in this area, others assert that the direction of the effect varies—being either beneficial or adverse—based on industry type and cultural setting. This research yields valuable insights for decision-makers and cor-porate leaders aiming to assess how gender equality initiatives influence firm perfor-mance, particularly in alignment with sustainability goals and governance standards.

Keywords: Board Gender Diversity, Financial Performance, Automotive Industry, Panel Data Analysis
JEL Classifications: M14, L25, G34

1. INTRODUCTION

Recently, factors influencing corporate governance and business performance have been extensively studied from various perspectives. Diversity on boards of directors (gender, age, nationality, etc.) has become an important topic of discussion. Specifically, the influence of gender composition in corporate boards on organizational outcomes has become an increasingly prominent subject in both scholarly investigations and applied research. In the globalizing business world, increasing competition and changing consumer expectations require companies to adopt innovative and inclusive management strategies. In this context, the question of how balanced gender representation on boards of directors affects financial success and social sustainability by bringing different perspectives to decision-making processes comes to the fore. The board of directors is regarded as a key component of corporate governance, playing a crucial role in mitigating conflicts of interest between managers and owners, as well as among various ownership groups within the company. It also significantly contributes to shaping corporate strategy and enhancing the firm's capacity to obtain essential strategic assets (Garanina and Muravyev, 2021: 1). As a result, the composition and variation in the composition of the governing board are closely linked to the overall performance of the company. Given the crucial position held by board members in influencing governance mechanisms and business outcomes, stakeholders must consider several factors when forming the board. One of the central aspects influencing a board's functioning and firm outcomes is the variety in its composition, often referred to as board diversity (Kang et al., 2007: 2), is one of the most critical issues related to the board's effectiveness and impact on firm performance.

The 5th goal of the United Nations Sustainable Development Goals (SDGs), "Gender Equality", advocates for the full and effective participation of women in decision-making processes. Article 5.5 of SDG 5 emphasizes enhancing women's leadership in all decision-making platforms, and achieving gender balance on boards directly aligns with this objective. In this context, board gender diversity stands out as a critical element that supports not only corporate performance but also the implementation of gender equality at the corporate level. Increasing diversity supports SDG 8: "Decent Work and Economic Growth" by expanding creative problem-solving capabilities and strengthening risk management. Inclusive and fair management structures create work environments that encourage innovation, productivity and sustainable economic growth. Therefore, enhancing the representation of female leaders on boards not only bolsters the competitive advantage of firms but also fosters the processes of qualified employment and inclusive growth. The board is considered a fundamental institutional mechanism that reduces conflicts of interest among stakeholders. In particular, the different perspectives that diversity brings to decision-making processes support the balance between financial success and social sustainability. Hence, enhancing the composition of the board can potentially boost firm performance while also aligning with global sustainability objectives, particularly those outlined in SDG 5 and SDG 8.

Various theories, such as agency theory and resource dependence theory, have been utilized to explain how gender diversity on boards may affect corporate performance. These frameworks propose that individuals with diverse experiences and skills collaborating together can generate more innovative solutions and enhance risk management. However, some studies contend that the relationship between gender diversity and firm performance may differ based on contextual factors such as sector, national culture, and institutional regulations.

This article seeks to explore the effect of gender diversity on the board of directors on firm performance, drawing upon both theoretical and empirical insights. The study will review the existing literature, examine the potential benefits of diversity, address the challenges faced, and offer recommendations for policymakers and business leaders. The research findings aim to assist companies in shaping their diversity and inclusion strategies, ultimately fostering sustainable competitive advantage.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Recent academic discussions, based on agency theory and the resource dependence framework, emphasize the strategic value of incorporating gender diversity into corporate structures. It is suggested that enhancing the presence of women in managerial roles across hierarchical levels may lead to improved organizational performance.

Agency theory establishes a direct link between gender diversity on the board and company performance. It asserts that greater gender diversity on boards enhances board independence and improves the oversight of managers, thereby suggesting that diversity can reinforce the control mechanisms over managerial actions (Gallego-Alvarez et al., 2010: 59). When company owners and managers are different, managers may prioritize their own interests. Diversity on boards can establish a form of control mechanism, making it more challenging for board members to make decisions that align solely with their personal interests. In this context, considering that men may exhibit greater levels of ambition compared to women, it can be argued that the inclusion of female members on boards enhances the likelihood of decisions that prioritize the interests of shareholders (Öcal, 2022: 4-5). According to agency theory, the structure of a board should reduce potential conflicts between managers and owners, whose interests may not always align. In this context, theorists suggest that a board with a high board size and a majority of independent members will have positive effects on the business. According to agency theory, it is anticipated that board size will have a positive impact on financial performance by reducing transaction costs (Karoğlu, 2016: 68). In addition, it is very difficult for managers to dominate large boards of directors (Mak and Roush, 2000: 149). Based on agency theory, in a board of directors with many members, the activities of managers can be monitored and the knowledge level of business owners who own the organizations can be increased. On the other hand, in large boards of directors, diversifying the board with members with different skills can contribute to a more successful management process. In addition, agency theory also states that CEO duality (persons who hold the general manager position are also board members) will have negative effects on financial performance (Kılıç and Ayrıçay, 2018: 188). In the case of CEO duality, the difficulty of control and supervision will prevent increased performance (Rechner and Dalton, 1989: 142).

According to resource dependency theory, companies must access specific resources in order to sustain their operations. Diversity in boards of directors can provide additional opportunities to access these resources. For example, women can contribute to the company because they have different relationship networks compared to men. On the other hand, there are also views that as the diversity of the board of directors increases, it will be difficult to reach a common point due to disagreements and communication problems, and therefore it will be difficult to make decisions, this will cause delays, opportunities may be missed and therefore company performance will be negatively affected. At this point, determining the optimum board structure is important (Öcal, 2022: 4-5). The resource dependency view posits that maintaining authority over essential resources is key to organizational sustainability and long-term success. According to this theoretical perspective, boards of directors play a crucial role in acquiring strategic resources and elevating the firm's overall worth. Achieving optimal firm value necessitates access to several key assets, such as a skilled and analytically capable board, the presence of independent members, effective financial leverage, a strong standing in the Global Gender Gap Index, and diversity in board composition, particularly in terms of gender. Organizations with gender-diverse boards tend to have enhanced access to varied resource pools, which may reduce reliance on external actors, minimize ambiguity, and contribute positively to firm valuation.

In the literature section of this study, up-to-date sources directly containing the title. "The Effect of Gender Diversity on the Board of Directors on Firm Performance" were included. Because there are many studies in the literature based on many factors affecting firm performance. This method was preferred to better explain the subject and compare the results.

Existing studies differ in their conclusions about how board gender diversity influences corporate performance. Specifically, the literature shows the presence of studies both with a positive and a negative relationship between two variables.

Dogan (2018) examined how the presence of women on corporate boards influences financial performance, analyzing internationally indexed studies between 1993 and 2015. The review revealed a spectrum of findings, with some studies reporting that female representation may strengthen board independence and improve collaborative decision-making, especially in complex, consensus-driven contexts. On the contrary, other scholars argued that having more women on boards might heighten interpersonal conflicts and extend the time required for decision-making. Expanding on this topic, Reddy and Jadhav (2019) investigated the evolution of research on gender diversity within boards and explored the determinants of female board participation. Their comparative analysis across developed and emerging economies demonstrated varied impacts of gender-diverse boards on firm outcomes. They emphasized that findings across studies remained inconclusive, and similar ambiguity was observed in research exploring the influence of gender quota laws on company performance.

Empirical evidence on the link between gender-diverse boards and firm success shows mixed outcomes, often shaped by contextual variables like region and methodology. In this context, systematic classification and comparison of the main studies in literature is important in terms of strengthening the context of the current research. Table 1 below provides a summary of selected studies exploring the impact of board gender diversity on firm performance. The table includes details such as the author(s) and year of publication, sample region, analysis period, gender diversity measure used, financial performance indicators, observed effects, and the econometric methods employed. Thanks to Table 1, general trends in literature can be evaluated in a more holistic way and it becomes easier to compare the findings of the study with the existing literature.

The empirical findings summarized in Table 1 reveal that the impact of gender diversity on corporate performance differs across national contexts, timeframes, and analytical approaches. However, it is noteworthy that the existing literature is limited in terms of studies focusing on specific sectors on a global scale, and that comprehensive and long-term empirical studies focusing on the automotive sector in particular are not sufficiently included. On the other hand, the automotive sector offers an area where strategic management decisions are quickly reflected in firm performance due to its high R and D expenditures and capital-intensive structure, as well as the breadth of the supply chain and global competitive pressure. In addition, the sector is notable for gender diversity studies in terms of having historically male-dominated boards. In recent years, transformations such as electrification, sustainable mobility and strict environmental regulations have increased the need for more inclusive and innovative decision-making processes in governance structures. Within this framework, the present research examines automotive companies operating in various countries, aiming to fill a sector-specific void in the existing literature by assessing how gender composition on boards influences firm performance through a broader analytical lens.

3. MATERIALS AND METHODS

The increasing scholarly and institutional focus on gender representation within corporate governance structures has positioned board-level diversity as a significant factor in evaluating firm performance. In particular, the presence of women on boards of directors has been linked to broader discussions on financial outcomes, regulatory compliance, and alignment with international development frameworks.

This study operates board gender diversity as a key explanatory variable and investigates its association with financial performance indicators, within the scope of corporate governance practices and the United Nations Sustainable Development Goals (SDGs). The methodological approach is structured to provide empirical evidence relevant to SDG 5 (gender equality) and SDG 8 (decent work and economic growth), both of which emphasize inclusive and sustainable corporate policies.

3.1. Purpose and Importance of Research

This research aims to explore how the proportion of women on corporate boards influences firms' financial performance. The analysis draws on data obtained from the world's largest automotive companies, collectively representing approximately 90% of global market capitalization, thereby offering a robust foundation for sectoral evaluation.

By focusing specifically on gender composition at the board level within the automotive industry, the study contributes a sector-focused perspective to an area where the most existing empirical evidence remains geographically constrained. Given the limited scope of prior analyses on globally dominant automotive firms, this research offers valuable insights into the dynamics between board-level gender diversity and financial outcomes. The findings address a critical gap in the literature and provide empirical support for assessing the real-world implications of gender equality policies in corporate settings.

3.2. Dataset and Model

The dataset used in this research consists of 39 major automotive companies representing 90% of the world in terms of market value. The data covers the period between 2020 and 2024 and was created using the annual financial statements of each company retrieved

Table 1: Review of previous studies on board gender diversity and company performance

Authors	Period	Gender diversity indicator	Performance measures	Sample	Econometric method	Effect
Marinova et al. (2016)	2007	Female member ratio	Tobin Q	186 EU companies	Two-stage least squares	No effect
Darmadi (2011)	2007	Female member ratio	PERF, ROA, Tobin Q	169 Indonesian firms	Cross-sectional regression	Negative
Menteş (2011)	2004-2009	Female member ratio	Tobin Q, ROA	123 Turkish firms	Multiple linear regression	Negative (Tobin Q), None (ROA)
Oba and Fodio (2013)	2005-2007	Female dummy, ratio, Blau index	ROCE	30 Nigerian firms	Cross-sectional	Positive
Karayel and Doğan (2014)	2009-2012	Female ratio	ROE, ROA, Tobin Q	100 BIST firms	Regression, t-test	Mixed
Iacoviello et al. (2015)	2008-2014	Female dummy, ratio, Blau index	EBITDA, ROE, ROA	153 Italian firms	Fixed effect regression	No effect
Kılıç et al. (2016)	2008-2012	Female dummy, ratio, Blau index	ROA, ROE, ROS	149 BIST firms	2SLS	Positive
Shehata et al. (2017)	2005-2013	Female ratio, indexes	ROA	UK SMEs	Panel data	Negative
Eker and Kurtaran (2017)	2011-2013	Female ratio	ROE	46 Turkish banks	Multiple regression	No effect
Conyon and He (2017)	2007-2014	Female ratio	Tobin Q, ROA	3,000 US firms	Quantile regression	Positive
Appiadjei et al. (2017)	2010-2014	Female ratio	ROE	34 Ghana firms	Regression	Strong positive
Ionascu et al. (2018)	2012-2016	Female dummy, ratio	ROA, ROE, Tobin Q	343 Romanian firms	Regression	No effect
Ataünal and Aybars (2018)	2008-2015	Female dummy, ratio, Blau index	ROA, ROE, Tobin Q	151 BIST firms	Panel data	No effect/Negative (Tobin Q)
Duppati et al. (2019)	2005-2016	Female ratio	Tobin Q	69 NZX companies	Panel, OLS, LAD	Positive
Tleubayev et al. (2020)	2016	Female ratio	RAO, ROS	261 Russian agri firms	Regression	Positive
Yurt (2020)	2012-2017	Female ratio	ROA, ROE	BIST firms	Panel, fixed effects	No effect
Çalış et al. (2020)	2014-2019	Female ratio	ROA, ROE	46 BIST holdings	T-test, content analysis	Mixed
Brahma et al. (2021)	2005-2016	Female ratio	ROA, Tobin Q	FTSE 100	Panel data	Negative
Song et al. (2020)	1993-2018	Female ratio	Tobin Q	320 US accommodation firms	Panel regression	Positive
EmadEldeen et al. (2021)	2000-2016	Female ratio	ROA, Tobin Q	FTSE 100/250 (233)	Panel data	Positive
Tan and Bal (2021)	2014-2019	Female ratio	ROA	102 Turkish firms	Correlation, regression	No effect
Garanina and Muravyev (2021)	1998-2014	Female dummy, ratio	Tobin Q, ROA, ROE	550 Russian firms	Panel data	Some positive
Arora (2022)	2015-2019	Female dummy, ratio	Tobin Q, ROA, RONW	442 Indian firms	Dynamic panel	Positive
Simionescu et al. (2021)	2009-2020	Female ratio	ROA	71 S and *P* 500 firms	OLS	No effect
Marquez-Cardenas et al. (2022)	2012-2018	Female ratio	ROA	243 LatAm firms	Panel data	No effect
Öcal (2022)	2007-2020	Female presence	Tobin Q, ROA	66 BIST 100	Panel regression	Positive (ROA), None (Tobin Q)
Türkoğlu and Köse (2022)	2012-2021	Female ratio	ROA, ROE, Tobin Q	26 BIST finance firms	Panel data	Negative (ROE), None (others)
Karslıoğlu and Sevim (2022)	2010-2019	Female ratio	Tobin Q	40 Turkish mfg. firms	Panel data	No effect
Saona and Azad (2023)	2010-2020	Female ratio, Blau index, Shannon index	ROA, ROE	19 EU countries	Regression	Context-dependent
Sevimli Örgün (2023)	2015-2020	Female ratio	ROA, Altman-Z, Springate-S	154 BIST mfg. firms	Logistic regression	Negative
Ferrary and Deo (2023)	2016	Female ratio	ROA, Tobin Q	159 French firms	OLS	Positive

from official websites. Table 2 contains information about these companies.

In this study, financial performance is assessed using three widely accepted indicators: ROA, ROE, and Tobin's Q. These metrics are summarized in Table 3, including their definitions, measurement approaches, and relevance in literature. ROA and ROE represent accounting-based performance, while Tobin's Q offers a market-based perspective. All three indicators have been frequently used in previous studies examining the impact of board gender diversity on firm outcomes.

In prior empirical literature, gender heterogeneity within corporate boards has been conceptualized through three primary methodological lenses. The first approach involves a binary indicator, wherein the existence of at least one female member is coded as 1, and the absence thereof as 0. This simplistic classification is frequently employed to detect the mere presence of female representation on boards (e.g., Oba and Fodio, 2013; Iacoviello et al., 2015; Arora, 2022; Duppati et al., 2019).

The second method operationalizes gender composition as a ratio, calculated by dividing the number of female directors by the total number of board members. This proportional metric quantitatively reflects the extent of female participation (e.g., Marinova et al., 2016; Simionescu et al., 2021; Ferrary and Deo, 2023).

Table 2: Companies ıncluded in the analysis

Company	Country	Company	Country
Bajaj Auto Ltd	India	Nio	China
BMW	Germany	Nissan	Japan
Daimler truck	Germany	Renault	France
Eicher motors	India	Rivian Automotive	United States
Ferrari	Italy	Seres	China
Ford	United States	Shimano	Japan
Geely	Hong Kong	Stellantis	Netherlands
General motors	United States	Subaru	Japan
Great wall motor	China	Suzuki	Japan
Guangzhou	China	Tata motors	India
Hero motocorp	India	Tesla	United States
Honda	Japan	Toyota	Japan
Hyundai	South Korea	Traton SE	Germany
Isuzu	Japan	TVS motor	India
Jardine	Singapore	Volkswagen	Germany
Kawasaki	Japan	Xpeng	China
Li Auto	China	Yamaha	Japan
Lucid	United States	Yutong bus	China
Mahindra	India	Zhejiang Leapmotor	China
Mercedes	Germany		

Lastly, the Blau Index is utilized to capture the degree of demographic balance in board structure. Unlike the other two, this index accounts for the overall distribution of gender groups, offering a more nuanced measure of diversity (e.g., Shehata et al., 2017; Ataünal and Aybars, 2018; Saona and Azad, 2023).

In the present analysis, all three indicators were initially computed. However, due to high inter-correlations and evidence of multicollinearity identified during panel data diagnostics, only the Blau Index was retained for the final model. This decision was based on its methodological strength in reflecting actual heterogeneity, especially in cases where numerical representation may not accurately depict diversity.

The Blau Index provides more granular insight, particularly when a board includes multiple women but lacks gender distributional balance. The index reaches its upper boundary of 0.5 under maximum diversity and drops to 0 under complete uniformity (Campbell and Mínguez-Vera, 2008). Accordingly, its adoption enhances the robustness and interpretive validity of diversity measurements in empirical models.

This study explores the link between gender diversity on the board of directors and financial performance, incorporating Business Size and Leverage Ratio as control variables to account for the potential influence of factors such as company size and debt structure on this relationship. In this way, the effect of gender diversity on financial performance was analyzed more accurately and reliably. Table 4 shows the variables used in the study and the symbols used in establishing the model.

Summary statistics for the variables are presented in Table 5, and these data constitute the basic basis for creating the model.

Assessing the influence of gender diversity on corporate boards in relation to financial performance requires the joint analysis of both longitudinal and cross-sectional data." Considering observations from different years of the same company with a holistic approach allows for the simultaneous consideration of time-dependent changes and firm-based differences. For this reason, panel data analysis was preferred in the analysis process. By integrating cross-sectional and time-series aspects, panel data analysis enables

Table 3: Financial performance indicators used in the study

Examples from literature	Indicator	Type	What it measures	Interpretation
Ujunwa et al. (2012) Javed et al. (2013) Darmadi (2011) Karayel and Doğan (2014) Iacoviello et al. (2015)	ROA	Accounting-based	Efficiency of asset utilization	A low ROA signals poor use of resources; reflects management's ability to create value with available assets
Ellinger et al. (2002) Otluoğlu et al. (2016) Appiadjei et al. (2017) EmadEldeen et al. (2021)	ROE	Accounting-based	Profitability in relation to shareholders' equity	Indicates the firm's ability to generate returns for investors; a widely used metric in performance assessment
Lindenberg and Ross (1981) Marinova et al. (2016) Menteş (2011) Conyon and He (2017) Ferrary and Deo (2023)	Tobin's Q	Market-based	Market valuation relative to the replacement cost of assets	A value above 1=market overvalues assets (optimism); below 1=undervaluation; used for market-based performance and governance studies

Table 4: Defining variables

Variables	Definition	Symbols
Return on assets (dependent variable)	$\frac{\text{Earnings Before Interest and Taxes (EBIT)}}{\text{Total Assets}}$	ROA
Return on equity (dependent variable)	$\frac{\text{Net Profit}}{\text{Shareholders' Equity}}$	ROE
Tobin's Q ratio (dependent variable)	$\frac{\text{Total Assets + Market Value − Book Value}}{\text{Total Assets}}$	TOBINQ
Blau index (independent variable)	$1-\sum_{i=1}^{n} P_i^2$ Pi=Gender proportions on the board of directors (female and male), n=Number of gender categories (2: Female and male)	BLAU
Firm size (Independent variable)	Natural logarithms of total assets	SIZE
Leverage ratio (Independent variable)	$\frac{\text{Total Debt}}{\text{Total Assets}}$	LEV

Table 5: Statistics of variables

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
ROA	195	2.564763692	9.052397184	−34.86	20.65
ROE	195	5.712876372	23.05740224	−142.47	50.24
TOBINQ	195	0.222958653	0.750352273	−8.326301321	0.760931667
BLAU	195	0.303776923	0.135307019	0	0.5
SIZE	195	26.42549949	2.458427139	21.0597	33.2746
LEV	195	0.573500513	0.223598544	0.0786	1.9429

a more precise and dependable investigation into the link between board diversity and financial outcomes.

The models developed for this purpose seek to examine the connection between gender diversity on corporate boards and financial performance with greater accuracy and reliability. To enhance the validity of the analyses, variables were carefully selected to minimize multicollinearity issues.

$$\text{Model 1 - } ROA_{It} = \beta_0 + \beta_1 BLAU_{It} + \beta_2 SIZE_{It} + \beta_3 LEV_{it} + u_{it}$$

$$\text{Model 2 - } ROE_{It} = \beta_0 + \beta_1 BLAU_{It} + \beta_2 SIZE_{It} + \beta_3 LEV_{it} + u_{it}$$

$$\text{Model 3 - } TOBINQ_{It} = \beta_0 + \beta_1 BLAU_{It} + \beta_2 SIZE_{It} + \beta_3 LEV_{it} + u_{it}$$

The subscript "it" used in the model represents the time series data of each automotive company in the panel data structure. This expression shows the observation value of the company specified with the letter "i" in year "t".

4. RESULTS AND DISCUSSION

In the process of determining the appropriate model in panel data analyses, testing whether the model parameters are homogeneous is an important step. Homogeneity refers to the assumption that the slope coefficients of different units are constant in panel data models. Following the approach proposed by Pesaran and Yamagata (2008), a homogeneity test was conducted to determine whether the slope coefficients are statistically homogeneous across cross-sectional units. The null hypothesis established in the homogeneity test is "that the parameters are homogeneous". Based on the test outcomes, the null hypothesis could not be rejected across all estimated models. This situation reveals the result that the parameters in the model are homogeneous among the units. The homogeneity test results of all models are presented in detail in Table 6.

Table 6: Homogeneity tests

Model	Test statistic (Δ)	P-value	Result
Model 1 - ROA	−0.104	0.917	Homogeneous (Null hypothesis accepted)
Model 2 - ROE	−0.213	0.832	Homogeneous (Null hypothesis accepted)
Model 3 - TOBINQ	−1.299	0.194	Homogeneous (Null hypothesis accepted)

A range of statistical diagnostics was conducted to identify the most appropriate methodological approach for the analysis. These tests contributed to the selection of the appropriate analysis method by evaluating the structural features of the model. First, Anova F test was used to evaluate the presence of unit effects in the model. This test tests the validity of the classical model by determining whether there are fixed effects in the panel data model. The Likelihood Ratio (LR) test was also applied to test the structural suitability of the model more comprehensively. The LR test analyzes whether both unit constants and time constants are included in the model and reveals whether the classical model can be accepted as correct. In other words, these two tests (F test and LR test) test the null hypothesis that "the variance of unit effects is zero" (H_0: $\sigma_u^2 = 0$). Rejection of the null hypothesis implies the presence of unit heterogeneity, thereby indicating that the assumptions of the classical model are violated and it may not be an appropriate specification.

As a result of the analyses conducted for all models, it was determined that the obtained p-values are smaller than 0.05, and the corresponding values are presented in Table VII; accordingly, the null hypothesis stating that "unit effects are zero" is rejected.This finding reveals that there are significant unit effects in the panel data set. Therefore, it is concluded that the classical model is not valid and that unit effects should be considered in the analysis. In this case, the analysis should be performed using fixed or random effects models.

The Hausman test questions whether there is a systematic difference between fixed and random effects estimators in panel data analysis. The null hypothesis of the test is "there is no systematic difference between the parameters". In cases where the null hypothesis is rejected, the fixed effects model is deemed more suitable; conversely, failure to reject the null supports the adoption of the random effects model. The Hausman test aims to determine the most accurate estimator by evaluating the fit between the models (Yerdelen Tatoğlu, 2016). According to the Hausman test results conducted in the study, the null hypothesis could not be rejected in all models because the P value was higher than 0.05. This shows that the random effects estimator is an effective estimator. The test results are given in Table 8.

For the estimators obtained in panel data analyses to have the Best Linear Unbiased Estimator quality, certain assumptions must be met. These assumptions are homoskedasticity (constant variance), serial independence (absence of autocorrelation) and cross-sectional independence (absence of correlation between units). Meeting these conditions is critical in terms of increasing the accuracy and reliability of the estimators obtained.

Classical F tests are used to test variance homogeneity and are basically based on the assumption that the data are normally distributed. However, in cases where this assumption is not met, more flexible methods are needed. For this purpose, Levene (1960) developed a heteroskedasticity test that provides reliable results regardless of the normal distribution assumption. Later, Brown and Forsythe (1974), in addition to Levene's test, suggested more robust test statistics based on the trimmed mean to reduce the effect of outlier observations (Yerdelen Tatoğlu, 2016). In this study, Levene and Brown-Forsythe test statistics (w_0, w_{50} and w_{10}) were compared with the Snedecor F table with a degree of freedom of 14.30. As a result of the analysis, the null hypothesis (H_0) established as "the variances of the unit effects are equal" was rejected. This finding shows that heteroskedasticity is present in the model (Yerdelen Tatoğlu, 2016, p. 185). The results of the heteroskedasticity test statistics are given in Table 9.

According to Table 10, the fact that the obtained $P < 0.05$ for all models has led to the rejection of the null hypothesis of "there is equality of variance between units". This situation reveals that there is a heteroscedasticity problem in the panel data set.

In order to evaluate the presence of autocorrelation in the random effects model, Langrange Multiplier (LM) and Extended Langrange Multiplier (ALM) tests were applied. Autocorrelation refers to the situation where error terms are not independent between consecutive observations, and this situation may negatively affect the accuracy of model estimates. Therefore, the existence of the autocorrelation problem was meticulously examined to ensure the reliability of the model. The findings obtained as a result of the analyses are given in Table 10.

LM and ALM autocorrelation tests are compatible with the combined LM test with 1 degree of freedom and the χ^2 distribution with 2 degrees of freedom. According to the results of these tests conducted to evaluate the presence of autocorrelation, since the $P < 0.05$, the basic hypothesis that there is no autocorrelation is rejected.

Cross-sectional dependence refers to the existence of correlation between units in panel data analysis. In a panel data structure, the existence of dependence between observations obtained

Table 7: Findings regarding the unit effect hypothesis

Model	Test	Test statistic	P-value
Model 1 - ROA	ANOVA F	37.58	0.000
	LR	265.31	0.000
Model 2 - ROE	ANOVA F	12.63	0.000
	LR	130.76	0.000
Model 3 - TOBINQ	ANOVA F	1.76	0.008
	LR	4.68	0.015

Table 8: Hausman test results

Model	χ^2	P-value	Result
Model 1 - ROA	6.58	0.865	Random effects model is valid.
Model 2 - ROE	4.99	0.172	Random effects model is valid.
Model 3 - TOBINQ	1.95	0.583	Random effects model is valid.

Table 9: Heteroscedasticity test results

Model	F-test	Test statistic	P-value
Model 1 - ROA	W0	3.0582266	0.000
	W50	3.0582266	0.124
	W10	3.0582266	0.000
Model 2 – ROE	W0	4.2704553	0.000
	W50	1.6345314	0.019
	W10	4.2704553	0.000
Model 3 - TOBINQ	W0	27.0971509	0.000
	W50	2.7310198	0.000
	W10	27.0971509	0.000

Table 10: LM - ALM test results

Model	Test	Test statistic	P-value
Model 1 - ROA	LM	197.94	0.000
	ALM	18.08	0.000
Model 2 - ROE	LM	113.09	0.000
	ALM	7.78	0.005
Model 3- TOBINQ	LM	397.52	0.000
	ALM	566.88	0.000

from different units may lead to deviations in model estimates and a decrease in reliability. Therefore, detecting the existence of cross-sectional dependence in panel data analyses is critical to ensuring the accuracy of the model. In this research, Pesaran (2004) test was applied to test the cross-sectional dependency. This test evaluates whether there is a correlation between the error terms of the units. The null hypothesis (H_0) is "there is no correlation between units". The analysis results of the models are given in Table 11.

According to the Pesaran test results, since the P value for Model 1 (ROA) and Model 3 (TOBINQ) was <0.05, the null hypothesis was rejected, and it was determined that there was cross-sectional dependence. This situation shows that there is a correlation between the units in these models. On the other hand, since the P value obtained for Model 2 (ROE) was >0.05, the null hypothesis could not be rejected, and it was concluded that there was no cross-sectional dependence. This result indicates that there is no significant correlation between the units in the ROE model.

As a result of the analyses performed, it was revealed that the model was a random effects model that included a one-way unit effect. However, the tests conducted to evaluate the basic assumptions of the model showed the existence of heteroscedasticity and inter-unit autocorrelation problems.

On the other hand, it was verified through the applied tests that there was no specification error in the model. Under these conditions, to obtain more reliable results without changing the parameter estimates of the model, the standard errors were made robust. Thus, a model with increased resistance to heteroskedasticity and autocorrelation problems was created. The findings of the analysis of the models using robust standard errors are presented in detail in Table 12.

Table 11: Cross section dependency

Model	Test statistic	P-value	Result
Model 1 - ROA	3.717	0.000	There is a cross section dependency
Model 2 - ROE	1.534	0.124	There is a cross section dependency
Model 3 - TOBINQ	3.168	0.001	There is a cross section dependency

Table 12: Robust standard error analysis results for all models

Model	Variables	Coefficient	Robust standard error	z-statistic	P>|z|
Model 1 - ROA	BLAU	−7.043511	6.686684	−1.05	0.292
	SIZE	1.579769	0.5118907	3.09	0.002
	LEV	−1.548329	1.639936	−0,94	0.345
	Constant	−36.15375	13.88999	−2.60	0.009
Model 2 - ROE	BLAU	1.670862	14.13675	0.12	0.906
	SIZE	3.524304	1.510671	2.33	0.020
	LEV	−31.25196	9.503568	−3.29	0.001
	Constant	−70.00324	40.45751	−1.73	0.084
Model 3 - TOBINQ	BLAU	1.331652	0.9809123	1.36	0.175
	SIZE	0.0656905	0.0335552	1.96	0.050
	LEV	0.5444303	0.1016312	5.36	0.000
	Constant	−2.22984	1.221771	−1.83	0.068

According to the analysis results using the random effect model, gender diversity (BLAU) was not significant in any model, indicating that the gender structure of the board of directors does not have a significant effect on financial performance. The firm size (SIZE) variable has a positive and significant effect in all models. This finding reveals that size plays a positive role on both profitability and market value. The leverage ratio (LEV) is negative and significant in the ROE model, while it is positive and significant in the Tobin Q model. This can be interpreted as a finding that the use of debt can increase market value while decreasing profitability.

As a result, considering the coefficients and robust standard errors obtained in the analyses, it was observed that size and debt ratio were significant determinants in some models, but the effect of the gender diversity variable on financial performance was not significant.

5. CONCLUSION

Gender diversity on corporate boards occupies a nuanced position within the broader discourse on firm performance and governance practices. In this analysis, where gender diversity is quantified through the Blau index, no statistically significant association is found between board composition and key financial indicators—namely Return on Assets (ROA), Return on Equity (ROE), and Tobin's Q ratio—across 39 leading automotive firms from 2020 to 2024. These findings echo the conclusions drawn by Marinova et al. (2016), Ionascu et al. (2018), Ataünal and Aybars (2018), Simionescu et al. (2021), and Marquez-Cardenas et al. (2022), all of whom report a similarly weak or non-existent correlation between gender representation and firm-level performance metrics.

The absence of a measurable effect, however, should not be interpreted as the irrelevance of board diversity. Contextual factors—ranging from sector-specific characteristics to institutional environments—play a decisive role in shaping performance outcomes. The male-dominated structure of the automotive industry, coupled with the limited presence of female board members, may dilute the observable influence of diversity in this setting. This contextual contingency is well reflected in prior studies (Oba and Fodio, 2013; Appiadjei et al., 2017; Brahma et al., 2021; EmadEldeen et al., 2021; Arora, 2022), which highlight how women's diverse cognitive and strategic contributions can enhance profitability and elevate market valuation, albeit under differing industrial and regulatory conditions.

Theoretical interpretations also point toward a non-uniform relationship between gender diversity and performance, one that is shaped by socio-institutional dynamics rather than universal mechanisms. Reddy and Jadhav (2019) emphasize the role of gender quotas and cultural norms in modulating the visibility of diversity effects. In sectors where patriarchal norms dominate governance structures, potential gains from inclusive leadership may be structurally suppressed. Öcal (2022), for instance, observes that while gender heterogeneity can yield improvements in accounting-based indicators, its effect on market-driven performance remains statistically inconclusive.

Collectively, these insights support a more layered understanding of the diversity–performance nexus. Rather than searching for direct and universal causalities, future research may be better served by interrogating the conditions under which board diversity translates into financial value—conditions shaped by sectoral logic, national policy frameworks, and organizational maturity. Through such a contextualized lens, the assessment of gender equity policies in corporate environments can progress from surface-level metrics to more meaningful institutional evaluation.

Taken together, the findings reinforce that gender diversity on boards should not be regarded as the exclusive determinant of organizational performance. Instead, when assessed in conjunction with sector-specific dynamics, institutional culture, and regulatory frameworks, gender diversity may yield more nuanced and meaningful insights. This highlights the importance of incorporating broader contextual variables into future empirical inquiries. Therefore, it is suggested that policy makers and companies should focus on strategies that will not only increase diversity rates but also strengthen the integration of diversity into corporate operations. Future research will provide more detailed evaluations through cross-sector comparative analyses, offering a deeper understanding of how diversity policies influence board performance.

Future studies may explore not only the quantitative but also the qualitative dimensions of female representation, examining more deeply how female board members influence corporate decision-making processes.

REFERENCES

Appiadjei, E.A., Ampong, G.O., Nsiah, F. (2017), Board, gender diversity and firm performance. International Journal of Economics, Commerce and Management, 5(10), 1-16.

Arora, A. (2022), Gender diversity in boardroom and its impact on firm performance. Journal of Management and Governance, 26, 735-755.

Ataünal, L., Aybars, A. (2018), Yönetim kurullarındaki cinsiyet çeşitliliği ile çeşitliliğin finansal performans etkisi: Gelişmekte olan piyasa örneği. Maliye ve Finans Yazıları, 109, 71-90.

Brahma,S. Nwafor,C. Boateng, A. (2021), Board gender diversity and firm performance: The UK evidence. International Journal of Finance and Economics, 26, 5704-5719.

Çalış, Y.E., Şahin, B.Ş., Gürel, C.A., Ayrancı, B. (2020), The effect of gender diversity on the financial performance of businesses: BIST holding and investment businesses. Finans Ekonomi ve Sosyal Araştırmalar Dergisi, 5(2), 359-368.

Campbell, K., Mínguez-Vera, A. (2008), Gender diversity in the boardroom and firm financial performance. Journal of Business Ethics, 83(3), 435-451.

Conyon, M.J., He, L. (2017), Firm performance and boardroom gender diversity: A quantile regression approach. Journal of Business Research, 79, 198-211.

Darmadi, S. (2011), Board diversity and firm performance: The Indonesian evidence. Journal Corporate Ownership and Control, 8(2), 450-466.

Dogan, M. (2018), Kadın yönetim kurulu üye Sayısının finansal performans üzerinde etkisi: Literatür taraması. International Journal of Management Academy, 1(2), 132-141.

Duppati, G., Rao, N.V., Scrimgeour, F., Matlani, N. (2019), Gender diversity reporting, performance, and exogenous shocks: Evidence from New Zealand. International Journal of Comparative Management, 2(3/4), 203-228.

Eker, D., Kurtaran, A. (2017), Bankalarin yönetim kurullarindaki cinsiyet Çeşitliliği ve finansal performans ilişkisi. Global Journal of Economics and Business Studies, 6(12), 64-72.

Ellinger, A.D., Ellinger, A.E., Yang, B., Howton, S.W. (2012), The relationship between the learning organization concept and firms' financial performance: An empirical assessment. Human Resource Development Quarterly, 13(1), 5-22.

EmadEldeen, R., Elbayoumi, A.F., Basuony, M.A.K., Mohamed, E.K.A. (2021), The effect of the board diversity on firm performance: An empirical study on the UK. Corporate Ownership and Control, 18(3), 337-347.

Ferrary, M., Deo, S. (2023), Gender diversity and firm performance: When diversity at middle management and staff levels matter. The International Journal of Human Resource Management, 34(14), 2797-2831.

Gallego-Alvarez, I., Garcia-Sanchez, I.M., Rodriguez-Dominguez, L. (2010), The influence of gender diversity on corporate performance. Revista de Contabilidad, 13(1), 53-88.

Garanina, T., Muravyev, A. (2021), The gender composition of corporate boards and firm performance: Evidence from Russia. Emerging Markets Review, 48, 100772.

Iacoviello, G., Mazzei, M., Riccardi, G. (2015), The gender composition of the board and firm performance. The role of regulatory measures. Corporate Ownership and Control, 13(1), 1385-1395.

Ionascu, M., Ionascu, I., Sacarin, M., Minu, M. (2018), Women on boards and financial performance: Evidence from a European emerging market. Sustainability, 10(5), 1644.

Javed, M., Saeed, R., Lodhi, R.N., Malik, Q.U.Z. (2013), The effect of board size and structure on firm financial performance: A case of banking sector in Pakistan. Middle-East Journal of Scientific Research, 15(2), 243-251.

Kang, H., Cheng, M., Gray, S.J. (2007), Corporate governance and board composition: Diversity and independence of Australian boards. Corporate Governance: An International Review, 15(2), 194-207.

Karayel, M., Doğan, M. (2014), Yönetim kurulunda cinsiyet çeşitliliği ve finansal performans ilişkisi: BIST 100 şirketlerinde bir araştirma. Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 19(2), 75-88.

Karoğlu, E. (2016), Vekâlet kurami perspektifinden yönetim kurulu kompozisyonunun finansal performans üzerindeki etkisi: BİST imalat sektörü örneği. Balkan and Near Eastern Journal of Social Sciences, 2(1), 65-77.

Karslıoğlu, İ., Sevim, U. (2022), Yönetim ve sahiplik yapisinin firma performansina etkisi. Asya Studies- Academic Social Studies, 6(20), 243-252.

Kılıç, M., Ayrıçay, Y. (2018), Yönetim kurulu ve sahiplik Yapısının finansal performans üzerindeki etkisi: BIST imalat sanayi sektöründe bir alan Araştırması. Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 20(2), 177-192.

Kılıç, M., Kuzey, C. (2016), The effect of board gender diversity on firm performance: Evidence from Turkey. Gender in Management: An International Journal, 31(7), 434-455.

Lindenberg, E.B., Ross, S.A. (1981), Tobin's q ratio and industrial organization. The Journal of Business, 54(1), 1-32.

Mak, Y.T., Roush, M.L. (2000), Factors affecting the characteristics of boards of directors: An empirical study of New Zealand initial public offering firms. Journal of Business Research, 47, 147-154.

Marinova, J., Plantenga J., Remery, C. (2016), Gender diversity and firm performance: Evidence from Dutch and Danish boardrooms. The International Journal of Human Resource Management, 27(15), 1777-1790.

Marquez-Cardenas, V., Gonzalez-Ruiz, J.D., Duque-Grisales, E. (2022), Board gender diversity and firm performance: Evidence from Latin America. Journal of Sustainable Finance and Investment, 12(3), 785-808.

Menteş, S.A. (2011), Gender diversity at the board and financial performance: A study on ISE (Istanbul stock exchange). Middle Eastern Finance and Economics, 14(14), 6-15.

Oba, V.C., Fodio, M.I. (2013), Boards' gender mix as a predictor of financial performance in Nigeria: An empirical study. International Journal of Economics and Finance, 5(2), 170-178.

Öcal, N. (2022), Yönetim kurulunda kadin üye varliğinin şirket performansina etkisi, Journal of Business and Trade, 3(1), 1-19.

Otluoğlu, E., Sarı, E.S., Otluoğlu, K.Ö.Ç. (2016), Yönetim kurulu çeşitliliğinin finansal performansa etkisi: BIST 100 üzerine bir araştırma. The Journal of International Social Research, 9(46), 749-758.

Pesaran, M.H., Yamagata, T. (2008), Testing slope homogeneity in large panels. Journal of Econometrics, 142(1), 50-93.

Rechner, P.L., Dalton, D.R. (1989), The impact of CEO as board chairperson on corporate performance: Evidence vs. Rhetoric. The Academy of Management Perspectives, 3(2), 141-143.

Reddy, S., Jadhav, A.M. (2019), Gender diversity in boardrooms - A literature review. Cogent Economics and Finance, 7(1), 1-12.

Saona, P., Azad, A.K., Kabir, A., Ikra, S.S. (2023), Board gender diversity and firm performance: New evidence from cultural diversity in the boardroom. LBS Journal of Management and Research, 21(1), 1-12.

Sevimli Örgün, G. (2023), Yönetim kurulu cinsiyet çeşitliliğinin finansal başarisizliğa etkisi: Borsa istanbul imalat sektöründe bir uygulama. Muhasebe Bilim Dünyası Dergisi, 25, 207-226.

Shehata, N., Salhin, A., El-Helalya, M. (2017), Board diversity and firm performance: Evidence from the U.K. SMEs. Applied Economics, 49(48), 4817-4832.

Simionescu, L.N., Gherghina, Ş.C., Tawil, H., Sheikha, Z. (2021), Does board gender diversity affect firm performance? Empirical evidence from standard & poor's 500 information technology sector. Financial Innovation, 7, 52.

Song, H.J., Yoon, Y.N., Kang, K.H. (2020), The relationship between board diversity and firm performance in the lodging industry: The moderating role of internationalization. International Journal of Hospitality Management, 86, 102461.

Tan, F.Z., Bal, K. (2021), Vekâlet teorisi çerçevesinde yönetim kurulu çeşitlendirmesi ve finansal performans ilişkisi: Yatırım kuruluşlari örneği. Eurasian Journal of Researches in Social and Economics, 8(1), 38-54.

Tleubayev, A., Bobojonov, I., Taras Gagalyuk, T., Glauben, T. (2020), Board gender diversity and firm performance: Evidence from the Russian agri-food industry. International Food and Agribusiness Management Review, 23(1), 35-53.

Türkoğlu, K., Köse, E. (2022), The effect of return of shares and gender diversity of board on financial performance. International Journal of Business, Economics and Management Perspectives, 6(2), 377-394.

Ujunwa, A., Okoyeuzu, C., Nwakoby, I. (2012), Corporate board diversity and firm performance: Evidence from Nigeria. Review of International Comparative Management, 13(4), 605-620.

Yerdelen Tatoğlu, F. (2016), Panel Veri Ekonometrisi. Baskı. 4. İstanbul: Beta Yayınları.

Yurt, N. (2020), Borsa istanbul'da işlem gören firmalarin yönetim kurullarindaki kadin üye varliği ile firma kârliliği arasindaki ilişkinin incelenmesi, Ç.Ü. Sosyal Bilimler Enstitüsü Dergisi, 29(1), 163-177.