Board of Directors Centrality and Firm Performance: Evidence from the Tehran Stock Exchange

Thesis Writing Sample

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Abstract

When directors serve on multiple boards, they create interlocking directorates that connect otherwise independent firms. Such board networks can transmit information, diffuse practices, and signal legitimacy, potentially improving firm performance. We model the network as a graph and measure four standard centralities—degree, closeness, betweenness, and eigenvector—to capture the board's position. Using a panel of Tehran Stock Exchange and Iran Fara Bourse firms from 2016–2024, we examine how centrality relates to subsequent performance, measured by Tobin's Q. A dynamic specification estimated via system GMM indicates economically meaningful effects: a one–standard-deviation increase in degree, closeness, betweenness, and eigenvector centrality is associated with approximately 8.32%, 22.53%, 10.82%, and 1.97% higher future Q, respectively. We further show that ownership concentration moderates these relationships: as concentration rises, the positive effect of board centrality weakens and can turn negative at high levels, consistent with the view that controlling shareholders substitute for network-mediated resources. Overall, our results suggest that the value of board networks depends on institutional features—most notably ownership structure.

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1 Introduction

The governance of modern corporations operates through complex networks of relationships that extend far beyond the formal boundaries of individual firms. At the center of these networks sits the board of directors—the apex of corporate decision-making and strategic oversight. While traditional corporate governance research has focused primarily on board characteristics such as size, independence, and diversity(Adams et al., 2009; Hermalin & Weisbach, 2003), a growing body of literature recognizes that who directors know may be as important as what they know(Fracassi & Tate, 2012; Larcker et al., 2013). When directors serve on multiple boards simultaneously, they create interlocking directorates that form networks connecting otherwise independent firms. These board interlocks can serve as conduits for information flow, resource sharing, and strategic learning across organizational boundaries(Mizruchi, 1996).

The economic significance of board networks has been documented across diverse institutional contexts. In the United States, firms with well-connected boards demonstrate superior performance(Chuluun et al., 2014; Larcker et al., 2013), better access to capital markets(Engelberg et al., 2012), and more sophisticated strategic decision-making(Haunschild & Beckman, 1998). European studies reveal similar patterns, with board connectivity associated with improved firm valuation and reduced information asymmetries(Ferris et al., 2003; Renneboog & Zhao, 2011). Evidence from emerging markets, including India(Shaw et al., 2016) and China(Liu et al., 2014), suggests that network effects may be even more pronounced in institutional environments characterized by weak formal institutions and imperfect capital markets.

However, despite this accumulation of evidence, fundamental questions remain unanswered. First, the mechanisms through which board networks create value remain incompletely understood. Does centrality in the network improve performance through superior information acquisition (resource dependence perspective), or does it reflect the selection of high-quality directors by successful firms (agency perspective)? Second, contingencies that amplify or attenuate the benefits of the network have not received enough attention. Zona et al.(2018) provide compelling evidence that ownership structure moderates the relationship between board interlocks and performance in European firms, but whether these findings generalize to other institutional contexts, particularly emerging markets with distinct ownership patterns, remains an open empirical question. Third, the endo-

geneity challenges inherent in network research demand methodological approaches that can credibly identify causal effects, yet many existing studies rely on static estimation methods that cannot adequately address reverse causality and omitted variable bias.

This study addresses these gaps by examining the relationship between board network centrality and firm performance on the Tehran Stock Exchange (TSE) and Iran Fara Bourse (IFB) market in an emerging market context characterized by concentrated ownership, significant state involvement, and limited access to international capital markets. Iran presents an ideal laboratory for testing theories of board network value for several reasons. First, with an average ownership concentration of 58.4% among the largest shareholders, Iranian listed firms exhibit substantially higher ownership concentration than developed markets (typically 15-25% in the US/UK) and are comparable to other emerging markets such as Brazil, Turkey, and India(Claessens et al., 2000; La Porta et al., 1999). This institutional feature allows us to test whether network benefits documented in dispersed ownership contexts extend to concentrated ownership environments, or whether large shareholders render external network connections redundant or even detrimental. Second, the relative isolation of the Iranian market from global financial markets and the limited development of formal institutions (credit rating agencies, analyst coverage, financial intermediaries) may increase firms' reliance on informal information channels, potentially magnifying the value of board networks. Third, the availability of comprehensive board composition data from mandatory disclosures (codal.ir) combined with audited financial statements allows construction of a detailed panel data set for 2016-2024, providing sufficient temporal variation to employ dynamic panel estimation methods.

2 Research Questions and Theoretical Framework

This study addresses three primary research questions:

RQ1: What is the causal effect of board network centrality on future firm performance in an emerging market with concentrated ownership?

RQ2: Does the relationship between board centrality and firm performance depend on the degree of ownership concentration?

RQ3: Do different dimensions of network centrality (degree, closeness, betweenness,

eigenvector) exhibit heterogeneous effects on performance, and what do these differences reveal about the underlying mechanisms? To address these questions, we build on two complementary perspectives: resource dependence theory and agency theory.

2.1 Resource Dependence Perspective

Resource dependence theory(Pfeffer & Salancik, 1978) posits that organizations depend on external resources for survival and performance, and that board members serve as critical linkages to the external environment. In this view, board interlocks function as bridges that provide access to information, expertise, and resources not available within the firm's boundaries. Directors who sit on multiple boards accumulate diverse experiences, encounter varied strategic approaches, and develop extensive professional networks that they can leverage on behalf of all firms they serve(Carpenter & Westphal, 2001).

Empirical evidence supports multiple channels through which board networks create value. Information acquisition: Connected directors provide early access to market intelligence, industry trends, and competitive dynamics(Haunschild & Beckman, 1998). Strategic learning: Exposure to diverse governance practices and strategic choices enables directors to import superior decision-making frameworks(Davis, 1991). Legitimacy and reputation: Association with prestigious, well-connected directors signals quality to external stakeholders, reducing information asymmetries and improving access to resources(Stuart et al., 1999). Monitoring enhancement: Network connections may improve oversight effectiveness by exposing directors to best practices in corporate governance and increasing reputational concerns(Fich & Shivdasani, 2006).

In emerging market contexts characterized by institutional voids—weak legal protection, underdeveloped capital markets, limited information intermediaries the value of network-mediated resources should be amplified. When formal institutions fail to provide reliable information or enforce contracts effectively, informal networks become critical mechanisms for reducing uncertainty and facilitating transactions(Khanna & Palepu, 2000). Board networks may thus serve as substitutes for missing formal institutions, making centrality particularly valuable in markets like Iran.

2.2 Agency Perspective and Ownership Structure

Agency theory(E. F. Fama & Jensen, 1983; Jensen & Meckling, 1976) offers a more skeptical view of board networks, emphasizing potential conflicts between managers, directors, and shareholders. From this perspective, board interlocks may facilitate collusion, reduce monitoring effectiveness, and enable value-destroying behavior. Directors serving on multiple boards face time and attention constraints that may compromise oversight quality(Falato et al., 2014; Fich & Shivdasani, 2006). Network connections may create reciprocal relationships that undermine director independence, as CEOs exchange board seats or directors hesitate to challenge peers in their social network(Fracassi & Tate, 2012; Hwang & Kim, 2009). In extreme cases, interlocks may facilitate explicit coordination on anti-competitive practices or rent extraction(Mizruchi, 1996).

Critically, the balance between resource benefits and agency costs likely depends on ownership structure. When ownership is dispersed, no single shareholder has sufficient incentive or ability to monitor management intensively. In this context, board networks may provide valuable monitoring enhancements and resources that atomistic shareholders cannot access individually(Larcker et al., 2013). However, when ownership is concentrated, large shareholders possess both the incentive (due to substantial equity stakes) and ability (through voting power and direct access to management) to monitor and control firm behavior effectively(Shleifer & Vishny, 1997). These controlling shareholders typically have direct access to resources, information, and influence networks through their own business empires, family connections, or government relationships. Consequently, external board networks become redundant—offering little marginal value beyond what controlling shareholders already provide(Zona et al., 2018).

Moreover, in concentrated ownership settings, board networks may create additional agency costs. Controlling shareholders may use network connections to pursue private benefits at the expense of minority shareholders for example, by facilitating related-party transactions, tunneling resources between affiliated firms, or coordinating strategies that benefit insiders but harm external investors(Bertrand et al., 2002; Johnson et al., 2000). Board members appointed by controlling shareholders may prioritize loyalty to the appointing shareholder over fiduciary duty to all shareholders, and network connections may enable subtle forms of collusion that are difficult for outsiders to detect or challenge.

This theoretical logic generates our core hypothesis:

H1 (Main Effect): *Board network centrality is positively associated with future firm performance.*

H2 (Moderation by Ownership): *The positive relationship between board centrality and firm performance is attenuated (or becomes negative) as ownership concentration increases.*

2.3 Multidimensional Nature of Network Centrality

A distinctive feature of our approach is the examination of four distinct dimensions of network centrality, each capturing different aspects of a firm's position in the board interlock network:

1. **Degree Centrality**: Counts the number of direct connections—firms with which a focal firm shares board members. This captures the volume of immediate network contacts and reflects local connectivity. High degree centrality implies access to diverse information sources and multiple channels for resource acquisition.

$$C_i^{deg} = \sum_{j \neq i} e(i,j) \tag{1}$$

   We calculate degree centrality using equation (1), C_i^{deg} is degree centrality associated to node i and $e(i,j)$ is the link between two nodes i and j.

2. **Closeness Centrality**: Measures the average distance from a focal firm to all other firms in the network. Firms with high closeness centrality can rapidly access information from distant parts of the network, serving as efficient conduits for knowledge diffusion. This dimension captures the speed of information flow.

$$C_i^{clo} = \frac{n-1}{\sum_{j \neq i} l(i,j)} \tag{2}$$

   In equation (2), C_i^{clo} is the closeness centrality associated to node i and $l(i,j)$ is the shortest path between two nodes i and j.

3. **Betweenness Centrality**: Quantifies how often a firm lies on the shortest path between other pairs of firms. High betweenness indicates a *brokerage* position that can control or mediate information flows across otherwise weakly connected regions

of the network, creating bargaining power and access to non-redundant information.

$$C_i^{bet} = \frac{2}{(n-1)(n-2)} \sum_{\substack{k<j \\ k\neq i\neq j}} \frac{\sigma_{kj}(i)}{\sigma_{kj}} \tag{3}$$

In equation (3), n is the number of firms (nodes), σ_{kj} is the number of shortest paths between k and j, and $\sigma_{kj}(i)$ is the number of those paths that pass through i. The factor $2/[(n-1)(n-2)]$ normalizes the index to $[0, 1]$ for undirected graphs, making values comparable across years and network sizes.

4. **Eigenvector Centrality**: Weights each connection by the importance of the neighbor—links to highly central firms contribute more than links to peripheral firms. This captures the *quality* of connections (status/prestige effects) rather than their count.

$$C_i^{eig} = \frac{1}{\lambda_1} \sum_{j=1}^{n} A_{ij}\, C_j^{eig}, \qquad \text{equivalently} \qquad A\,\mathbf{C}^{eig} = \lambda_1\,\mathbf{C}^{eig} \tag{4}$$

In equation (4), A is the adjacency matrix of the interlock network (with $A_{ij} = 1$ if firms i and j share at least one director, or A_{ij} equal to the number of shared directors in the weighted case), λ_1 is its largest eigenvalue, and $\mathbf{C}^{eig}$ is the associated positive eigenvector (Perron–Frobenius). We scale scores to $[0, 1]$ by dividing by the maximum entry; isolates receive $C_i^{eig} = 0$.

By examining these multiple dimensions simultaneously, we can draw inferences about the mechanisms through which networks create value. If degree centrality drives performance effects, this suggests that volume of connections matters—consistent with resource accumulation through diverse ties. If betweenness centrality dominates, this points to the value of *brokerage* and control over information flows. Eigenvector centrality would highlight the importance of status and association with elite firms. Our empirical strategy estimates separate effects for each centrality measure while controlling for potential correlations among them through the use of a comprehensive control variable set and dynamic panel methods.

3 Literature Review

The study of board interlocks and their implications for corporate performance has evolved through multiple theoretical lenses and empirical contexts. This section reviews the relevant literature organized around five key themes: the theoretical foundations of board networks, empirical evidence on network effects, the role of ownership structure, methodological considerations in network research, and gaps in the existing literature that motivate our study.

3.1 Theoretical Foundations of Board Networks

The study of interlocking directorates has deep historical roots, with early work by Bunting (1976) and Pennings (1980) documenting the prevalence and structure of board connections in developed markets. However, theoretical development accelerated in the 1980s with two seminal contributions that continue to frame contemporary research.

Burt (1983) advanced a structural approach grounded in social network theory, arguing that board interlocks create channels for information flow and resource exchange that can enhance firm performance. His analysis of the American corporate network demonstrated that firms occupying central positions—those with numerous connections to well-connected others—enjoy superior profitability through privileged access to information and strategic opportunities (Mizruchi, 1986). This perspective aligns with resource dependence theory (Pfeffer & Salancik, 2015), which posits that organizations depend on external resources for survival, and that board members serve as critical linkages to the external environment (Pfeffer, 1972).

The resource dependence perspective suggests multiple mechanisms through which board networks create value. First, interlocked directors facilitate *information acquisition*, providing early access to market intelligence, industry trends, and competitive dynamics (Haunschild & Beckman, 1998). Davis (1991) demonstrated this mechanism empirically by showing how the adoption of poison pills diffused through the intercorporate network, with firms connected to early adopters more likely to implement similar defensive strategies. Second, networks enable *strategic learning* as directors import superior decision-making frameworks and governance practices from their multiple board experiences (Shropshire, 2010). Third, board connections confer *legitimacy and repu-*

tation, signaling quality to external stakeholders and reducing information asymmetries (Stuart et al., 1999). Fourth, network exposure may enhance *monitoring effectiveness* by allowing directors to benchmark practices across firms and strengthening their reputational concerns (Fich & Shivdasani, 2006).

However, agency theory offers a more skeptical view of board networks (E. Fama & Jensen, 1983; Jensen & Meckling, 1976). From this perspective, board interlocks may facilitate collusion, reduce monitoring effectiveness, and enable value-destroying behavior. Directors serving on multiple boards face time and attention constraints that may compromise oversight quality—the so-called "busyness hypothesis" (Ferris et al., 2003; Fich & Shivdasani, 2006). Jiraporn et al. (2009) provide evidence that busy directors are more likely to be absent from board meetings, raising questions about their monitoring capacity. Moreover, network connections may create reciprocal relationships that undermine director independence, as CEOs exchange board seats or directors hesitate to challenge peers in their social network (Fracassi & Tate, 2012; Hwang & Kim, 2009). Fracassi and Tate (2012) find that firms with greater CEO-director network ties engage in more value-destroying acquisitions and exhibit weaker corporate governance.

Recent theoretical work has sought to integrate these competing perspectives. Hillman and Dalziel (2003) argue that boards simultaneously perform monitoring (agency) and resource provision (resource dependence) roles, and that the relative importance of these functions varies with firm characteristics and environmental conditions. Similarly, Zona et al. (2018) propose a contingency framework suggesting that the net effect of board interlocks depends on firm-specific factors, particularly ownership structure. This integrated perspective recognizes that board networks involve both benefits (information, resources, expertise) and costs (distraction, collusion, rent extraction), with the balance determined by contextual factors.

3.2 Empirical Evidence on Board Networks and Firm Performance

Empirical research on the relationship between board centrality and firm performance has produced mixed results, with findings varying across institutional contexts, time periods, and measurement approaches. Early studies in the United States provided initial evidence of positive network effects. Burt (1983) found that firms with more central positions in

the interlock network exhibited higher profitability, though Richardson (1987) challenged these findings, arguing that the relationship was spurious and driven by firm size and industry effects.

More recent U.S. research using sophisticated network measures and panel data methods has documented economically significant positive effects. Larcker et al. (2013) construct a comprehensive network of board connections among S&P 1500 firms and find that companies with central boards earn superior risk-adjusted stock returns of approximately 4.68% annually. Importantly, they show that return prediction is concentrated among high growth opportunity firms or firms facing adverse circumstances, suggesting that boardroom connections matter most when information and resources from the network are most valuable. Chuluun et al. (2014) confirm these findings, demonstrating that network centrality predicts future profitability and Tobin's Q, with effects strongest for firms in dynamic, uncertain environments.

Research has also examined specific mechanisms through which board networks affect performance. Chang and Wu (2021) show that well-connected boards enhance corporate innovation, with firms benefiting more when they have higher demands for advising or face severe agency problems. The effect is stronger when directors' connections are related to the firm's industry and business model. Similarly, Wu and Dong (2021) exploit a natural experiment in China to demonstrate that independent director network centrality has a causal positive effect on corporate patenting, with the mechanism operating through information transmission in the board network. Song and Wang (2024) find that network effects on investment decisions are strongest when firms strategically follow connected peers with high-quality information, supporting the view that networks serve as information conduits.

Beyond direct performance effects, research documents that board networks influence various corporate outcomes. Y. Kim et al. (2022) find that firms with well-connected boards demand higher audit quality, consistent with networks enhancing governance and monitoring. D. Li et al. (2019) show that director network centrality accelerates firms' speed of capital structure adjustment toward target leverage in China, suggesting that networks improve access to financing information and resources. Benson et al. (2018) demonstrate that larger director networks are associated with higher credit ratings, with effects particularly pronounced during recessions and financial uncertainty.

However, not all evidence supports the beneficial effects of board networks. Khan and Baker (2024) find that interlocking directorships negatively impact firm performance in Turkey, providing support for the busyness hypothesis. They show that board diversity moderates this relationship, with diverse boards mitigating the negative effects of director busyness. Bizjak et al. (2009) document how the controversial practice of stock option backdating spread through board interlocks, with firms connected to backdating firms significantly more likely to adopt the practice themselves—an example of networks facilitating the diffusion of illegal innovations (Armstrong & Larcker, 2009; Snyder et al., 2009).

International evidence further illustrates the contingent nature of network effects. Non and Franses (2007) find nonlinear effects of interlocks on performance in the Netherlands, with moderate levels of connectivity associated with improved performance but excessive connections harmful. Y. Kim (2005) document positive effects of board network density and external social capital on firm value in Korea, with elite educational networks playing an important role. Pombo and Gutiérrez (2011) show that outside director appointments and board interlocks positively affect performance in Colombian business groups, particularly among non-state-owned enterprises, though effects depend on ownership contestability.

3.3 Ownership Structure as a Moderating Factor

A growing body of literature examines how ownership structure conditions the relationship between board networks and firm performance. This line of inquiry is motivated by the observation that the governance challenges firms face—and consequently the value of governance mechanisms—differ systematically between dispersed and concentrated ownership environments (Shleifer & Vishny, 1986).

In dispersed ownership contexts typical of U.S. and U.K. firms, the central governance problem is the separation of ownership and control, with atomistic shareholders lacking the incentive or ability to monitor management intensively (E. Fama, 1980). Board networks may provide valuable monitoring enhancements and resources that individual shareholders cannot access (Larcker et al., 2013). However, in concentrated ownership environments, large shareholders possess both the incentive (due to substantial equity stakes) and ability (through voting power and direct management access) to monitor

effectively (Shleifer & Vishny, 1997). These controlling shareholders typically have direct access to resources, information, and influence networks through their own business empires, family connections, or government relationships, potentially rendering external board networks redundant (Zona et al., 2018).

Zona et al. (2018) provide the first rigorous test of this ownership moderation hypothesis using data from Italian firms. They find that board interlocks positively affect firm performance, but this effect is attenuated—and becomes negative at high levels—as ownership concentration increases. They interpret this pattern as evidence that large shareholders can substitute for the information and monitoring benefits provided by external network connections. When ownership is highly concentrated, the marginal value of board networks diminishes and may turn negative if networks facilitate entrenchment or rent extraction by controlling shareholders.

Barak and Kapah (2016) extend this analysis to Israel, another concentrated ownership environment characterized by pyramidal control structures. They find that network centrality of expert directors (neither external directors nor ultimate owners) promotes firm valuation and mitigates the negative effects of pyramidal structures. However, central external directors tend to harm performance and magnify tunneling opportunities for controlling shareholders, consistent with the view that such directors serve the interests of controlling shareholders rather than monitoring them effectively.

Research in emerging markets provides additional evidence on the ownership-network interaction. Singh and Delios (2017) examine Indian firms and find that board network resources positively affect both domestic and international growth, but effects are stronger for widely-held firms compared to family-controlled business groups. Similarly, L. Li et al. (2013) show that network centrality enhances performance in Chinese firms, with effects more pronounced among non-state-owned enterprises than state-owned enterprises, suggesting that state ownership provides alternative channels for information and resource access.

The moderating role of ownership structure extends beyond concentration levels to ownership type. Nguyen et al. (2015) compare Singapore (well-developed governance) and Vietnam (under-developed governance) and find that concentrated ownership positively affects performance in both markets, but the effect is stronger in Vietnam, consistent with the substitution hypothesis—that concentrated ownership compensates for

weak national governance institutions. Guerrero-Villegas et al. (2018) demonstrate that both board monitoring and resource provision roles positively moderate the ownership concentration-performance relationship in European firms, though the resource provision effect diminishes at extremely high concentration levels.

Collectively, this literature suggests that the value of board networks depends critically on the ownership context. In dispersed ownership settings, networks provide information and monitoring enhancements that atomistic shareholders cannot supply. In concentrated ownership environments, however, large shareholders may already provide these functions internally, reducing the marginal benefit of external connections and potentially creating opportunities for network-facilitated rent extraction.

3.4 Methodological Considerations in Network Research

Research on board networks confronts significant methodological challenges that complicate causal inference. The fundamental difficulty is endogeneity: successful firms attract better-connected directors, while better-connected boards may cause superior performance (Fracassi & Tate, 2012). This simultaneity, combined with omitted variable bias from unobserved firm quality and dynamic panel bias from performance persistence (Nickell, 1981), means that conventional regression approaches may yield biased estimates.

Researchers have employed various strategies to address these concerns. Some studies use static fixed effects models with lagged independent variables (Blanco-Alcántara et al., 2019; Non & Franses, 2007), though these methods cannot fully resolve simultaneity and may amplify measurement error (Griliches & Hausman, 1986). Others exploit natural experiments or regulatory changes as sources of exogenous variation. Wu and Dong (2021) use China's anti-corruption campaign as a shock to director networks, while Faia et al. (2020) exploit a ban on interlocking directorates among Italian financial firms. Bakke et al. (2024) employ director deaths as unexpected shocks to network structure, finding that these negative shocks significantly reduce interlocked firms' values.

However, natural experiments are rare, and their external validity may be limited. Consequently, several studies have turned to dynamic panel methods, particularly the Generalized Method of Moments (GMM) estimators developed by Arellano and Bover (1995) and Blundell and Bond (1998). System GMM addresses dynamic panel bias by differencing out fixed effects and using lagged levels of variables as instruments, while also

incorporating level equations with lagged differences as instruments (Beck et al., 2000). L. Li et al. (2013) apply this approach to Chinese firms, though GMM studies of board networks remain relatively uncommon despite the method's advantages for addressing endogeneity in dynamic settings.

Recent methodological work has also emphasized the importance of properly specifying network measures. Bonacich et al. (1998) argue that many centrality measures are strongly correlated with simple degree (the number of connections), potentially confounding interpretation. They develop size-adjusted centrality measures that isolate network effects from scale effects. Borgatti and Halgin (2011) provide a theoretical framework for understanding different centrality measures and their implications, emphasizing that degree, closeness, betweenness, and eigenvector centrality capture distinct aspects of network position and may operate through different mechanisms.

3.5 Research Gaps and Study Positioning

Despite substantial progress, important gaps remain in the literature on board networks and firm performance. First, the vast majority of empirical research focuses on developed markets, particularly the United States and Europe, with limited evidence from emerging markets (Lamb & Roundy, 2016). The few emerging market studies that exist focus primarily on China, India, and Brazil, with many other institutional contexts unexplored. Iran, with its unique combination of high ownership concentration, significant state presence, limited international integration, and Persian business culture, represents an important but unstudied setting.

Second, while Zona et al. (2018) demonstrate that ownership structure moderates network effects in Europe, it remains unclear whether these findings generalize to more extreme ownership concentration environments. Iranian firms exhibit average ownership concentration of 58.4% among largest shareholders, substantially higher than Continental Europe (30-40%) and much higher than dispersed ownership markets. Whether the moderation effect continues to operate, or whether there exists a threshold beyond which networks become uniformly detrimental, is an open empirical question.

Third, few studies employ rigorous dynamic panel methods to address endogeneity concerns in network research. While L. Li et al. (2013) apply System GMM to Chinese data, and D. Li et al. (2019) use similar methods for capital structure dynamics, com-

prehensive examinations of multiple network centrality measures using dynamic panel approaches remain scarce. Most existing studies rely on static methods that cannot fully resolve simultaneity and reverse causality concerns.

Fourth, the mechanisms through which networks create value remain incompletely understood. While studies document effects on innovation (Chang & Wu, 2021), investment (Song & Wang, 2024), capital structure (D. Li et al., 2019), and audit quality (Y. Kim et al., 2022), the relative importance of different centrality dimensions (degree, closeness, betweenness, eigenvector) and what they reveal about underlying mechanisms has received limited attention. Larcker et al. (2013) examine only degree centrality, while Non and Franses (2007) focus primarily on the number of interlocks without distinguishing centrality types.

Finally, there is limited understanding of how corporate governance regulations shape network formation and effects in different institutional contexts. Recent regulatory developments in Iran, including corporate governance guidelines issued in 2018 and updated in 2022 (Securities & Organization, 2018, 2022), provide a unique opportunity to examine how governance reforms interact with board network structures. The extent to which these regulations influence network formation patterns and moderate network-performance relationships remains unexplored.

Our study addresses these gaps by: (1) providing the first comprehensive analysis of board networks in Iran, extending evidence to a high-concentration, emerging market context; (2) testing whether ownership structure moderation operates at concentration levels substantially higher than previously studied; (3) employing System GMM estimation with comprehensive specification testing to credibly identify causal effects; (4) examining four distinct centrality measures simultaneously to understand which aspects of network position drive performance effects; and (5) contextualizing findings within Iran's evolving corporate governance regulatory framework. By addressing these gaps, we aim to advance understanding of when and how board networks create value, and to test the generalizability of network theories across diverse institutional environments.

3.6 Institutional Context: The Iranian Capital Market

Iran's capital market presents a distinctive institutional environment characterized by high ownership concentration, significant state involvement, and an evolving corporate

governance framework. Understanding these institutional features is critical for interpreting our findings on board networks and firm performance, as they shape both the formation of director networks and the mechanisms through which networks may create or destroy value. This section describes the key institutional characteristics of the Iranian capital market that motivate our research design and inform our hypotheses.

3.6.1 Overview of the Iranian Capital Market

The Tehran Stock Exchange (TSE), established in 1967, and the Iran Fara Bourse (IFB), launched in 2009 as a secondary market, constitute Iran's formal equity markets. As of 2024, the TSE lists approximately 423 companies with a combined market capitalization of approximately $113 billion, making it the largest stock exchange in the Middle East by number of listed companies. The IFB, designed for small and medium enterprises and companies that do not meet TSE listing requirements, hosts an additional 410 firms with a combined market capitalization of approximately $20 billion.

The Iranian capital market operates within a civil law framework inherited from the country's pre-revolutionary legal system but modified to align with Islamic finance principles. The Securities and Exchange Organization (SEO), established in 1966 and reconstituted in 2005, serves as the primary regulatory body responsible for supervising securities markets, protecting investors, and promoting market development. Unlike many emerging markets that primarily rely on foreign capital, Iran's market is predominantly domestically financed due to international sanctions that have limited foreign investment flows since the 1979 revolution, with restrictions intensifying after 2006 and particularly after 2018.

This relative isolation from global capital markets has several important implications. First, Iranian firms have limited access to international sources of financing and expertise, potentially increasing their reliance on domestic networks for information and resources. Second, the absence of foreign institutional investors means that corporate governance mechanisms common in globally integrated markets—such as foreign investor activism and international best practice adoption—play minimal roles. Third, the market exhibits lower correlation with global equity markets, suggesting that Iranian firms face predominantly domestic and regional rather than global competitive pressures.

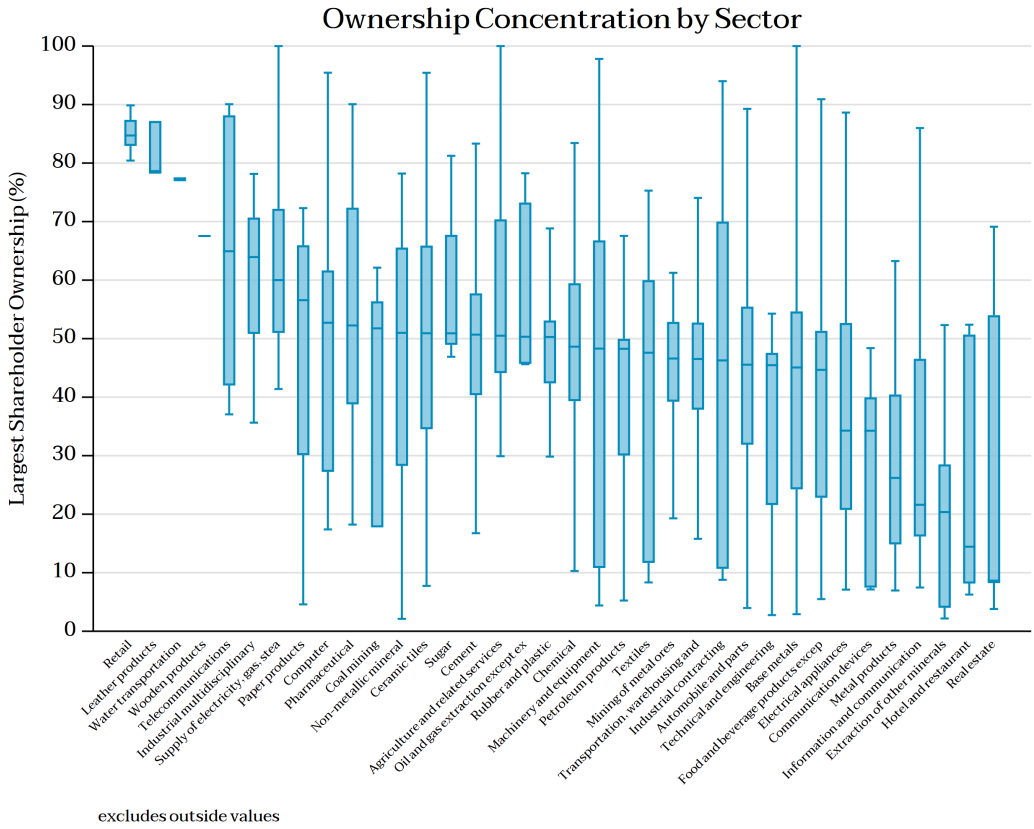

Figure 1: Ownership Concentration across sectors

3.6.2 Ownership Structure and Concentration

The most distinctive feature of Iran's corporate governance landscape is the exceptionally high level of ownership concentration. Our sample reveals that the largest shareholder controls, on average, 47.14% of shares2. At the two-digit ISIC level, ownership concentration varies markedly across sectors, some industries cluster near majority control while others sit well below the sample mean (47.14%), as summarized in Figure 1. This concentration level is substantially higher than in dispersed ownership markets (typically 15-25% in the US and UK) and comparable to or exceeding concentration in other emerging markets such as Brazil (51%), Turkey (54%), and India (46%) (Claessens et al., 2000; La Porta et al., 1999).

The distribution of ownership concentration is also noteworthy. Approximately 35% of firms in our sample have a single shareholder controlling more than 70% of shares, while only 12% have largest shareholder ownership below 30%. This prevalence of controlling blockholders contrasts sharply with the widely dispersed ownership structures documented in Anglo-American markets and has profound implications for corporate governance.

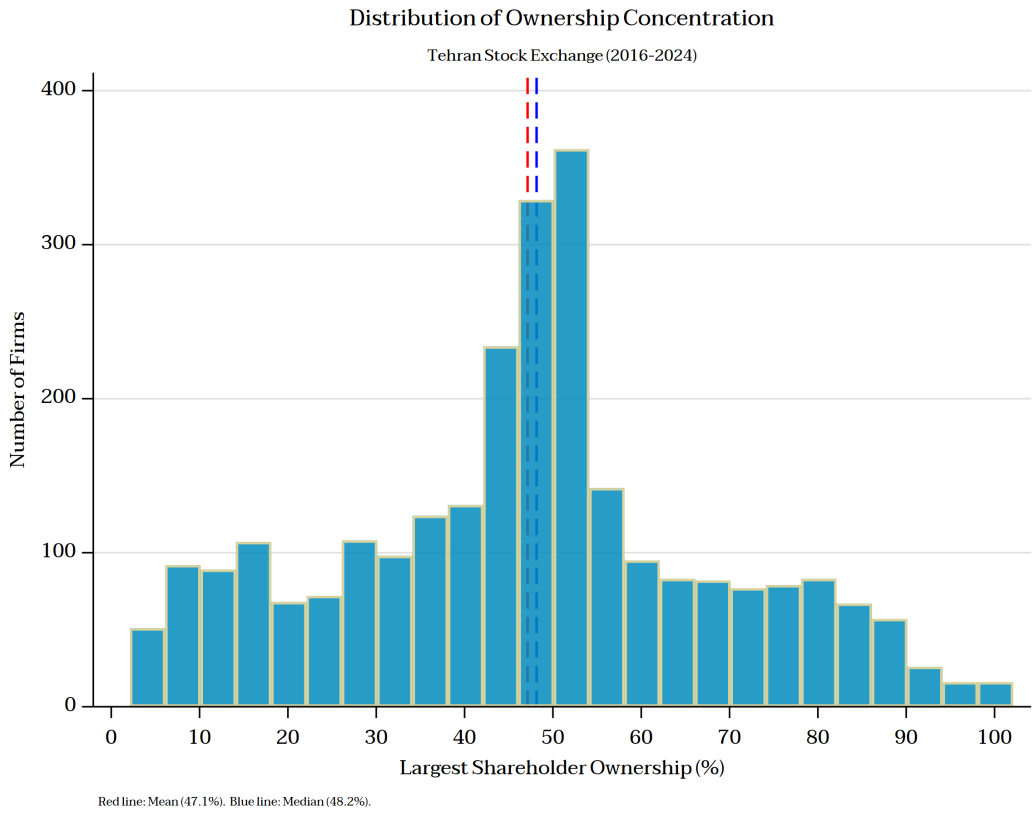

Figure 2: Overall Ownership Concentration Distribution

The identity of controlling shareholders reveals three dominant ownership types in Iran's listed companies:

State Ownership: Despite ongoing privatization efforts, the government remains a significant corporate owner, either directly through ministries and government agencies, or indirectly through state-owned enterprises and quasi-governmental organizations. In our sample, approximately 38% of firms have state-related entities as their largest shareholder. These state-controlled firms tend to be larger, older, and concentrated in strategic sectors such as petrochemicals, steel, mining, and banking.

Institutional Ownership: Iranian institutional investors include pension funds (particularly the Social Security Investment Company and various occupational pension funds), insurance companies, investment companies, and banks. Institutional investors are the largest shareholders in approximately 32% of sample firms. Iranian institutional investors differ from their Western counterparts in important ways: they often have concentrated holdings in few firms, face weaker governance themselves, and may pursue objectives beyond pure financial returns.

Individual/Family Ownership: Wealthy individuals and family groups control ap-

proximately 30% of listed firms in our sample. These controlling families often have historical ties to pre-revolution business elites or have accumulated wealth through post-revolution business activities, particularly in trade, construction, and manufacturing sectors. Family-controlled firms in Iran exhibit similar characteristics to those documented in other emerging markets: long-term investment horizons, extensive family member involvement in management, and frequent use of pyramidal ownership structures.

This ownership structure creates a governance environment fundamentally different from dispersed ownership markets. The central agency problem shifts from the classical manager-shareholder conflict to a conflict between controlling shareholders and minority shareholders (Shleifer & Vishny, 1997). Controlling shareholders have both the incentive and ability to monitor management intensively, but they may also have incentives and opportunities to expropriate minority shareholders through related-party transactions, tunneling, and other mechanisms (Bertrand et al., 2002; Johnson et al., 2000).

3.6.3 Board Interlocks in the Iranian Context

The institutional features described above create a distinctive environment for board interlock formation. Several factors are particularly relevant for understanding how and why director networks form in Iran:

Limited Director Pool: The pool of qualified and willing directors is relatively small, constrained by educational requirements, experience expectations, and the limited number of individuals with appropriate business backgrounds. This scarcity creates a natural tendency toward interlocking, as firms seek directors from a limited pool of candidates. The phenomenon is reinforced by social networks based on university ties (particularly graduates of top Tehran engineering schools), prior business relationships, and family connections.

Information Scarcity: Iran's relatively underdeveloped information infrastructure enhances the value of informal information channels. Credit rating agencies are nascent, analyst coverage is limited, financial media is less developed than in advanced markets, and accounting quality and auditing standards, while improving, remain uneven. In this environment, board connections may serve as important conduits for information about market conditions, business opportunities, and corporate practices that would be more readily available through formal channels in developed markets.

Regulatory Uncertainty: Businesses in Iran face substantial regulatory and policy uncertainty due to changing government policies, international sanctions regimes, and inconsistent enforcement of rules. Board connections may provide early warning of regulatory changes, insights into government intentions, and channels for influencing policy implementation. Directors with government experience or connections to regulatory bodies may be particularly valuable in this context.

State-Private Connections: The overlap between state and private sectors creates opportunities for politically valuable interlocks. Directors who simultaneously serve on boards of state-controlled and privately-controlled firms may facilitate access to government contracts, permits, financing, and regulatory favorable treatment. Such connections may be especially valuable for private firms navigating Iran's complex business-government interface.

Family and Social Networks: Persian business culture emphasizes personal relationships, family ties, and long-term trust-based connections. Director appointments often follow from existing social networks based on family relationships, university classmates, military service connections, or shared regional origins. These social foundations of interlocking may imbue director networks with different characteristics—more trust, longer tenure, greater information sharing—compared to purely professional networks in Anglo-American markets.

3.6.4 Why Iran Provides an Ideal Research Setting

The institutional characteristics of the Iranian capital market make it an ideal laboratory for testing theories about board networks and ownership structure moderation for several reasons:

High Ownership Concentration: With average largest shareholder ownership of 47.14%, Iranian firms exhibit substantially higher concentration than previously studied European markets (30-40% in Zona et al., 2018's Italian sample). This allows us to test whether ownership moderation effects documented at moderate concentration levels extend to more extreme environments, or whether there exist thresholds beyond which network benefits disappear entirely.

Controlled Institutional Variation: Iran shares many characteristics with other emerging markets (concentrated ownership, weak legal protection, underdeveloped capital

markets) but differs in important ways (sanctions-induced isolation, state involvement patterns, Islamic finance principles). By studying Iran, we can assess which network effects are universal and which depend on specific institutional features.

Limited Foreign Influence: The absence of significant foreign investment eliminates a potential confounding factor present in many emerging market studies. In markets like Brazil, India, or Turkey, foreign institutional investors actively engage in governance and may drive both network formation and performance outcomes. Iran's isolation allows cleaner identification of domestic network effects.

In summary, Iran's combination of extreme ownership concentration, limited international integration, evolving governance framework, and high-quality data availability creates an exceptional natural laboratory for studying board networks. The institutional context simultaneously validates examining network effects (due to information scarcity and network prevalence) and questions their value (due to controlling shareholder dominance), making it an ideal setting for testing competing theoretical predictions about when and how board networks matter.

4 Data and Variable Construction

4.1 Data Sources and Sample Construction

We analyze board interlock networks and firm performance in the Tehran Stock Exchange (TSE) and Iran Fara Bourse (IFB) markets from 2016 to 2024 (Persian calendar years 1395-1403). Our data come from two sources. First, we construct board networks using mandatory "Changes in Board Composition" reports from CODAL (codal.ir), Iran's official corporate disclosure platform. We developed a Python web scraping tool to systematically collect all board appointment reports across our sample period. Second, we obtain audited financial data from Rahavard Novin software, which aggregates official filings with the Securities and Exchange Organization of Iran. We impose several sample restrictions. Following Iran's Corporate Governance Code (revised 2018 and 2022), which exempts financial institutions from the 20% independent director requirement, we exclude all banks, insurance companies, and financial intermediaries. We also exclude firms that: (i) changed their fiscal year during the sample period; (ii) have fiscal years ending in months other than Esfand (March); and (iii) experienced trading halts exceeding three

months. After applying these filters, our final sample comprises 2,688 firm-year observations covering 424 unique firms over nine years, forming an unbalanced panel representing approximately 60-70% of non-financial TSE/IFB firms.

4.2 Board Network Construction

For each year t, we identify all board members serving on each firm's board as disclosed in reports filed at the beginning of the fiscal year. A board interlock exists when at least one individual serves simultaneously on two or more boards. In the Iranian context, board members may represent either individuals or legal entities (institutional investors). We treat the representative individual as the unit creating interlocks, as these individuals attend meetings, vote, and facilitate information flow.

4.3 Variable Definitions

4.3.1 Dependent Variables

We employ three performance measures (denoted $Y_{i,t+1}$ to reflect measurement in fiscal year $t+1$ relative to board composition at time t):

1. **Tobin's Q (TOBIN)**:(Market value of equity + Book value of debt) / Book value of assets. We use natural logarithm to reduce skewness.

2. **Return on Assets (ROA)**: Net income / Total assets

3. **Return on Sales (ROS)**: Operating income / Total sales

4.4 Independent Variables: Network Centrality

As discussed in section 2.3, We calculate four normalized centrality measures–Degree, Closeness, Betweenness and Eigenvector–as independent variables.

4.5 Key Variables

1. **Ownership Concentration (SHARES_PERCENT)**: Percentage of shares held by the largest shareholder

2. **Control Variables**: Firm size (log total assets), age (years since IPO), leverage, sales growth from year $t-1$ to t, capital expenditure intensity, board size, board independence ratio, and same-industry connections

5 Empirical Methodology

5.1 Econometric Challenges

Estimating the causal effect of board network centrality on firm performance confronts several fundamental econometric challenges that motivate our methodological approach:

5.1.1 Reverse Causality

Board composition and network position are endogenous to firm performance. Successful firms attract more prestigious and better-connected directors, creating reverse causality from performance to network centrality. Directors may strategically target boards of firms with favorable growth prospects, or high-performing firms may possess greater financial resources and reputational capital to recruit well-connected board members. This simultaneity biases cross-sectional or static panel estimates, potentially generating spurious positive associations between network centrality and performance even if networks have no causal impact.

5.1.2 Omitted Variable Bias

Unobserved firm characteristics—such as management quality, organizational culture, strategic orientation, or investment opportunities—may simultaneously drive both network formation and performance. If innovative, well-managed firms both seek network connections and perform well for reasons unrelated to the network itself, conventional regression estimates will confound these separate effects. While firm fixed effects eliminate time-invariant unobservables, time-varying omitted variables (e.g., changes in top management, strategic shifts, evolving competitive positions, or market opportunities) can still bias estimates.

5.1.3 Performance Persistence and Dynamic Panel Bias

Firm performance exhibits strong autocorrelation: successful firms tend to remain successful, and struggling firms continue to struggle. This persistence creates *Nickell bias* (Nickell, 1981) when lagged dependent variables are included in fixed effects models. The bias arises because the within-transformation (demeaning) mechanically correlates the lagged dependent variable with the transformed error term, rendering standard fixed effects estimators inconsistent in short panels. The bias is of order $O(1/T)$ and does not vanish as the number of cross-sectional units grows, making it particularly severe in corporate finance panels where T is typically small relative to N.

5.2 Empirical Strategy

To address these challenges, we adopt a three-stage empirical approach that progresses from simpler specifications to increasingly credible identification strategies:

5.2.1 Stage 1: Static Fixed Effects Baseline

We begin with a standard two-way fixed effects specification to establish baseline correlations:

$$Y_{i,t+1} = \alpha + \beta, CENTRALITY_{i,t} + \gamma X_{i,t} + \mu_i + \lambda_{t+1} + \epsilon_{i,t+1} \tag{5}$$

where $Y_{i,t+1}$ measures firm i's performance in fiscal year $t+1$ (Tobin's Q in logarithms, or alternatively ROA or ROS), $CENTRALITY_{i,t}$ captures network position at the beginning of fiscal year $t+1$, $X_{i,t}$ is a vector of firm-level controls, μ_i denotes firm fixed effects absorbing time-invariant heterogeneity, λ_{t+1} represents year fixed effects controlling for common macroeconomic shocks, and $\epsilon_{i,t+1}$ is the idiosyncratic error term. **Notation and Timing**: The dependent variable $Y_{i,t+1}$ denotes performance measured in fiscal year $t+1$, while regressors are dated t to reflect measurement at the beginning of that fiscal year. This notation makes explicit the temporal ordering essential for causal interpretation: board network composition is determined at annual general meetings (AGMs) in the first quarter of the Iranian fiscal year (ending March 20), before the bulk of annual performance is realized. When we estimate the model using historical data, all variables—including $Y_{i,t+1}$ are observed. The lead notation clarifies the **timing of realization**, not

the timing of estimation(Arellano & Bond, 1991; Blundell & Bond, 1998). **Identifying Assumption**: Equation (5) requires strict exogeneity:

$$\mathbb{E}[\epsilon_{i,t+1} \mid \{CENTRALITY_{i,\tau}, X_{i,\tau}\}_{\tau=1}^{T}, \mu_i, \lambda_{t+1}] = 0 \tag{6}$$

This assumption is highly restrictive and likely violated in our context. It requires that network centrality at all time periods including future periods be uncorrelated with current performance shocks. This rules out feedback from performance to subsequent board appointments, which is implausible: firms experiencing positive performance shocks plausibly attract better-connected directors in subsequent years.

5.2.2 Stage 2: Dynamic Panel Specification

To accommodate feedback effects and performance persistence, we augment the model with lagged dependent variables:

$$\begin{aligned} Y_{i,t+1} = \alpha + \sum_{s=1}^{p} \theta_s Y_{i,t+1-s} + \beta CENTRALITY_{i,t} \times SHARES\_PERCENT_{i,t} \\ + \gamma X_{i,t} + \mu_i + \lambda_{t+1} + \epsilon_{i,t+1} \end{aligned} \tag{7}$$

Where $Y_{i,t+1-s}$ for $s \in \{1, 2, \ldots, p\}$ are lagged values of the dependent variable capturing performance persistence, and the interaction term $CENTRALITY_{i,t} \times SHARES\_PERCENT_{i,t}$ tests our hypothesis that ownership concentration moderates the network-performance relationship. the dynamic specification requires sequential exogeneity (weaker than strict exogeneity):

$$\mathbb{E}[\epsilon_{i,t+1} \mid Y_{i,t}, Y_{i,t-1}, \ldots, CENTRALITY_{i,s}, X_{i,s}, \mu_i] = 0, \quad \forall s \leq t \tag{8}$$

Sequential exogeneity permits feedback from past performance to current network formation—consistent with directors joining firms after observing prior performance—but requires that network position at time t is predetermined with respect to unexpected performance shocks at $t + 1$. This is more plausible given that board appointments occur at annual AGMs before most of the fiscal year's performance is realized. However, standard fixed effects estimation of equation (7) remains inconsistent due to Nickell bias. The within-transformation creates mechanical correlation between the lagged dependent variable and

the transformed error:

$$Cov(Y_{i,t} - \bar{Y}_i,\ \epsilon_{i,t+1} - \bar{\epsilon}_i) \neq 0 \tag{9}$$

even under sequential exogeneity, because $\bar{Y}_i$ and $\bar{\epsilon}_i$ both depend on $\epsilon_{i,t+1}$. The bias is approximately $\frac{\theta}{1+\theta} \cdot \frac{1}{T}$ for a single lag(Nickell, 1981), which is substantial in our panel with $T \approx 9$ years. to address this, we employ two complementary approaches:

5.2.3 Bias-Corrected Fixed Effects Estimator

We first estimate equation (7) using the bias-corrected least squares dummy variable (LSDVC) estimator (Bruno, 2005; Bun & Carree, 2006; Kiviet, 1995).

The bias-corrected estimator is consistent as $N \to \infty$ with fixed T and does not require external instruments, making it transparent and easy to implement. However, it assumes homoskedasticity and cannot accommodate additional endogenous regressors beyond the lagged dependent variable.

5.2.4 System GMM Estimator

For our primary estimates, we employ the Arellano-Bover/Blundell-Bond System GMM estimator (Arellano & Bover, 1995; Blundell & Bond, 1998), which addresses both Nickell bias and the potential endogeneity of network centrality through the use of internal instruments.

System GMM Framework: System GMM combines two sets of equations:

1. **Difference Equations**: First-differencing eliminates firm fixed effects:

$$\begin{aligned}\Delta Y_{i,t+1} = \sum_{s=1}^{p} \theta_s \Delta Y_{i,t+1-s} + \beta \Delta (CENTRALITY \times SHARES\_PERCENT)_{i,t} \\ + \gamma \Delta X_{i,t} + \Delta \lambda_{t+1} + \Delta \epsilon_{i,t+1}\end{aligned} \tag{10}$$

For the differenced equation, we use lagged levels as instruments:

$$\mathbb{E}\big[Y_{i,k}\, \Delta \varepsilon_{i,t+1}\big] = 0, \qquad \forall\, k \leq t-1 \tag{11}$$

$$\mathbb{E}\big[Z_{i,k}\, \Delta \varepsilon_{i,t+1}\big] = 0, \qquad \forall\, k \leq t-1 \tag{12}$$

where $Z = \{CENTRALITY, SHARES\_PERCENT, X\}$ represents predeter-

mined or endogenous regressors. These moment conditions require that past values of variables are uncorrelated with current period innovations, which holds under sequential exogeneity.

2. **Level Equations**: System GMM adds equations in levels, using lagged differences as instruments:

$$Y_{i,t+1} = \sum_{s=1}^{p} \theta_s Y_{i,t+1-s} + \beta(CENTRALITY \times SHARES_PERCENT)_{i,t} + \gamma X_{i,t} + \mu_i + \lambda_{t+1} + \epsilon_{i,t+1} \tag{13}$$

The additional moment conditions for level equations are:

$$\mathbb{E}\left[\Delta Y_{i,k}\left(\mu_i + \varepsilon_{i,t+1}\right)\right] = 0, \qquad \forall\, k \leq t \tag{14}$$

$$\mathbb{E}\left[\Delta Z_{i,k}\left(\mu_i + \varepsilon_{i,t+1}\right)\right] = 0, \qquad \forall\, k \leq t \tag{15}$$

The validity of level moment conditions (14)-(15) requires mean stationarity:

$$\mathbb{E}[Y_{i,t} \cdot \mu_i] = \mathbb{E}[Y_{i,s} \cdot \mu_i], \quad \forall t, s \tag{16}$$

This assumes the correlation between performance and the firm fixed effect is constant over time—equivalently, deviations from the firm-specific mean are uncorrelated with the fixed effect. Mean stationarity is plausible if firms fluctuate around their long-run equilibrium rather than following divergent growth trajectories. We test this assumption using the Difference-in-Hansen test (see Section 4.3).

6 Main Results

7 Contribution to Literature

This study makes several contributions to the literature on corporate networks, governance, and firm performance:

First, we provide the first comprehensive analysis of board networks in the Iranian capital market, extending the empirical evidence base beyond the predominantly US, Eu-

ropean, and East Asian contexts that dominate existing literature. Given Iran's unique institutional environment—characterized by high ownership concentration, significant state presence, limited international integration, and Persian business culture. our findings test the generalizability of network theories across diverse institutional contexts. The consistency of our results with those from other markets provides insights into which network effects are universal and which depend on specific institutional arrangements.

Second, we contribute to the growing literature on contingencies in network value by providing rigorous evidence on how ownership structure moderates network effects. While Zona et al.(2018) pioneered this line of inquiry in European markets, our study extends their framework to a setting with substantially higher ownership concentration (58% average in Iran vs. 30-40% in Continental Europe). This extreme ownership concentration allows us to test whether the moderation effect continues to operate at higher concentration levels or whether there is a threshold beyond which networks become uniformly detrimental. Furthermore, our evidence from an emerging market complements Zona et al.'s developed market findings, strengthening the theoretical argument that large shareholders can substitute for external network resources.

Third, we advance methodological practice in board network research by employing System GMM estimation, which relatively few network studies have adopted despite its clear advantages for addressing endogeneity in dynamic settings. Many existing studies rely on static fixed effects, lagged independent variables, or instrumental variable approaches that may not fully resolve endogeneity concerns. Our dynamic panel approach with internal instruments provides more credible causal identification, and our comprehensive specification testing (AR tests, Hansen J-tests, difference-in-Hansen tests) allows readers to evaluate instrument validity. We also present bias-corrected fixed effects estimates(Bruno, 2005) as a complementary approach, demonstrating robustness across different estimators that rely on distinct identifying assumptions.

Fourth, by examining four distinct centrality measures derived from graph theory, we provide a more nuanced understanding of how network position matters. The differential effects across centrality dimensions—if they emerge—can inform theory development by revealing which aspects of network position (volume, speed, brokerage, status) drive performance effects. This multidimensional approach represents an advance over studies that examine only degree centrality or aggregate network measures, and aligns with re-

cent calls in the networks literature for greater attention to the structural properties of positions(Borgatti & Halgin, 2011).

Fifth, We contribute to the broader literature on corporate governance in emerging markets. Understanding how governance mechanisms operate in concentrated ownership environments is crucial for policy design, as most countries worldwide exhibit ownership structures closer to Iran's than to the dispersed ownership patterns of the US and UK. Our findings speak to debates about the optimal governance arrangements in emerging markets and the complementarity (or substitutability) between formal governance institutions and informal network-based coordination.

8 Main Findings and Implications

Our analysis of 1,220 firm-year observations from 2016 to 2024 yields several important findings. Using System GMM estimation, we document economically and statistically significant positive effects of board network centrality on future firm performance (Tobin's Q). Specifically, a one-standard-deviation increase in degree centrality is associated with an 8.32% increase in future Q, while comparable increases in closeness, betweenness, and eigenvector centrality generate effects of 22.53%, 10.82%, and 1.97%, respectively. These magnitudes suggest that network position represents an economically meaningful determinant of firm value in the Iranian market.

The heterogeneity across centrality dimensions provides insights into mechanisms. The particularly large effect for closeness centrality suggests that the speed of information diffusion matters substantially—firms that can rapidly access information from across the network experience superior performance. The significant betweenness effect indicates value from brokerage positions that control information flow. The relatively modest eigenvector effect suggests that association with prestigious firms per se matters less than the structural properties of a firm's network position.

These findings have important implications for managers, investors, and policymakers. For managers, the results highlight that board composition decisions should consider not only individual director qualifications but also the network properties that directors bring. However, the value of network connections depends critically on firm ownership structure: in widely held firms, recruiting well-connected directors appears valuable, but

in firms with dominant shareholders, network-based benefits may be limited and alternative governance mechanisms may be more important. For investors, network centrality represents a potentially underutilized signal of firm quality and future performance, though this signal should be interpreted in light of ownership structure. For policymakers, the results suggest that regulations promoting board independence and diversity should account for ownership structure heterogeneity—governance policies that work well in dispersed ownership contexts may have limited effectiveness or unintended consequences in concentrated ownership environments.

9 Structure of the Paper

The remainder of this study proceeds as follows. Section 2 reviews the related literature on board networks, ownership structure, and firm performance, positioning our contribution within existing research. Section 3 describes the institutional context of the Iranian capital market and explains why it provides an ideal setting for testing our hypotheses. Section 4 details our data sources, variable construction, and sample characteristics. Section 5 presents our empirical methodology, including the System GMM specification and identification strategy. Section 6 reports our main results on the relationship between network centrality and performance, the moderation by ownership concentration, and heterogeneity across centrality dimensions. Section 7 presents extensive robustness checks, including alternative performance measures, different network specifications, subsample analyses, and placebo tests. Section 8 discusses the economic mechanisms and implications of our findings. Section 9 concludes with a summary of contributions, limitations, and directions for future research.

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Table 1: Static Baseline Regression Results

Dependent Variable	ln(Tobin's $Q_{i,t+1}$)				
Independent Variables	(1)	(2)	(3)	(4)	(5)
ln(DEGREE)	−6.5127				
	(−1.2094)				
ln(CLOSE)		−0.9096			
		(−0.1455)			
ln(BTWN)			3.0173***		
			(2.6028)		
ln(EIGEN)				−6.1238**	
				(−2.0779)	
ln(CENT_PCA)					−0.0203
					(−1.4443)
$SHARES\_PERCENT$	0.0006	0.0008	0.0008	0.0009	0.0010
	(0.6592)	(0.8067)	(0.8730)	(0.9231)	(1.0318)
ln(DEGREE) × $SHARES\_PERCENT$	0.0745				
	(0.7256)				
ln(CLOSE) × $SHARES\_PERCENT$		−0.0109			
		(−0.0883)			
ln(BTWN) × $SHARES\_PERCENT$			−0.0484*		
			(−1.7236)		
ln(EIGEN) × $SHARES\_PERCENT$				0.1176**	
				(2.1180)	
ln(CENT_PCA) × $SHARES\_PERCENT$					0.0003
					(1.2527)
$SALES\_GROWTH$	−0.0000**	−0.0000***	−0.0000***	−0.0000***	−0.0000**
	(−2.2242)	(−2.8021)	(−2.8382)	(−2.8533)	(−2.5302)
$SAME\_IND$	−0.0004	−0.0053	−0.0095	−0.0082	−0.0028
	(−0.0378)	(−0.5306)	(−1.1450)	(−1.0314)	(−0.2906)
CPX	0.0941	0.0926	0.0919	0.0902	0.0943
	(1.5898)	(1.5564)	(1.5591)	(1.5301)	(1.5839)
$SIZE$	−0.0680***	−0.0673***	−0.0670***	−0.0660***	−0.0681***
	(−2.7297)	(−2.7029)	(−2.6904)	(−2.6455)	(−2.7394)
$DEBT\_RATIO$	−0.0876	−0.0895*	−0.0894*	−0.0915*	−0.0874*
	(−1.6455)	(−1.6689)	(−1.6878)	(−1.7374)	(−1.6472)
$BOARD\_SIZE$	−0.0195	−0.0199	−0.0204	−0.0202	−0.0192
	(−0.4396)	(−0.4490)	(−0.4579)	(−0.4539)	(−0.4363)
IND_RATIO	−0.0254	−0.0263	−0.0263	−0.0315	−0.0244
	(−0.4613)	(−0.4739)	(−0.4763)	(−0.5730)	(−0.4373)
AGE	0.0432**	0.0430**	0.0429**	0.0430**	0.0432**
	(2.5658)	(2.5448)	(2.5476)	(2.5497)	(2.5614)
Constant	0.9401*	0.9261*	0.9231*	0.9074*	0.9163*
	(1.8661)	(1.8312)	(1.8309)	(1.7975)	(1.8233)
Obs.	1,158	1,158	1,158	1,158	1,158
Adj. R^2	0.5432	0.5425	0.5429	0.5427	0.5438
Year FE	✓	✓	✓	✓	✓

Numbers in parentheses are t statistics. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.