

# Governance, Corruption & Innovation

## Corporate Governance, Corruption, and Innovation: An Empirical Analysis

Kiran Saba \*<sup>1</sup>, Muhammad Azhar Farooq<sup>2</sup>, and Ammara Saba<sup>3</sup>

<sup>1,3</sup> National Skill University, Islamabad, Pakistan

<sup>2</sup> Ghazi University, DG Khan, Pakistan

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**Abstract:** This study examines the relationship among corporate governance, corruption, and innovation in publicly listed firms in Pakistan, filling a significant need in developing market research. Unlike prior studies focused on developed economies or China, this paper uniquely contextualizes the governance–corruption–innovation nexus in Pakistan. Employing a mixed-methods approach, the study analyses panel data from 100 firms listed on the Pakistan Stock Exchange (2012–2020) and incorporates qualitative case studies of high-profile corruption scandals. Patent filings are used as an indicator of innovation, while excessive CEO salary serves as a proxy for corruption. Fixed effects and instrumental variable regressions indicate that a one-unit rise in excess remuneration decreases patent filings by 0.05 units, but a 10% increase in board independence enhances innovation by 0.012 patents. Financial limitations partially mediate this association, exhibiting a notable indirect effect (0.015,  $p < 0.05$ ). The findings highlight the necessity for enhanced governance to alleviate the detrimental impact of corruption on innovation, offering novel insights for policymakers and business executives in emerging markets.

**Keywords:** Corporate governance; Innovation; Board independence; Indirect effect; Emerging markets.

Corresponding author: [kiransaba640@gmail.com](mailto:kiransaba640@gmail.com)

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## 1. Introduction

Pakistan faces significant challenges to the development of economic growth. The issue of corruption is deeply rooted at every societal level including government institutions as well as business organizations (Transparency International, 2021). The country regularly scores poorly on corruption indices, highlighting structural problems with the World Bank (2020) which reduces social trust and economic results. At the same time, the Pakistani corporate governance is characterized by the lack of regulatory enforcement, a low level of transparency, and concentrated ownership patterns, which are often dominated by family conglomerates (Ahmed & Ali, 2017; Hussain, 2019). The weaknesses in the governance make the corruption more pronounced creating an environment that favors the rent-seeking behaviors that hamper positive activities like innovation (Khan et al., 2018). The field of innovation in Pakistan is one of the most important but underdeveloped areas, with an investment in R&D being at a level of only 0.16 percent of GDP and the filing of patent applications being 70 percent lower than regional competitors like India (Pakistan Bureau of Statistics, 2021; WIPO, 2020). This background shows the need to study how governance and corruption affect innovation, as improving the mentioned aspects could unlock significant economic potential (State Bank of Pakistan, 2022).

Corporate governance, corruption, and innovation are pivotal drivers of economic development in

emerging economies, yet their interplay remains underexplored in contexts like Pakistan, where institutional voids—such as family-dominated firms (78% of PSX-listed companies; SECP, 2021) and weak regulatory enforcement (Hussain, 2020)—amplify their impact (Shleifer & Vishny, 1997; Acemoglu & Robinson, 2012). This study addresses a critical research gap: how do corporate governance and corruption affect innovation in publicly listed firms in Pakistan, and what role do financial constraints play in mediating this relationship? Despite recent Securities and Exchange Commission of Pakistan (SECP) reforms (2019) and Pakistan’s Vision 2025 emphasizing governance and innovation, firm-level analyses integrating these factors within Pakistan’s unique institutional framework—marked by concentrated ownership and regulatory gaps—remain scarce (Mahmood & Bashir, 2022; Ahmed & Ali, 2017).

Pakistan’s economic growth is hindered by pervasive corruption, costing an estimated \$10 billion annually and ranking the country 140 out of 180 on the Corruption Perceptions Index (Transparency International, 2022). Concurrently, innovation lags, with R&D spending at just 0.16% of GDP and patent filings 70% below regional averages (WIPO, 2020). While prior studies have explored broader economic impacts or isolated factors like corruption or governance (Khan et al., 2019), they often overlook Pakistan-specific firm-level dynamics, unlike research in other emerging markets like China (Chen et al., 2020; Bai et al., 2024). This study fills this gap by examining how governance mechanisms, such as board independence, mitigate corruption’s adverse effects on innovation, particularly in the context of recent SECP reforms and unresolved issues like family dominance and weak enforcement (Hussain, 2020). By integrating agency theory (Jensen & Meckling, 1976) with institutional theory (North, 1990), it addresses unanswered questions about how Pakistan’s institutional environment shapes these relationships, offering insights for other emerging markets with similar challenges (Khanna & Palepu, 2000).

The findings contribute to the literature by providing actionable insights for policymakers and executives to unlock Pakistan’s economic potential through improved governance and reduced corruption, particularly considering recent regulatory developments (State Bank of Pakistan, 2022). This review establishes the theoretical foundation for examining governance, corruption, and innovation in Pakistan. The next section details the data and methodology used to empirically test these relationships in the context of publicly listed firms.

The significance of this research cannot be overestimated. Corruption takes away resources that can be used in positive ways and reduces investor confidence and economic security (Shleifer & Vishny, 1993; Mauro, 1995). Innovation is particularly detrimental to the effect of corruption in Pakistan, where many experts estimate the annual economic burden of corruption to be as high as \$10 billion (Khan et al., 2021; Transparency International, 2022). The innovation is essential to promote competitiveness and economic development (Porter, 1990); however, the innovation ecosystem in Pakistan is affected by the systematic issues including financial constraints (State Bank of Pakistan, 2022) and poor governance (Hussain, 2020). This paper offers some practical knowledge to policymakers and business executives because it examines the role of governance systems in mitigating the negative effects of corruption on innovation. To improve on governance structures such as the independence of the boards (Adams & Ferreira, 2009) and transparency (Bushman & Smith, 2001) could create a better environment in which innovation is encouraged, therefore benefiting the entire economy.

This paper is structured as follows: the Literature Review synthesizes global and Pakistan-specific studies to establish the theoretical foundation. The Data and Methodology section details the mixed-methods approach, including panel data regression and qualitative case studies. The Results section presents empirical findings, followed by a Discussion that interprets these results, outlines implications, and acknowledges limitations. The Conclusion offers policy recommendations to enhance governance and foster innovation in Pakistan. This structure ensures a logical progression from context and theory to empirical analysis and practical implications, addressing the interplay of governance, corruption, and innovation cohesively.

## 2. Literature Review

Corporate governance, corruption, and innovation are essential elements of economic success, especially in emerging economies such as Pakistan (World Bank, 2022). Robust corporate governance guarantees that companies function with openness, accountability, and efficiency—crucial prerequisites for promoting innovation (OECD, 2019). Corruption, characterized as the use of public or private authority for individual benefit (Transparency International, 2022), subverts governance systems, reallocating resources away from constructive endeavors such as research and development (Mauro, 1995; Anokhin & Schulze, 2009). Empirical research illustrates that corruption adversely affects innovation by causing inefficient resource distribution and heightened uncertainty, which deters long-term investment (Dutta & Sobel, 2016; Athanasouli et al., 2012). Méon and Sekkat's (2005) cross-country investigation revealed that economies with elevated corruption levels have 30% reduced technical innovation outputs. In contrast, strong governance frameworks can alleviate these impacts by improving openness (Bushman & Smith, 2001) and diminishing rent-seeking prospects (Shleifer & Vishny, 1993). This global viewpoint highlights the necessity of analyzing these processes within Pakistan's own institutional framework (Hussain, 2020; Khan et al., 2021).

In developing economies, corporate governance is often characterized by particular problems that are related to institutional weaknesses, as well as concentrated ownership (Claessens & Yurtoglu, 2013). According to La Porta et al. (1999), ownership concentration, common in the developing countries, could exaggerate Type II agency problems whereby overpowering shareholders could exploit minority investors and could be an obstacle to innovation as a result of risk aversion. Poor legal systems and legal enforcement systems seek rented behavior (Schleifer and Winnie, 1997), especially in Pakistan, where 78 percent of the listed companies are owned by family groups (SECP, 2021). According to international data, these challenges can be solved by improving governance: in India, Bertrand et al. (2018) found that the presence of independent directors increases R&D spending by 40%, and in China, Chen et al. (2020) found that changes in transparency increased patent applications by 25%. These results stress that the improvement of governance mechanisms, particularly the independence of the board (Adams & Ferreira, 2009) and transparency requirements (Bushman et al., 2004), is vital to the encouragement of innovation in institutional environments with corruption (World Bank, 2022).

Corruption is a common issue in various developing countries that lead to serious economic impacts. Mauro (1995) demonstrated that corruption hinders economic development by distorting the investment of the population and increasing uncertainty. Murphy et al. (1993) also state that corruption acts as a tax on innovation and makes corporations take their resources towards bribes rather than research and development. In developing nations with weak institutional systems, corruption is playing a major role in hindering innovation through undermining the rule of law and property rights (Acemoglu & Johnson, 2005). Chen et al. (2020) found that corruption of the CEO in China reduces innovation of the company by 18-22 percent because of funding limitations. Such results indicate the need to fight corruption to achieve innovation, especially in the environment with a developing system of governance (World Bank, 2022). Innovation propels economic competitiveness; nevertheless, developing countries have challenges in cultivating creative ecosystems. Lederman (2019) emphasizes that R&D investment below 0.5% of GDP and inadequate intellectual property protection severely hinder innovation. Institutional problems such as corruption decrease FDI inflows by 30-40% and impair R&D effectiveness (Dutta & Sobel, 2016). Targeted policies demonstrate potential; India's technology parks augmented patent filings by 35% (Ghosh et al., 2021), whilst Brazil's incubators enhanced startup survival rates (OECD, 2020). These instances illustrate the necessity for context-specific innovation initiatives.

This study examines the interplay of corporate governance, corruption, and innovation in Pakistan's publicly listed firms, drawing on agency theory (Jensen & Meckling, 1976) and institutional theory (North, 1990) to frame how governance mechanisms and corruption influence innovation outcomes. Agency theory posits that governance structures, such as board independence, align managerial decisions with firm goals, mitigating opportunism that diverts resources from innovation (Fama & Jensen, 1983).

Institutional theory highlights how Pakistan's institutional voids—weak legal systems, family-dominated ownership (78% of PSX-listed firms; SECP, 2021), and regulatory gaps—shape these dynamics (Hussain, 2020; Khanna & Palepu, 2000). This section critically synthesizes recent literature to establish the theoretical foundation, focusing on CEO decision-making, governance mechanisms, and corruption's impact on innovation, particularly in emerging markets like Pakistan.

Corruption, defined as the abuse of entrusted power for private gain (Transparency International, 2023), undermines innovation by diverting R&D resources. Anokhin and Schulze (2009) found that corruption reduces entrepreneurial innovation, with Méon and Sekkat (2015) reporting a 25–30% decrease in technical innovation in high-corruption settings. In Pakistan, where corruption costs \$10 billion annually (Transparency International, 2022), family-dominated firms exacerbate rent-seeking, diverting 15–20% of R&D funds (Mahmood & Bashir, 2022). These findings contrast with Dutta and Sobel (2016), who argue corruption may facilitate entrepreneurship in weak regulatory environments, a claim less applicable to Pakistan's innovation-constrained context (Khan et al., 2021). Recent studies emphasize governance's role in mitigating these effects, with board independence enhancing oversight and reducing resource misallocation (Adams & Ferreira, 2019; Shabbir & Rehman, 2022).

Agency theory provides a robust lens for understanding CEO decision-making in innovation. CEOs control resource allocation for R&D, but misaligned incentives, such as excess compensation, reflect rent-seeking that reduces innovation funding (Bebchuk & Fried, 2018). Li and Zhang (2024) found that CEO incentives tied to performance boost sustainable innovation by 15–20% in emerging markets, while Khan et al. (2023) highlight how CEO characteristics—such as risk tolerance and environmental focus—drive green innovation, critical in Pakistan's resource-scarce context (R&D at 0.16% of GDP; Pakistan Bureau of Statistics, 2022). In Pakistan, family control and weak enforcement amplify Type II agency problems, where controlling shareholders prioritize private benefits over innovation (Cheema & Naseer, 2021; Claessens & Yurtoglu, 2013). For instance, Bai et al. (2024) found that CEO corruption in China reduced firm innovation by 18–22%, a finding this study adapts to Pakistan's concentrated ownership structure.

Governance mechanisms, particularly board independence, are critical for aligning CEO incentives with innovation goals. Shabbir and Rehman (2022) report that a 10% increase in independent directors boosts innovation outcomes by 12% in Pakistani firms, echoing global findings (Bhagat & Bolton, 2019). However, Pakistan's low board independence (average 20%; SECP, 2021) limits oversight, unlike India, where governance reforms increased R&D spending by 40% (Bertrand et al., 2018). Ownership concentration and board size often yield mixed effects, with Yermack (2017) noting smaller boards enhance decision-making, while La Porta et al. (2019) argue concentrated ownership stifles innovation in weak legal systems like Pakistan's.

This study addresses gaps in the literature by integrating agency and institutional theories to examine firm-level dynamics in Pakistan, where prior studies focus on broader economic impacts (Khan et al., 2019) or other emerging markets (Chen et al., 2020). Unlike Bai et al. (2024), which overlooks Pakistan's family-dominated governance, this research leverages recent SECP reforms (2019) and qualitative insights (e.g., PIA scandal) to contextualize findings. By using excess CEO compensation as a corruption proxy and patent filings for innovation, it aligns with established metrics (Bebchuk & Fried, 2018; Griliches, 1990) while addressing Pakistan's unique challenges, such as low R&D and regulatory enforcement (Hussain, 2020).

The theoretical framework justifies the variables—patent filings, excess compensation, board independence, ownership concentration, and board size—and grounds the empirical analysis in Pakistan's institutional context. The next section outlines the data and methodology used to test these relationships.

### **3. Data and Methodology**

This study employs a quantitative research design to examine the relationships between corporate governance, corruption, and innovation in Pakistani listed companies over the period 2012–2020. The analysis utilizes a balanced panel dataset comprising 100 non-financial firms listed on the Pakistan Stock

Exchange (PSX), yielding 900 firm-year observations (PSX, 2021). Following Wooldridge (2018), the panel data approach controls for unobserved heterogeneity while capturing both cross-sectional and time-series variations, enabling robust estimation through fixed effects models (Hsiao, 2014). The methodology adapts Chen et al.'s (2020) instrumental variables framework from China, modifying it for Pakistan's institutional context by: (1) incorporating family ownership concentration measures (Claessens et al., 2000), (2) accounting for SECP regulatory enforcement gaps (Hussain, 2020), and (3) using industry-adjusted corruption proxies (Bushman et al., 2004). These adaptations address Pakistan's unique governance challenges where controlling shareholders dominate 73% of listed firms (SECP, 2021) and regulatory compliance averages just 62% (World Bank, 2022).

The study focuses on publicly listed firms due to the availability of reliable financial and governance data, which remains systematically lacking for Pakistan's private sector (World Bank, 2022; State Bank of Pakistan, 2021). The 2012-2020 timeframe was strategically selected to: (1) capture post-2011 SECP governance reforms (SECP, 2019), (2) align with Pakistan's adoption of international financial reporting standards, and (3) ensure complete patent filing data from WIPO's updated coverage of Pakistan (WIPO, 2020). The mixed-methods design incorporates qualitative case studies of high-profile scandals like Pakistan International Airlines' aircraft procurement irregularities (National Accountability Bureau, 2021), following Eisenhardt's (1989) case study methodology to triangulate quantitative findings. This approach combines the statistical power of panel regression (Wooldridge, 2018) with the contextual richness of embedded case studies (Yin, 2017), addressing what Creswell and Clark (2017) identify as a critical gap in emerging market research.

### **3.1 Sample and Data Sources**

The sample consists of 100 non-financial firms listed on the PSX, selected for their reliable and standardized financial and governance disclosures, which are often inconsistent in Pakistan's private sector due to limited regulatory oversight and low compliance rates (62% average; World Bank, 2022). Non-financial firms were chosen to avoid sector-specific distortions, as financial institutions typically exhibit minimal patent activity and distinct governance structures (Claessens & Yurtoglu, 2013). The 2012–2020 period captures the impact of SECP's 2011 and 2019 governance reforms, ensuring relevance to recent policy changes, and spans multiple economic cycles to enhance generalizability within Pakistan's context. The sample size balances statistical power with data availability, given that only approximately 200 non-financial PSX firms consistently report governance metrics, and smaller firms often lack patent data (SECP, 2021; WIPO, 2020). This selection ensures robust data for analyzing innovation, governance, and corruption dynamics.

Data were sourced from credible repositories to ensure reliability in Pakistan's challenging data environment:

#### **3.1.1. Innovation Data**

Patent filings were retrieved from WIPO's Patentscope database (<https://patentscope.wipo.int>) using its API, filtered to include only Pakistani firm-level patents. This source is robust despite Pakistan's low patent activity (70% below regional averages; WIPO, 2020), ensuring accurate innovation metrics.

#### **3.1.2. Governance and Compensation Data**

Obtained from PSX annual reports and SECP disclosures (<https://www.secp.gov.pk>). Due to inconsistent reporting formats, manual extraction was necessary for governance metrics like board independence and size, cross-verified with Bloomberg Terminal data for accuracy.

### **3.1.3. Financial Data**

Firm size, profitability, leverage, and other financial metrics were sourced from Bloomberg Terminal and PSX, with cross-verification to address discrepancies common in emerging markets (World Bank, 2022).

### **3.1.4. Qualitative Data**

Case studies, such as the Pakistan International Airlines (PIA) scandal, were drawn from National Accountability Bureau (NAB) reports (2021) and reputable news sources (e.g., Dawn, 2022), ensuring credible contextual insights.

Accessing data in Pakistan is complicated by incomplete SECP compliance (62% average) and fragmented reporting systems, necessitating rigorous cross-verification and manual data collection to ensure integrity (World Bank, 2022).

Pakistan's developing economy context poses significant data challenges, including incomplete disclosures (10% of governance data missing) and non-standardized reporting formats (SECP, 2021). To address these:

Governance metrics were manually extracted from PSX annual reports, with inconsistencies resolved through cross-verification with SECP and Bloomberg data. Patent data was cleaned to exclude non-firm filings (e.g., individual or academic patents) using WIPO's API and manual checks.

Missing data (10% of governance disclosures, 5% of financial metrics) was handled using multiple imputation techniques, following Huang and Peng (2025), to preserve statistical robustness. This approach accounts for systematic gaps in Pakistan's reporting environment, ensuring reliable estimates. Data integrity was further ensured by cross-referencing all sources, addressing issues like duplicate filings or misreported financials common in emerging markets.

## **3.2 Description of Variables**

The choice of variables is grounded in agency theory (Jensen & Meckling, 1976) and institutional theory (North, 1990), reflecting Pakistan's unique governance challenges and low innovation output. These variables are carefully selected to capture firm-level dynamics in a context marked by family dominance and regulatory gaps:

**Innovation (Dependent Variable):** Patent filings per firm-year, sourced from WIPO's Patentscope database, serve as a proxy for innovation due to their objectivity and applicability in emerging markets, where R&D expenditure data is limited (0.16% of GDP in Pakistan; UNESCO, 2021). Patents are a reliable metric for innovation output, as they reflect tangible technological advancements, despite potential underreporting in service sectors (Griliches, 1990; Hu & Jefferson, 2009).

**Corruption (Independent Variable):** Excess executive compensation, calculated as residuals from a regression of CEO pay on firm performance (return on assets, ROA), firm size, and industry controls, proxies corruption by capturing rent-seeking behavior. This metric is appropriate for Pakistan, where direct corruption data (e.g., bribery) is unreliable due to underreporting and weak enforcement mechanisms (Bebchuk & Fried, 2018; Khan, 2006). It aligns with agency theory, linking misaligned CEO incentives to resource misallocation.

### **3.2.1. Governance Variables**

**Board Independence:** Measured as the proportion of independent directors, this variable reflects oversight capacity to mitigate managerial opportunism, critical in Pakistan's family-dominated firms where independent directors average only 20% (Fama & Jensen, 1983; Shabbir & Rehman, 2022).

**Ownership Concentration:** Defined as the percentage of shares held by the largest shareholder, this captures family control, prevalent in 78% of PSX firms, which often prioritizes private benefits over innovation (La Porta et al., 2019; Cheema & Naseer, 2021).

**Board Size:** The number of directors affects decision-making efficiency, with smaller boards linked to better outcomes in weak governance settings (Yermack, 2017).

**Control Variables:** Firm size (log of total assets), age, leverage, profitability (ROA), and industry dummies account for firm-specific and sectoral variations, ensuring robust estimates in Pakistan's heterogeneous market (Coles et al., 2008).

These variables are justified by their alignment with global studies (e.g., Bai et al., 2024) and their relevance to Pakistan's institutional context, where family dominance and low R&D investment necessitate context-specific proxies for corruption and innovation.

### 3.3 Empirical Models

The proposed study aims to examine the correlation between corporate governance, corruption, and innovation in listed companies in Pakistan, and it uses the approach applied in the research described by Bai et al. (2024), which examined the impact of executive corruption on innovation in Chinese firms. The study employs numerous empirical models to study the interrelationships between corporate governance, corruption and innovation based on their earlier empirical research by Core et al. (1999), Shleifer and Vishny (1993) and La Porta et al. (2000). These models are based on agency theory, which asserts that governance procedures diminish agency costs (Jensen & Meckling, 1976), and rent-seeking theory, which elucidates the misallocation of business resources due to corruption (Murphy, Shleifer, & Vishny, 1991).

The innovation model evaluates the direct impact of corruption and governance on innovation, as indicated by patent applications. It is delineated as

$$Patents_{i,t} = \beta_0 + \beta_1 ExcessComp_{i,t} + \beta_2 BoardInd_{i,t} + \beta_3 OwnConc_{i,t} + \beta_4 BoardSize_{i,t} + \sum \beta_k Controls_{k,i,t} + \alpha_i + \varepsilon_{i,t} \quad 1$$

$Patents_{i,t}$  denotes the quantity of patents submitted by firm  $i$  in year  $t$ ,  $ExcessComp_{i,t}$  represents excess executive compensation (a proxy for corruption),  $BoardInd_{i,t}$  indicates board independence,  $OwnConc_{i,t}$  signifies ownership concentration, and  $BoardSize_{i,t}$  refers to board size.  $Controls_{k,i,t}$  encompasses firm size, age, leverage, profitability, and industry dummies,  $\alpha_i$  is the firm-specific effect, and  $\varepsilon_{i,t}$  is the error term. This model anticipates  $\beta_1 < 0$  (corruption diminishes creativity) and  $\beta_2 > 0$  (board independence promotes innovation). Bai et al. (2024); Aghion et al. (2013). It is customised for Pakistan's setting, where deficiencies in governance exacerbate the impact of corruption (Javid & Iqbal, 2008).

The corruption model examines how governance structures influence excess executive compensation, positing that stronger governance reduces rent-seeking. It is specified as:

$$\begin{aligned}
ExcessComp_{i,t} &= \gamma_0 + \gamma_1 BoardInd_{i,t} + \gamma_2 OwnConc_{i,t} + \gamma_3 BoardSize_{i,t} \\
&+ \sum \gamma Controls_{i,t} + \alpha_i + \mu_{i,t}
\end{aligned} \tag{2}$$

where  $ExcessComp_{i,t}$  represents the dependent variable, and the remaining variables are specified as previously stated. The model anticipates  $\gamma_1 < 0$ , signifying that board independence mitigates corruption (Core et al., 1999; Fama & Jensen, 1983). Cheema et al. (2003).

The mediation models examine if finance restrictions moderate the association between corruption and innovation. They are delineated as:

$$FinConst_{i,t} = \delta_0 + \delta_1 ExcessComp_{i,t} + \sum \delta Controls_{i,t} + \alpha_i + \eta_{i,t} \tag{3}$$

$$Patents_{i,t} = \theta_0 + \theta_1 ExcessComp_{i,t} + \theta_2 FinConst_{i,t} + \sum \theta Controls_{i,t} + \alpha_i + \zeta_{i,t} \tag{4}$$

where  $FinConst_{i,t}$  is a measure of financing constraints (e.g., interest coverage ratio). Mediation is confirmed if  $\delta_1$  and  $\theta_2$  are significant, and the indirect effect ( $\delta_1 \times \theta_2$ ) is non-zero ((Baron & Kenny, 1986;). These models are relevant in Pakistan, where corruption exacerbates capital access issues ((Hussain & Mahmood, 2019).).

The excess compensation model constructs the corruption proxy by regressing executive pay on performance and controls:

$$ExecComp_{i,t} = \alpha_0 + \alpha_1 ROA_{i,t} + \alpha_2 FirmSize_{i,t} + \alpha_3 Industry_{i,t} + v_{i,t} \tag{5}$$

where  $ExecComp_{i,t}$  is executive compensation,  $ROA_{i,t}$  is return on assets,  $FirmSize_{i,t}$  is log of total assets,  $Industry_{i,t}$  are industry dummies, and  $v_{i,t}$  is the residual, used as  $ExcessComp_{i,t}$ . This ensures that only compensation unrelated to performance is considered corruption.

### 3.4 Estimation Methods

To rigorously address the research question—how corporate governance and corruption affect innovation in Pakistan’s publicly listed firms, and the mediating role of financial constraints—this study employs a combination of ordinary least squares (OLS), fixed effects (FE), and two-stage least squares (2SLS) regressions, complemented by mediation analysis and qualitative case studies. These methods are applied to a panel dataset of 100 non-financial firms listed on the Pakistan Stock Exchange (PSX) from 2012–2020, yielding 900 firm-year observations. Each method is selected to address specific challenges in Pakistan’s institutional context, characterized by family-dominated ownership (78% of PSX firms; SECP, 2021), weak regulatory enforcement (Hussain, 2020), and data limitations (e.g., 10% missing governance data; World Bank, 2022). Below, each method is described in detail, including its rationale, procedural steps, statistical considerations, assumptions, and suitability, with equations provided to clarify their application, ensuring comprehensive and clear explanations (Wooldridge, 2010).

#### 3.4.1 Ordinary Least Squares (OLS) Regression

OLS regression serves as a baseline method to estimate the relationships between excess executive compensation (a proxy for corruption), governance variables (board independence, ownership

concentration, board size), and innovation (patent filings), as well as governance's effect on corruption.

OLS is chosen as an initial approach due to its simplicity and ability to provide preliminary insights into cross-sectional relationships between variables. It is useful for benchmarking results against more advanced methods like FE and 2SLS, particularly in Pakistan, where data inconsistencies (e.g., incomplete governance disclosures) necessitate a straightforward starting point (World Bank, 2022). However, OLS is prone to bias in the presence of unobserved firm-specific heterogeneity, such as family control prevalent in 78% of PSX firms, making it a preliminary step before applying FE and 2SLS (Baltagi, 2008). The method aligns with agency theory (Jensen & Meckling, 1976) by testing how governance mechanisms influence rent-seeking and innovation outcomes.

OLS is implemented in Stata 17, minimizing the sum of squared residuals to estimate parameters. For the innovation model, the estimator is:

$$\beta_{OLS} = \arg \min \sum_i \sum_t (Patents_{i,t} - \beta_0 - \beta_1 ExcessComp_{i,t} - \beta_2 BoardInd_{i,t} - \beta_3 OwnConc_{i,t} - \beta_4 BoardSize_{i,t} - \sum \beta \text{Controls}_{i,t})^2 \quad 6$$

This estimates the effect of excess compensation, board independence, ownership concentration, board size, and controls (firm size, age, leverage, profitability, industry dummies) on patent filings. A separate OLS regression examines governance's effect on excess compensation. Robust standard errors are used to account for heteroskedasticity, common in Pakistan's heterogeneous firm data (World Bank, 2022). Results are compared with FE to assess potential bias from unobserved heterogeneity.

OLS assumes linearity, exogeneity of regressors, homoskedasticity, and no multicollinearity. These are tested using residual diagnostics and variance inflation factors ( $VIF < 5$ ). In Pakistan, exogeneity is unlikely due to family dominance and endogeneity concerns, limiting OLS's reliability but justifying its use as a baseline (Wooldridge, 2010).

### 3.4.2 Fixed Effects (FE) Regression

FE regression controls for unobserved time-invariant firm-specific effects, estimating the impact of excess compensation and governance variables on innovation and corruption.

FE is ideal for panel data in Pakistan, where time-invariant factors like family ownership (78% of PSX firms) or corporate culture significantly influence outcomes (SECP, 2021). By focusing on within-firm variation, FE mitigates omitted variable bias, a critical issue in emerging markets with inconsistent reporting (Hussain, 2020). The method supports agency theory by examining how governance curbs rent-seeking and institutional theory by addressing Pakistan's weak regulatory context (North, 1990), making it highly suitable for the study's objectives.

Implemented in Stata 17, FE regression demeans variables within each firm to remove time-invariant effects. For the innovation model, the estimator is:

$$Patents_{i,t} - Patent\bar{s}_i = \beta_1(ExcessComp_{i,t} - ExcessComp\bar{p}_i) + \beta_2(BoardInd_{i,t} - BoardInd\bar{d}_i) + \beta_3(OwnConc_{i,t} - OwnConc\bar{c}_i) \quad 7$$

Where  $Patent\bar{s}_i$  is the firm-specific mean of patents, and similarly for other variables. This estimates the effect of changes in excess compensation, board independence, ownership concentration, and board size on changes in patent filings, controlling for firm-specific effects ( $\alpha_i$ ). A separate FE regression examines

governance's effect on excess compensation. Clustered standard errors at the firm level account for heteroskedasticity and serial correlation (Cameron & Miller, 2015). The Hausman test ( $p < 0.01$ ) confirms FE over random effects, validating the assumption of correlated unobserved effects (Hausman, 1978).

FE assumes strict exogeneity conditional on fixed effects, no perfect multicollinearity, and sufficient within-firm variation. These are reasonable given the 2012–2020 panel and time-varying controls, though limited variation in board independence (20% average; SECP, 2021) may moderate effect sizes.

### 3.4.3 Two-Stage Least Squares (2SLS) Regression

2SLS regression addresses endogeneity in excess executive compensation, which may arise from reverse causality (e.g., low innovation leading to higher pay) or omitted variables (e.g., political connections). Industry-average excess compensation is used as the instrument.

Endogeneity is a significant concern in Pakistan, where family control and weak oversight enable CEOs to manipulate pay (Bebchuk & Fried, 2018). 2SLS isolates exogenous variation, enhancing causal inference in a context with governance challenges (Bai et al., 2024). The instrument is relevant due to industry pay norms and exogenous as it does not directly affect firm-specific innovation, making it suitable for PSX firms (Staiger & Stock, 1997).

Implemented in Stata 17, 2SLS involves two stages:

First stage: Regress excess compensation on the instrument and other variables.

$$ExcessComp_{i,t} = \pi_0 + \pi_1 IndAvgExcessComp_{i,t} + \pi_2 BoardInd_{i,t} + \pi_3 OwnConc_{i,t} + \pi_4 BoardSize_{i,t} + \sum \pi \text{Controls}_{i,t} \quad (8)$$

$IndAvgExcessComp_{i,t}$  is the industry-average excess compensation, and  $ExcessComp_{i,t}$  is the predicted value.

Second stage: Use predicted excess compensation in the innovation model.

$$Patents_{i,t} = \beta_0 + \beta_1 ExcessComp_{i,t} + \beta_2 BoardInd_{i,t} + \beta_3 OwnConc_{i,t} + \beta_4 BoardSize_{i,t} + \sum \beta \text{Controls}_{i,t} + \alpha_i \quad (9)$$

The instrument's strength is verified (F-statistic  $> 10$ ), and clustered standard errors address heteroskedasticity and serial correlation (Cameron & Miller, 2015). The Sargan test ensures instrument validity.

Assumes instrument relevance and exogeneity, empirically tested. Comprehensive controls and fixed effects mitigate other endogeneity sources, aligning with governance studies (Core et al., 1999).

### 3.4.4 Mediation Analysis

Mediation analysis tests whether financial constraints mediate the relationship between excess compensation and innovation, addressing the research question's focus on financial mechanisms.

Pakistan's weak capital markets and low R&D investment (0.16% of GDP; UNESCO, 2021) make

financial constraints a likely channel for corruption’s impact on innovation. Mediation analysis quantifies this indirect effect, complementing FE and 2SLS by exploring causal pathways in Pakistan’s institutional voids (Cheema & Naseer, 2021; Gorodnichenko & Schnitzer, 2013).

Using the Baron and Kenny (1986) framework in Stata 17, three regressions are conducted: (1) financial constraints (interest coverage ratio) on excess compensation and controls, (2) patent filings on excess compensation and controls, and (3) patent filings on both excess compensation and financial constraints. The indirect effect is calculated and tested using Sobel’s test. Clustered standard errors and fixed effects ensure robustness, accounting for firm-level heterogeneity and serial correlation.

Assumes sequential causality, no unmeasured confounders, and correct specification. Comprehensive controls and 2SLS checks mitigate risks, though unobserved factors like political connections may persist.

### 3.4.5 Qualitative Case Studies

Qualitative case studies, such as the PIA scandal (NAB, 2021), complement quantitative findings by providing contextual insights into governance failures.

In Pakistan, statistical data may miss nuanced dynamics due to incomplete disclosures (World Bank, 2022). The PIA case illustrates how low board independence enables rent-seeking, grounding findings in practical reality and aligning with regression results (Yin, 2017).

Cases are selected for relevance to governance and corruption, analyzed using NVivo for thematic coding (e.g., weak oversight, resource misallocation). Findings are triangulated with quantitative results to ensure consistency (Creswell & Clark, 2017).

Assumptions: Assumes cases represent broader governance issues, validated by alignment with SECP reports (2021).

### 3.4.6 Robustness Checks

Robustness checks include alternative specifications (e.g., using R&D intensity or CEO duality), multicollinearity tests ( $VIF < 5$ ), and sensitivity analyses (e.g., excluding industry dummies). Conducted in Stata 17, these confirm result stability, addressing Pakistan’s data challenges, such as missing governance data (10%) and inconsistent reporting formats (Wooldridge, 2010).

These methods—OLS, FE, 2SLS, mediation analysis, and qualitative case studies—are tailored to Pakistan’s institutional context, with detailed procedural explanations and statistical rigor ensuring a robust and transparent analysis of governance, corruption, and innovation dynamics

## 4. Results

This section presents findings from fixed effects and instrumental variable regressions examining the impact of corruption (proxied by excess executive compensation) and corporate governance (board independence, ownership concentration, board size) on innovation (patent filings) in 100 non-financial firms listed on the Pakistan Stock Exchange (PSX) from 2012–2020, yielding 900 firm-year observations. The results are interpreted through agency theory (Jensen & Meckling, 1976) and institutional theory (North, 1990), emphasizing how Pakistan’s family-dominated governance (78% of PSX firms; SECP, 2021) and weak regulatory context (Hussain, 2020) shape these relationships. The focus is on key regression outcomes, with deeper interpretation to highlight their theoretical and contextual significance.

**Table 1. Descriptive Statistics**

Variable	Mean	Median	Std. Dev.	Min	Max
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Patents	1.2	0	2.5	0	15
Excess Compensation	0.0	0.1	1.2	-2.5	3.0
Board Independence	0.20	0.15	0.10	0	0.50
Ownership Concentration	0.60	0.65	0.20	0.10	0.90
Board Size	7.5	7	2.0	5	12
Firm Size	15.8	15.6	1.5	12	20

Table 1 displays the descriptive Statistics provides a summary of key variables for a panel dataset of 100 non-financial firms listed on the Pakistan Stock Exchange (PSX) from 2012 to 2020, comprising 900 firm-year observations. The table reports that the mean number of patents per firm-year is 1.2, with a median of 0 and a standard deviation of 2.5 (ranging from 0 to 15), indicating low and highly variable innovation output, consistent with Pakistan's low R&D spending (0.16% of GDP; UNESCO, 2021). Excess compensation, a proxy for corruption, has a mean of 0.0 (median 0.1) and a standard deviation of 1.2 (ranging from -2.5 to 3.0), reflecting variability in rent-seeking behavior. Board independence averages 0.20 (median 0.15) with a standard deviation of 0.10 (ranging from 0 to 0.50), underscoring limited independent oversight in family-dominated firms (78% of PSX firms; SECP, 2021). Ownership concentration is high, with a mean of 0.60 (median 0.65) and a standard deviation of 0.20 (ranging from 0.10 to 0.90), typical of Pakistan's concentrated ownership structure. Board size has a mean of 7.5 (median 7) with a standard deviation of 2.0 (ranging from 5 to 12), showing moderate variation. Firm size, measured as the log of total assets, averages 15.8 (median 15.6) with a standard deviation of 1.5 (ranging from 12 to 20), indicating diverse firm scales. These statistics highlight Pakistan's governance and innovation challenges, providing context for the study's analysis of corporate governance, corruption, and innovation dynamics.

#### 4.2. Correlation Matrix

**Table 2. Correlation Matrix**

	Patents	ExcessComp	BoardInd	OwnConc	BoardSize
Patents	1.00	-0.25	0.15	-0.10	0.05
ExcessComp	-0.25	1.00	-0.20	0.18	0.12
BoardInd	0.15	-0.20	1.00	-0.15	-0.08
OwnConc	-0.10	0.18	-0.15	1.00	0.10
BoardSize	0.05	0.12	-0.08	0.10	1.00

Table 2 displays the correlation matrix for the principal variables, offering initial insights into their interrelations. The correlation between patents and excess remuneration is -0.25, indicating a moderate negative relationship, aligning with the hypothesis that corruption impedes innovation (Aghion et al., 2013). This is consistent with Mauro (1995), who observes that corruption diverts resources from constructive endeavours.

There exists a positive connection of 0.15 between patents and board independence, suggesting that companies with a greater number of independent directors are inclined to submit more patents. This underscores the need of robust governance in promoting innovation (Chen et al., 2011). The association is modest yet substantial, indicating Pakistan's low levels of board independence (Javid & Iqbal, 2010).

Excess compensation has a negative correlation with board independence (-0.20), indicating that enhanced governance mitigates rent-seeking behaviour (Core et al., 1999). This conclusion aligns with Fama and Jensen (1983), who contend that independent boards alleviate agency issues. The positive association of 0.18 between excess compensation and ownership concentration suggests that concentrated ownership may facilitate elevated executive remuneration, possibly indicative of entrenchment (Shleifer & Vishny, 1997).

Ownership concentration and patents have a negative correlation of -0.10, indicating that elevated ownership concentration may impede innovation, either owing to risk aversion or resource diversion (La

Porta et al., 1999). The modest connection between board size and other factors (e.g., 0.05 with patents, 0.12 with excess compensation) suggests that board size exerts minimal direct influence, aligning with Yermack (1996), who identifies mixed effects of board size on company results.

These correlations offer preliminary evidence of the links examined in the regression models, however they are inconclusive due to possible confounding variables. Multivariate analysis is essential for isolating causal effects (Wooldridge, 2010).

### 4.3. Innovation Model Results

**Table 3. Innovation Model Results**

Variable	Coefficient	Std. Error
Excess Compensation	-0.05**	0.02
Board Independence	0.12*	0.06
Ownership Concentration	-0.03	0.04
Board Size	0.01	0.03
Firm Size	0.08**	0.03
R-squared	0.25	
Observations	900	

\*p<0.05, \*\*p<0.01

Fixed effects regression as shown in Table 3 reveals that excess executive compensation significantly reduces patent filings, with a coefficient of -0.05 (p<0.01). This suggests that a one-unit increase in excess compensation decreases patents by 0.05 units, supporting agency theory's view that rent-seeking diverts resources from R&D (Bebchuk & Fried, 2018). In Pakistan, where innovation is already constrained by low R&D investment, this effect underscores how managerial opportunism exacerbates resource scarcity, limiting technological advancement. Board independence positively impacts innovation, with a coefficient of 0.12 (p<0.05), indicating that a 10% increase in independent directors boosts patent filings by 0.012 units. This aligns with agency theory, as independent boards enhance oversight, aligning CEO incentives with innovation goals (Fama & Jensen, 1983). The modest effect size reflects Pakistan's low board independence, constrained by family control (Shabbir & Rehman, 2022). Firm size is positively significant (coefficient: 0.08, p<0.01), indicating larger firms have greater R&D capacity, consistent with resource-based views (Rehman & Anwar, 2019). Ownership concentration (-0.03, p>0.10) and board size (0.01, p>0.10) are insignificant, likely due to pervasive family control reducing variability in governance structures (Cheema & Naseer, 2021).

### 4.4 Corruption Model Results

**Table 4: Corruption Model Results**

Variable	Coefficient	Std. Error
Board Independence	-0.08*	0.04
Ownership Concentration	0.04	0.03
Board Size	0.02	0.02
Firm Size	0.06**	0.02
R-squared	0.20	
Observations	900	

\*p<0.05, \*\*p<0.01

Board independence significantly reduces excess compensation as shown in Table 4, with a coefficient of -0.08 (p<0.05), suggesting that a 10% increase in independent directors decreases excess pay by 0.008

units. This supports agency theory’s emphasis on independent oversight curbing rent-seeking (Core et al., 1999), particularly critical in Pakistan’s weak regulatory environment, where family dominance often undermines governance (Hussain, 2020). Firm size is positively significant (0.06,  $p < 0.01$ ), reflecting complex pay structures in larger firms, while ownership concentration (0.04,  $p > 0.10$ ) and board size (0.02,  $p > 0.10$ ) remain insignificant, consistent with limited governance variability in family-controlled firms.

#### 4.5 Mediation Analysis Results

**Table 5. Mediation Analysis Results**

Path	Coefficient	Std. Error
ExcessComp → FinConst	0.10**	0.03
ExcessComp → Patents	-0.03*	0.02
FinConst → Patents	-0.15**	0.05
Indirect Effect	-0.015*	0.007

\* $p < 0.05$ , \*\* $p < 0.01$

The mediation model confirms that financial constraints partially mediate the relationship between excess compensation and innovation. Excess compensation increases financial constraints (coefficient: 0.10,  $p < 0.01$ ), which in turn reduce patent filings (-0.15,  $p < 0.01$ ). The indirect effect is -0.015 ( $p < 0.05$ ), indicating that corruption exacerbates funding barriers, reducing innovation. This aligns with institutional theory, as Pakistan’s underdeveloped capital markets amplify financial constraints (Gorodnichenko & Schnitzer, 2013). The partial mediation suggests additional mechanisms, such as managerial priorities, also influence innovation outcomes (Khanna & Palepu, 2000).

#### 4.6 Qualitative Case Study

The PIA scandal (NAB, 2021) illustrates governance failures, with low board independence (15%) enabling excessive executive compensation, diverting resources from innovation. This case reinforces the regression findings, highlighting how weak governance in Pakistan’s institutional context undermines innovation (Yin, 2017).

#### 4.7. Robustness Checks

**Table 6. Robustness Check – IV Results**

Variable	Coefficient	Std. Error
	-0.06**	0.03
Board Independence	0.10*	0.05
R-squared	0.22	
Observations	900	

\* $p < 0.05$ , \*\* $p < 0.01$

IV regressions, using industry-average excess compensation as an instrument, confirm the negative effect of excess compensation (-0.06,  $p < 0.01$ ) and the positive effect of board independence (0.10,  $p < 0.05$ ), with a strong instrument (F-statistic  $> 10$ ; Staiger & Stock, 1997). Alternative specifications, including R&D intensity and CEO duality, yield consistent results, reinforcing reliability (Wooldridge, 2010).

These regression results highlight that corruption significantly hinders innovation, while board independence mitigates this effect, offering actionable insights for governance reforms in Pakistan’s institutional context

## 5. Discussion

This study advances the understanding of corporate governance, corruption, and innovation in Pakistan's publicly listed firms, addressing a gap in emerging market research. The findings are organized around three themes: (1) corruption's detrimental effect on innovation, (2) the role of governance mechanisms, particularly board independence, and (3) the mediating role of financial constraints. This thematic approach ensures a cohesive narrative, integrating regression results with Pakistan's institutional context—family-dominated firms (78% of PSX firms; SECP, 2021) and weak regulatory enforcement (Hussain, 2020)—and theoretical frameworks (agency and institutional theories).

The regression results demonstrate that excess executive compensation, a proxy for corruption, significantly reduces patent filings by 0.05 units per unit increase ( $p < 0.01$ ), aligning with agency theory's assertion that rent seeking diverts resources from R&D (Bebchuk & Fried, 2018). In Pakistan, where R&D spending is only 0.16% of GDP (UNESCO, 2021), these findings highlight how managerial opportunism exacerbates resource scarcity, stifling innovation. Compared to Bai et al. (2024), who reported an 18–22% reduction in innovation due to corruption in China, the effect in Pakistan is less pronounced due to its limited innovation base (patent filings 70% below regional averages; WIPO, 2020). The qualitative case study of the Pakistan International Airlines (PIA) scandal (NAB, 2021) illustrates this, where low board independence (15%) enabled excessive compensation, diverting funds from innovation-related investments. This underscores the pervasive impact of corruption in Pakistan's weak institutional environment, where regulatory gaps and family control amplify resource misallocation (Hussain, 2020).

Board independence significantly enhances innovation, with a 10% increase in independent directors boosting patent filings by 0.012 units ( $p < 0.05$ ) and reducing excess compensation by 0.008 units ( $p < 0.05$ ). These findings support agency theory, as independent boards strengthen oversight, aligning CEO decisions with firm innovation goals (Fama & Jensen, 1983; Shabbir & Rehman, 2022). However, the modest effect size reflects Pakistan's low board independence (20% average; SECP, 2021), constrained by family dominance and limited regulatory enforcement. In contrast, India's governance reforms increased R&D spending by 40% through higher board independence (Bertrand et al., 2018), suggesting untapped potential for Pakistan's 2019 SECP reforms if compliance improves (World Bank, 2022). The insignificance of ownership concentration ( $-0.03$ ,  $p > 0.10$ ) and board size ( $0.01$ ,  $p > 0.10$ ) reflects the dominance of family control, which reduces variability in these governance mechanisms (Cheema & Naseer, 2021). These results highlight the critical role of independent directors in mitigating corruption and fostering innovation in Pakistan's context.

The mediation analysis confirms that financial constraints partially mediate the corruption-innovation relationship, with an indirect effect of  $-0.015$  ( $p < 0.05$ ). Excess compensation increases financial constraints ( $0.10$ ,  $p < 0.01$ ), which in turn reduce patent filings ( $-0.15$ ,  $p < 0.01$ ). This aligns with institutional theory, as Pakistan's underdeveloped capital markets and weak financial infrastructure exacerbate funding barriers for innovation (Gorodnichenko & Schnitzer, 2013; Cheema & Naseer, 2021). The partial mediation suggests that while financial constraints are a key mechanism, other factors, such as managerial priorities or political connections, also influence innovation outcomes (Khanna & Palepu, 2000). This finding underscores the need for alternative funding mechanisms to support innovation in Pakistan's resource-constrained environment.

### 5.1. Conclusion

This research establishes that executive corruption, indicated by excessive salary, substantially obstructs innovation in publicly listed companies in Pakistan. An increase of one unit in excess compensation results in a decrease of 0.05 units in patent submissions. Board independence alleviates this

impact, since a 10% rise in independent directors enhances innovation by 0.012 patents and diminishes excess compensation by 0.008 units. Financial limitations partially moderate the link between corruption and innovation, resulting in a minor yet important indirect effect. Ownership concentration and board size have little impacts, perhaps attributable to the widespread family control in Pakistan. These results are resilient to different metrics, instrumental factors, and supplementary specifications.

The detrimental impact of corruption on innovation is persistent yet less pronounced, indicative of Pakistan's diminished innovation foundation. The beneficial impact of board independence corresponds with the findings of Brickley et al. (1997) and Ayyagari et al. (2011), but the benefit is diminished by Pakistan's governance issues. The mediation by financial limitations aligns with the findings of Gorodnichenko and Schnitzer (2013), underscoring a crucial mechanism in emerging economies. These findings address a significant void in the literature by offering Pakistan-specific information about the relationship among governance, corruption, and innovation (Ahmed & Qureshi, 2021).

## **5.2. Practical implications**

The findings offer actionable recommendations for policymakers, regulators, and business executives to enhance governance and innovation in Pakistan:

**Strengthen Board Independence:** The Securities and Exchange Commission of Pakistan (SECP) should mandate a minimum board independence ratio (e.g., 33%, as in India's IICA model; SECP, 2019) and establish a national director training institute to equip independent directors with skills to counter family dominance and enhance oversight. This can boost innovation by aligning managerial incentives with R&D goals.

**Enforce Transparent Compensation:** Regulators should implement stricter disclosure requirements for executive pay, linking compensation to performance metrics like ROA. This would reduce rent-seeking and free resources for innovation, particularly in firms with limited R&D budgets.

**Promote Alternative Funding:** The government should expand venture capital and innovation grant programs to alleviate financial constraints. Public-private partnerships, modeled on successful emerging market initiatives could provide firms with access to capital for R&D.

**Enhance Anti-Corruption Measures:** The National Accountability Bureau (NAB) should strengthen investigations into corporate misconduct, supported by whistleblower protections, to deter rent-seeking behaviors. This is critical in Pakistan's high-corruption environment.

**Invest in Innovation Ecosystems:** Investments in innovation hubs and intellectual property rights enforcement, per Pakistan's Vision 2025, can stimulate patent activity and encourage firms to prioritize R&D.

These measures can unlock Pakistan's economic potential by fostering innovation and reducing corruption, addressing the institutional voids that hinder competitiveness.

## **5.3. Limitations of study**

The study has several limitations that warrant critical reflection. First, reliance on patent filings as a proxy for innovation may underrepresent innovation in service sectors, where patents are less common (Ahmed & Qureshi, 2021). This limits the findings' applicability to Pakistan's diverse economy, where services contribute significantly to GDP. Second, R&D data was available for only 30% of firms, restricting the ability to capture broader innovation inputs and reducing generalizability (World Bank, 2022). Third, excess executive compensation, while a robust proxy for rent-seeking, does not encompass other corruption forms, such as bribery or political rent extraction, which are prevalent in Pakistan (Khan, 2006). Fourth, the focus on PSX-listed firms excludes small and medium enterprises (SMEs), which account for 40% of Pakistan's GDP (Asghar & Hussain, 2020), limiting the study's scope. Finally, unobserved variables, such as political connections or informal governance practices, may introduce bias, despite controls like instrumental variables (Bai et al., 2024). These limitations suggest caution in generalizing the findings and highlight the need for broader data and metrics in future research.

## **5.4. Future Directions**

To support replication and advancement, future studies should address the identified limitations and extend the research in the following ways:

- **Broader Innovation Metrics:** Incorporate alternative innovation measures, such as process improvements or non-patent intellectual property (e.g., trademarks), to capture service sector innovation, enhancing applicability to Pakistan's economy.
- **Direct Corruption Measures:** Explore direct corruption indicators, such as bribery indices or NAB case data, to complement excess compensation and provide a fuller picture of corruption's impact.
- **Inclusion of SMEs:** Expand the sample to include SMEs, using survey-based data or regional business registries, to improve generalizability and capture innovation dynamics in Pakistan's broader economy.
- **Comparative Regional Analysis:** Conduct comparative studies with other South Asian economies (e.g., India, Bangladesh) to identify regional differences in governance and innovation, leveraging frameworks.
- **Political Connections:** Investigate the role of political connections in shaping governance and innovation, using network analysis or qualitative data to address unobserved biases.
- **Post-Reform Analysis:** Perform longitudinal studies post-2020 to assess the impact of SECP's 2019 governance reforms on innovation outcomes, providing insights into policy effectiveness.
- These directions offer clear pathways for replication and advancement, enabling researchers to build on this study's findings in Pakistan and similar emerging markets with governance challenges

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