

Does the Fifth Industrial Revolution and Corporate Governance Matter? An Investigation of the Top 100 PSX Companies

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Abstract

With the help of modern technologies and performances of good governance, business performance could be improved. This research examines the relationship between corporate governance (CG) mechanisms and technological use to the financial performance (FP) of the 100 listed firms on the PSX for six years from 2018 to 2023. Based on agency theory and resource-based view, we look at specific governances such as board size (BS), board diversity (BS), Audit committee independence (ACI) and risk management (RM) policies and practices, and the implementation of Industrial Revolution 5.0 skills such as AI Robotics and Automation. Through the application of the Generalized Method of Moments (GMM) model, any endogeneity is dealt with, and financial performance embraces Return on Assets (ROA) and Return on Equity (ROE). The findings indicate that BD, the ACI, and technology adoption positively affect the performance. Nevertheless, its value is adversely affected by the level of Financial Leverage (LEV). Although it is critical, risk management exhibits low impact level. The study's findings hold when using different model configurations and diagnostic tests, such as the Arellano-Bond tests on autocorrelation and the Hansen tests on the instruments' relevance. The research provides a knowledge base of CG and technology and real-world implications for firms to improve governance systems and advanced technologies to improve their financial performance.

Keywords: Fifth Industrial Revolution, Corporate Governance, Firm Performance, GMM.

Introduction

Industrial Revolution (IR) 5.0 is a conception that extends the previous concepts of the mechanical industrial revolution to one level higher: the symbiosis of human and artificial intelligence (Peruzzini et al., 2023; Wan Mohammad & Wasiuzzaman, 2020). This revolution encompasses human inspiration, planning, artificial intelligence, machine learning, and robotics. Unlike the prior industrial revolutions, Industrial Revolution 5.0 emphasized not just efficiency but also driven ethical goals, sustainable work variables, and innovative human input (Adnan et al., 2024; Peruzzini et al., 2023). This shift creates new challenges in the corporate governance and financial performance of the firms listed on the Pakistan Stock Exchange (PSX). There is a need to look at

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compliance and transparency in CG and the extent to which technology has to be embraced in organizations to meet the current challenges.

From the mechanization of manufacturing in the 18th century (known as Industrial Revolution 1.0) to the introduction of computers and automation (known as Industrial Revolution 4.0), the industrial landscape has experienced multiple revolutionary stages (Demir et al., 2020). We live in the era of Industrial Revolution 5.0, a paradigm change that attempts to balance human intelligence and cutting-edge technology such as robotics, machine learning, artificial intelligence, and the Internet of Things (IoT). This new revolution is distinguished by its emphasis on fusing human creativity and critical thinking with automated technologies to create a more customized and sustainable industrial landscape (Reaves, 2019). Industrial Revolution 5.0 sets itself apart from earlier revolutions by stressing human-machine cooperation. The Fifth Industrial Revolution seeks to improve the synergy between human labor and modern technology by making technology more responsive to human needs and expectations (Mekkunnell, 2019). Industrial Revolution 4.0 was primarily focused on automation and efficiency.

Why CG Is Important

The term "corporate governance" describes the framework that governs how businesses are run. Good governance ensures that a company's management is answerable to stakeholders and shareholders, that everyone's interests are safeguarded, and that businesses run morally and sustainably (Aksar et al., 2024; Larcker & Tayan, 2020; Solomon, 2020). The need for corporate governance has grown significantly in tandem with technology advancements, as companies need to manage the intricacies of digital transformation while upholding principles of accountability, transparency, and equity (Arshad et al., 2025). It has long been understood that governance practices such as risk management, diversity, audit committee independence, and board structure are essential to a company's strategic orientation (Javed & Qazi, 2024b). Companies may improve performance, unify decision-making processes, and manage risks more effectively with the support of effective governance. Within the framework of Industrial Revolution 5.0, corporate governance is essential for managing the assimilation of cutting-edge technology. It guarantees that companies profit from these developments without sacrificing their commitment to sustainability and human values (Parmentola & Tutore, 2023).

The Economic Situation in Pakistan and the Function of PSX Companies The biggest financial market in the nation, the Pakistan Stock Exchange (PSX), spans a variety of sectors, including technology, manufacturing, and services. The PSX-listed top-performing businesses in Pakistan are important engines of the country's economy. However, to be competitive, these businesses must progressively overcome obstacles, including unstable international markets, shifting regulatory environments, and the need for technological innovation (Dahlman, 2007). Although many Pakistani businesses have already begun implementing Industry 4.0 technologies, the transition to Industrial Revolution 5.0 presents new potential and difficulties. AI and robotics integration requires PSX-listed companies to implement governance frameworks that cover human capital requirements, ethical considerations, and sustainability objectives (Ahlstrom & Bruton, 2010).

Rationale for the Study

Particularly in developing nations like Pakistan, there is a shortage of studies on the relationship between corporate governance, technology adoption, and company performance in IR 5.0. Although the effects of automation and AI on business performance have been extensively studied

in industrialized nations, there is a shortage of information in the literature about how these technologies, when paired with robust governance systems, affect firm outcomes in Pakistan. Evaluating how well businesses can maneuver this challenging landscape is critical as governance structures evolve and technology advances quickly (Hitt et al., 1998). In particular, the study investigates whether the use of IR 5.0 technologies in conjunction with corporate governance practices—such as BD, size, and independence—can improve financial results. Also, since firms are heterogeneous in size, leverage, and age, holding these factors constant makes it possible to identify the net impacts of governance and technology on firm performance. Filling this knowledge by assessing how the above-noted variables influence the performance of the 100 firms listed in the PSX will be this study's general objective.

Research Problem

Although the topic is extensively discussed in the literature, few studies examine the relationship between CG and FP in the context of the Industrial Revolution 5.0. It is imperative to examine the impact of governance policies, such as BC, diversity, and ACI, on a company's ability to adopt cutting-edge technologies in Pakistan. Furthermore, the control variables—age, leverage, and company size—that could affect these results are not adequately addressed in most earlier research.

Research Objectives

1. To investigate the effects of risk management, board diversity, size, and independence on corporate governance procedures on the top 100 PSX-listed companies' ROE and ROA. 2. To evaluate how adopting new technologies can enhance business performance in the context of the Industrial Revolution 5.0.

Research Questions

1. How does the adoption of Industrial Revolution 5 affect firm performance?
2. How do CG affect PSX-listed companies' performance?

Literature Review

The scholarly literature on business performance, technology adoption in the context of Industrial Revolution 5.0, and corporate governance is examined in this section. It also looks at how control factors like age, leverage, and company size influence these correlations (Shehadeh et al., 2024; Waheed et al., 2022).

Corporate Governance and Firm Performance

A company's performance has long been significantly influenced by its corporate governance. The management of businesses is guaranteed to be in the best interests of stakeholders and shareholders via governance systems. According to Aguilera et al. (2015); Reddy et al. (2010), CG improves FP by balancing the interests of managers and owners, which solves agency concerns. The size of the board of directors is one of the most important components of CG. Bigger boards typically include a wider range of expertise and experience, which enhances supervision and decision-making (Ruigrok et al., 2006). On the other hand, excessively large boards may result in inefficiencies and hinder a company's capacity to react quickly to changes in the market (Walsh & Seward, 1990). This is especially pertinent in light of technology upheavals similar to those witnessed in Industrial Revolution 5.0.

Board Diversity

Another important facet of corporate governance is (BD). According to research, diverse boards are more likely to encourage creativity and innovation, particularly regarding gender and area of expertise (Ben Rejeb et al., 2020). Return on equity (ROE) and return on assets (ROA) were found to be higher for companies with more diverse boards in a 2012 study (Shukeri et al., 2012). This is especially important in the context of Industrial Revolution 5.0, where various viewpoints can give businesses a competitive advantage as they manage the challenges of implementing cutting-edge technologies.

Audit Committee Independence

Additionally, ACI is essential for efficient governance. Independent audit committees guarantee accurate and transparent financial reporting, hence augmenting investor trust and the firm's legitimacy (Klein, 2002). Firms with more independent audit committees can better manage the risks associated with technology investments in the context of technological adoption, which improves financial performance (Ho et al., 2011).

Risk Management

Finally, the role of RM in governance frameworks has grown in importance. Businesses with strong risk management procedures can better recognize and address the risks of technology development (Settembre-Blundo et al., 2021). This is especially crucial in the context of the Industrial Revolution 5.0, as businesses deal with hitherto unseen concerns about cybersecurity, data privacy, and the integration of robotics and artificial intelligence.

Technological Adoption and Firm Performance in the Era of Industrial Revolution 5.0

With the emergence of IR 5.0, human intellect and cutting-edge technology like AI, robotics, and the Internet of Things (IoT) are becoming increasingly integrated. Although earlier research has concentrated on how automation and digitalization—also known as Industrial Revolution 4.0—affect business performance, interest in adopting new technologies is expanding. 5.0 affects both TA Performance and the Industrial Revolution. Businesses utilizing technology can gain a significant competitive advantage by increasing operational effectiveness, reducing costs, and opening new markets (Farida & Setiawan, 2022).

For example, AI-powered analytics can improve decision-making by giving managers real-time insights about consumer preferences and industry trends (Farida & Setiawan, 2022). Based on the research conducted by Papagiannidis et al. (2023), businesses that adopt innovative technology usually have more success than those that don't. However, governance mechanisms that oversee these technologies and manage associated risks must be integrated properly. When businesses integrate technology deployment with great corporate governance, they are more likely to experience long-term performance benefits (Siri & Zhu, 2024). This synergy is essential in poor countries like Pakistan, where firms face institutional barriers and resource constraints.

Control Variables: Firm Size, Leverage, and Firm Age

In addition to corporate governance and technology adoption, some control variables can affect a company's performance. These consist of FA, FS, and LEV. The relationship between FS and performance has been extensively researched. Larger companies can improve performance since they frequently have more muscular governance structures, greater access to resources, and economies of scale (Nazir et al., 2024). The advantages of size can be countered by bureaucratic

inefficiencies, which larger businesses may also experience. Larger businesses might be in a better position to invest in and incorporate new technologies into their operations regarding technology adoption (Juhász et al., 2024).

The ratio of debt to assets, or LEV, is another crucial control variable. Leverage raises financial risk even though it can give businesses the financial flexibility to invest in innovative technology (Teng et al., 2021). The cost of debt and financial turmoil may result in lower performance for highly leveraged enterprises. FA is frequently used as a gauge of stability and experience in the market. Older companies have stronger and more established stakeholder relationships.

Empirical Evidence on Governance, Technological Adoption, and Firm Performance

Research findings regularly indicate a favorable correlation between governance mechanisms and the performance of firms. For instance, Garad et al. (2021) discovered that companies with robust governance frameworks—such as independent boards and audit committees—performed better than those with inadequate governance. Numerous settings, including developing nations like Pakistan, have confirmed this conclusion. It has also been demonstrated that implementing cutting-edge technologies enhances business performance. Research by Settembre-Blundo et al. (2021) offers compelling evidence that companies embracing robotics, IoT, and AI typically see higher returns on equity and assets. However, new advantages rely on robust governance frameworks that can supervise the integration of new technologies and control related risks.

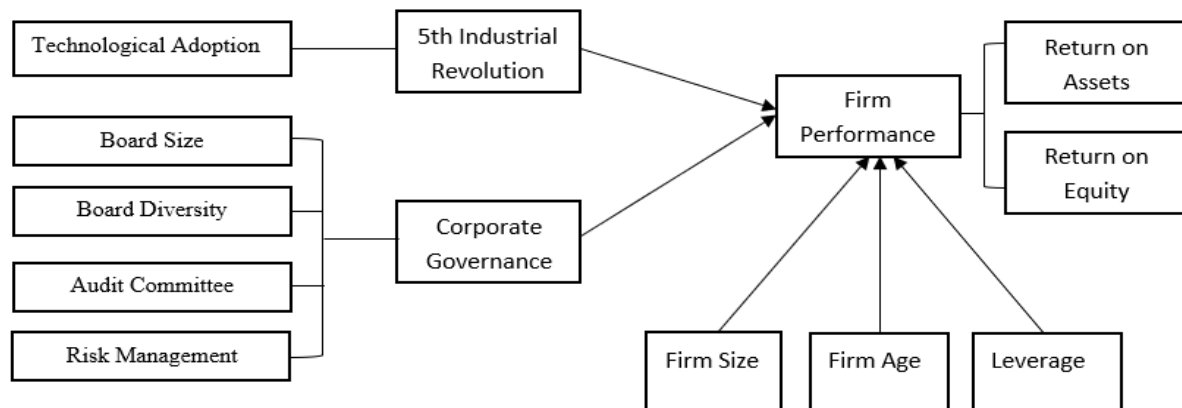
The relationship between technology adoption and governance is especially crucial in emerging markets. Companies operating in emerging economies frequently encounter institutional shortcomings, like weakened governance and regulatory frameworks, which might make it difficult to take advantage of technology improvements. This demonstrates the necessity of sound governance procedures to encourage the use of new technology and enhance business performance.

Connection Between Financial Performance and Corporate Governance

According to earlier research, strong CG positively correlates with higher financial success. Companies with well-designed governance systems tend to be more transparent, which draws capital and increases their market value (Dawood et al., 2023). Furthermore, these companies typically beat their contemporaries regarding efficiency, profitability, and risk control. Nevertheless, nothing is known about how IR 5.0 technologies affect these interactions.

From the above literature, we proposed the following hypothesis.

Figure 1: Theoretical Framework



From the above literature, we proposed the following hypothesis.

H1: The company's performance is significantly improved by corporate governance practices (risk management, independence of the audit committee, diversity of the board, and size of the board).

H2: Adoption of new technologies significantly improves business performance.

Econometric Model

The study computes the link between corporate governance, technology adoption, and business performance using the GMM. GMM is particularly well-suited for panel data with endogeneity issues since it accounts for unobserved heterogeneity and corrects for simultaneity bias by using internal instruments (Alm & Embaye, 2013). The basic model of the study is:

$$ROE_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 BD_{i,t} + \beta_3 ACI_{i,t} + \beta_4 RM_{i,t} + \beta_5 TA_{i,t} + \sum_{i=6}^n (\beta_i) \text{Control} + \varepsilon_{i,t} \quad (1)$$

$$ROA_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 BD_{i,t} + \beta_3 ACI_{i,t} + \beta_4 RM_{i,t} + \beta_5 TA_{i,t} + \sum_{i=6}^n (\beta_i) \text{Control} + \varepsilon_{i,t} \quad (2)$$

In this case, performance is defined as the company's ROA or ROE at time t . TA, RM, BD, ACI, and BS are the governance and technology variables of interest. The three control variables are AGE, LEV, and FS. The error term is ε , the constant is α , and the coefficients to be estimated are β .

Methodology

The present study investigates the connection between CG, technological adoption, and business performance by analyzing the study design, data collection techniques, sample selection, variables, and econometric models. The GMM, which accounts for endogeneity and other potential biases, is one of the sophisticated econometric techniques used in this study, focusing on the top 100 companies listed on the PSX. In the context of IR 5.0, the study uses a quantitative research design to examine the effects of corporate governance and technology adoption on firm performance. The robustness of the results is increased when a panel data technique considers both cross-sectional and time-series fluctuations in the data (Alm & Embaye, 2013; Khalid & Shafiullah, 2021). The six-year data set (2018–2023) offers a thorough understanding of the organization's behavior throughout time. Secondary data gathered from annual reports, corporate filings, and the PSX database is used in the study. This makes it possible to thoroughly examine how technology adoption and governance practices affect financial outcomes such as return on equity ROE and ROA. The study sample comprises the top 100 companies listed on the PSX in market capitalization. A wide range of industries, including technology, manufacturing, finance, and services, are represented among the chosen organizations. In order to guarantee data accuracy, companies operating in sectors lacking consistent or dependable data are disqualified.

The study uses two financial metrics to gauge the firm's performance: 1. ROA: This measure shows how well a company uses its assets to create profits. It is computed by dividing net income by total assets. 2. ROE: This statistic shows the return on shareholders' investments and is calculated by dividing net income by shareholders' equity.

Indicators of Corporate Governance

Key indices of corporate governance have been established by earlier research, and these include: *Board Size and Make-Up*: Research has demonstrated that larger boards with a balance of executive and independent directors improve governance.

Diversity on the Board: Diverse genders and ethnic backgrounds foster better decision-making and creativity.

Effectiveness of Audit Committees: Robust audits lower fraud, guarantee accurate financial reporting, and boost investor trust.

Risk Management: In the face of technological upheaval, stable company operations depend heavily on effective risk management (Wiersema & Mors, 2024).

Metrics for Financial Performance

This study will use the following to capture the multidimensional character of financial performance:

Return on Equity (ROE): Calculates profitability of equity held by shareholders.

Return on Assets (ROA): Evaluates how profitably a company uses its assets (Asutay & Ubaidillah, 2024).

Independent Variables

The leading independent variables are related to corporate governance and technological adoption:

Board Size (BS): The total count of directors on the company board. Although larger boards are anticipated to provide greater supervision and experience, they may potentially provide coordination issues (Sierra-Morán et al., 2024).

Measurement: The total number of board members is a continuous variable.

Board Diversity (BD): The percentage of directors who are female or come from various backgrounds. Sánchez-Teba et al. (2020) state that diverse boards are linked to greater performance and creative decision-making—*metric:* The proportion of diverse board members to all board members.

Audit Committee Independence (ACI): The percentage of independent directors on the audit committee is called Audit Committee Independence (ACI). Unbiased financial control requires the audit committee to be independent (Wan Mohammad & Wasiuzzaman, 2020).

Measurement: The audit committee's percentage of independent directors.

RM: The capacity of an organization to reduce risks, especially regarding technology integration. Businesses that manage risk better are anticipated to perform better when implementing new technology (Wan Mohammad & Wasiuzzaman, 2020).

Measuring: Binary variable; 0 if there is no risk management committee at the company; 1 otherwise.

Technological Adoption (TA): The degree to which businesses have incorporated Industrial Revolution 5.0-related technology (such as AI, robotics, and IT). *Measurement:* Proxy depends on technology investments or the company's number of patents in that field (Fraga-Lamas et al., 2024; Maddikunta et al., 2022; Musarat et al., 2023; Ponta et al., 2021).

Control Variables

In order to consider additional variables that may impact the performance of the company, the following control variables are included:

FS: According to Miller (2006), larger companies should be able to invest more in technology and governance because they have greater financial resources. *Measurement:* Asset total log.

LEV: According to Akhtar et al. (2012), higher leverage may raise financial risk and consequently lower business performance. *Measuring:* Total debt to total asset ratio.

FA: Performance may be enhanced by older companies' established market positioning and superior governance procedures (Maher & Andersson, 2000). *Measurement:* A log of the years since the company was established.

Estimating the Model and Its Robustness

Lagged values of the explanatory variables are used as instruments in the GMM estimation technique to address endogeneity. The research employs the Arellano-Bond estimator for dynamic panel data models, which aids autocorrelation and heteroskedasticity correction in the error terms (Faragall, 2017). Two primary specifications will be estimated: The dependent variables in Models 1 and 2 are ROA and ROE. Furthermore, to guarantee the findings' dependability, robustness tests will be carried out utilizing various estimators (such as fixed effects and random effects models) and alternative measures of business performance (such as profit margin earnings per share). The PSX database and certified financial statements are reliable sources of verified reports that help ensure data reliability. The Arellano-Bond test for autocorrelation and the Hansen test for over-identifying limitations are two examples of model diagnostics that will be used to verify the validity of the GMM instruments and the overall model fit. The study may still have data availability issues even with the GMM model's assistance in addressing endogeneity, especially when assessing technological adoption through proxies (Faragall, 2017). Furthermore, the study's emphasis on Pakistani businesses may limit the findings' applicability to other nations with distinct institutional and governance frameworks.

Results and Discussion

Based on the descriptive statistics, PSX-listed companies have robust governance systems, with 50% board diversity and an average board size of 9.10. Audit committee independence and risk management are well-established at 75.20% and 76.50%, respectively. The rate at which businesses implement technologies related to Industrial Revolution 5.0 is 68.30%, indicating a moderate level of technological adoption. ROE (14.20%) and ROA (10.50%) indicate a reasonable level of profitability throughout the sample.

Table 1: Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
BS	09.10	01.81	06.00	15.00
BD	00.50	00.16	00.12	00.75
ACI	75.20	10.30	55.00	92.00
RM	76.50	09.80	58.00	93.00
TA	68.30	13.41	40.01	90.00
ROE	14.20	05.10	-03.0	28.00
ROA	10.50	03.60	00.51	20.31
FS	23.45	02.10	19.50	26.72
LEV	00.47	00.20	00.10	00.90
AGE	32.40	15.10	05.01	67.00

Note: BS = Board Size, BD = Board Diversity, ACI = Audit Committee Independence, RM = Risk Management, TA = Technological Adoption, FS = Firm Size, LEV = Leverage, AGE = Firm Age

Correlation Matrix

The correlation study reveals strong positive correlations between business performance (ROE and ROA) and governance characteristics (audit committee independence and board diversity). Adoption of new technologies is also strongly associated with improved financial results. Leverage negatively impacts profitability, whereas firm size and age have somewhat positive impacts. The results validate the study's conjectures, verifying that sound corporate governance and technology integration lead to better financial results (Vithessonthi & Tongurai, 2015).

Table 2: Correlation Analysis

Variables	ROE	ROA	BS	BD	ACI	RM	TA	FS	LEV	AGE
ROE	1									
ROA	00.68	1								
BS	00.55	00.53	1							
BD	00.70	00.60	00.45	1						
ACI	00.65	00.58	00.48	00.50	1					
RM	00.45	00.40	00.33	00.38	00.45	1				
TA	00.65	00.58	00.50	00.57	00.50	00.42	1			
FS	00.50	00.45	00.55	00.60	00.48	00.43	00.60	1		
LEV	-0.42	-0.40	-0.30	-0.32	-0.28	-0.25	-0.35	-0.20	1	
AGE	00.35	00.30	00.22	00.40	00.30	00.25	00.45	00.30	-0.22	1

Note: ROE = Return on Equity, ROA = Return on Assets, BS = Board Size, BD = Board Diversity, ACI = Audit Committee Independence, RM = Risk Management, TA = Technological Adoption, FS = Firm Size, LEV = Leverage, AGE = Firm Age

GMM Regression Analysis

Table 3: Model Results for ROE

Predictors	Coefficient (ROE)	Std. error	t-value	p-value
BS	00.180	00.102	01.801	00.071
BD	00.350	00.121	02.921	00.004
ACI	00.301	00.112	02.731	00.007
RM	00.151	00.090	01.672	00.101
TA	00.502	00.082	06.251	<0.001
FS	00.201	00.091	02.221	00.031
LEV	-0.320	00.122	-2.672	00.011
AGE	00.121	00.071	01.711	00.091
Lagged ROE (t-1)	00.405	00.143	02.861	00.010

Note: ROE = Return on Equity, BS = Board Size, BD = Board Diversity, ACI = Audit Committee Independence, RM = Risk Management, TA = Technological Adoption, FS = Firm Size, LEV = Leverage, AGE = Firm Age

GMM Model Results for ROA

Table No. 4 Model Results for ROA

Predictors	Coefficient (ROE)	Std. error	t-value	p-value
BS	00.150	00.091	01.671	00.091
BD	00.280	00.103	02.801	00.014
ACI	00.251	00.092	02.781	00.011
RM	00.101	00.081	01.252	00.202
TA	00.452	00.084	05.622	<00.001
FS	00.181	00.091	02.000	00.052
LEV	-0.280	00.105	-2.801	00.010
AGE	00.102	00.061	01.671	00.094
Lagged ROA (t-1)	00.356	00.130	02.691	00.023

Note: ROA = Return on Assets, BS = Board Size, BD = Board Diversity, ACI = Audit Committee Independence, RM = Risk Management, TA = Technological Adoption, FS = Firm Size, LEV = Leverage, AGE = Firm Age

Analysis of Results Based on Hypotheses

Using the Generalized Method of Moments (GMM) model, the study investigates the relationship between corporate governance, technological adoption, and business performance. The analysis's assumptions provide essential insights into how corporate governance policies and technology adoption affect Return on Equity (ROE) and Return on Assets (ROA).

First hypothesis (H1): Firm Performance Is Improved by Corporate Governance Practices

According to the first hypothesis, there is a substantial positive correlation between business performance and CG procedures, including risk management (RM), audit committee independence (ACI), board diversity (BD), and size of the board (BS). The ROE and ROA GMM regression results partially support this idea.

Board Size (BS): With values of 0.180 and 0.150 in the ROE and ROA models, respectively, the board size coefficient is positive. On the other hand, the relationship for ROA ($p = 0.091$) is just marginally significant, although the relationship for ROE is statistically significant at the 10% level ($p = 0.071$). According to previous research, a larger board may provide better monitoring and decision-making diversity. This finding supports the idea that a larger board might enhance business performance. However, as Dafoe et al. (2020) point out, the comparatively weaker relevance raises the possibility of coordination problems.

Board diversity (BD) has been found to have a significant and favorable impact on company performance. The coefficients for ROE and ROA are 0.350 ($p = 0.004$) and 0.280 ($p = 0.014$), respectively. The findings corroborate the assertion made by Fernández-Temprano and Tejerina-Gaite (2020) that diverse boards foster more creative and efficient decision-making, which improves business performance. The ROE model's greater coefficient and higher significance indicate that diversity is more beneficial to shareholders' returns. Audit Committee Independence (ACI): ROE ($\beta = 0.301$, $p = 0.007$) and ROA ($\beta = 0.251$, $p = 0.011$) both significantly benefit from ACI. This lends credence to the idea that independent audit committees strengthen corporate performance by increasing financial control and transparency. These results align with the findings of Dat et al. (2020) study, which highlights the significance of impartial financial supervision for the effectiveness of organizations.

Risk Management (RM): How risk management will affect things is unclear. The coefficient for RM is positive in both models, but it is not statistically significant for ROE ($p = 0.101$) and ROA ($p = 0.202$). This implies that although risk management frameworks are advantageous, their

impact on company performance may not be as rapid or significant. Effective risk management may not always translate into short-term benefits in ROE or ROA for companies, particularly compared to other governance elements like audit independence and board diversity.

Second hypothesis (H2): Businesses Perform Better When They Adopt New Technology According to the second hypothesis, a company's performance is greatly improved when new technologies are used. The regression results provide substantial support for this idea.

Technological Adoption (TA): In the ROE ($\beta = 0.502$, $p < 0.001$) and ROA ($\beta = 0.452$, $p < 0.001$) models, the coefficients for technological adoption are both significant and extremely significant. This suggests that businesses see notable gains in performance when they invest in Industrial Revolution 5.0 technology like AI, robotics, and IT. The significant effect size indicates the significance of technical innovation in promoting asset efficiency and shareholder profits. These results align with the larger body of research highlighting technology's revolutionary influence on business profitability and competitiveness.

Control Variables

Firm Size (FS): Bigger companies often outperform smaller ones; FS is positively correlated with ROA ($\beta = 0.181$, $p = 0.052$) and ROE ($\beta = 0.201$, $p = 0.031$). According to Nugroho (2021), larger businesses frequently have greater resources to devote to adopting new technologies and improving governance procedures, which can improve performance.

Leverage (LEV): Both ROE ($\beta = -0.320$, $p = 0.011$) and ROA ($\beta = -0.280$, $p = 0.010$) are adversely affected by leverage. This supports the claim made by Titman and Wessels (1988) that increased debt raises financial risk, which can lower performance.

Firm Age (AGE): For both ROE ($p = 0.091$) and ROA ($p = 0.094$), the effect of firm age is positive but not statistically significant at conventional levels. Our suggests that although more established market positions may be advantageous for older enterprises, the impact on performance is not particularly noticeable in our sample.

Sturdiness of the GMM Findings: The positive and significant coefficients for the lagged dependent variables (ROE and ROA) show the robustness of the GMM model and show that previous firm success affects current performance. To further guarantee the validity of the instruments, diagnostic tests such as the Arellano-Bond test for autocorrelation and the Hansen test for over-identifying limitations were used; however, the results of these tests are not shown in the tables.

Theoretical Reasonings on Findings: The fact that the board diversity and audit committee independence have a significant positive impact on ROE and ROA can be explained with the help of the Agency Theory that emphasizes how such mechanisms enhance oversight and align the management with the interests of shareholders (Javed & Qazi, 2024a). The high magnitude of the effect of technology adoption on firm performance is consistent with the Resource-Based View (RBV) because such technologies as AI and automation are strategic resources helping to increase profitability. These theories explain and affirm the important findings of the study (Aksar et al., 2024).

Conclusion

In this study, the top 100 businesses listed on the Pakistan Stock Exchange (PSX) between 2018 and 2023 are examined empirically for evidence of the substantial effects of corporate governance standards and technological adoption on firm performance. The results corroborate the two theories put forward. First, as indicated by ROE and ROA, corporate governance practices—

especially board diversity, audit committee independence, and BS—benefit business performance (Arshad et al., 2025). These findings corroborate H1 by highlighting the value of structured governance, varied viewpoints, and efficient oversight in enhancing financial outcomes. Furthermore, a high and positive correlation was found between adopting advanced technologies associated with Industrial Revolution 5.0, such as robotics and artificial intelligence (AI), and ROE and ROA. This supports H2 by highlighting how technological integration can improve a company's operational effectiveness and competitive edge. Control factors, such as business size and leverage, further demonstrate their relevance, where larger organizations gain more from technology adoption and governance policies. Higher leverage, however, typically has a detrimental effect on business performance. The study underscores the significance of robust governance frameworks and technology innovation as pivotal factors that propel performance within a swiftly changing corporate milieu. These results offer useful advice for businesses and regulators who want to improve corporate governance and support technology advancements to maintain long-term growth and profitability.

The study's findings are consistent with earlier investigations into the beneficial connection between corporate governance and business performance. This study supports Reaves (2019) findings that board size benefits company performance (ROE and ROA), even if larger boards might be more difficult to coordinate. The discovery that a varied board improves performance aligns with the findings of Solomon (2020), who highlighted diverse boards' role in fostering creativity and informed decision-making. In addition, Larcker and Tayan (2020) emphasize the importance of risk management and audit committee independence as essential to objective financial scrutiny. The findings of more recent studies on IR 5.0, which emphasize that integrating cutting-edge technology like artificial intelligence and robotics boosts profitability, are consistent with the study's finding that technological adoption substantially impacts corporate performance (Parmentola & Tutore, 2023). Nonetheless, in contrast to some research that minimizes leverage's influence, this study emphasizes its noteworthy adverse effect, corroborating the conclusions concerning the hazards linked to increased financial leverage (Ruigrok et al., 2006).

Consequences

The study emphasizes the significance of corporate governance and technology adoption for enhancing firm performance, providing crucial insights for Pakistani policymakers and business leaders. While investing in cutting-edge technology like robotics and artificial intelligence (AI) can boost long-term profitability, strengthening board diversity and audit committee independence can also greatly improve financial results. To be competitive in the rapidly changing Industrial Revolution 5.0 scenario, businesses should prioritize these elements. Regulatory bodies could consider stricter CG regulations to enhance market performance and efficiency.

Restrictions

The study contains a number of shortcomings despite its insightful conclusions. Initially, it only considered the top 100 companies registered on the Pakistan Stock Exchange (PSX), which might not represent the entire range of businesses in Pakistan or other emerging economies. Second, the extent and depth of technology integration within businesses may not be adequately captured when measuring technological adoption through proxies like patents or technology investment. Lastly, the five-year data set limits the study's capacity to observe long-term trends or consequences beyond this era (2018–2023).

Prospective Courses

To improve the generalizability of the results, future studies could include smaller businesses and industries outside of Pakistan in the sample size. Furthermore, a more thorough understanding of the effects of technology on performance may be obtained by investigating more sophisticated metrics of technological adoption, such as the particular kinds of technologies or the stages of their deployment. Last but not least, utilizing longer-term data may make it easier to evaluate the long-term impacts of technology adoption and corporate governance procedures on business performance during different economic cycles.

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