



Research article

The impact of ownership type on intellectual capital – the case of Iran

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Abstract: In this study, we examined the relationship between ownership structures and intellectual capital efficiency, employing an innovative approach that decomposes structural capital into customer, process, and innovation capital components within the unique context of the Iranian economy. We utilized data from 1,376 firm-year observations of 172 companies listed on the Tehran Stock Exchange from 2013 to 2020. The findings revealed that family, institutional, and multi-level ownership structures have a positive and significant relationship with overall intellectual capital (IC) efficiency and its key components: human capital and structural capital. Crucially, the analysis of disaggregated structural capital yields differentiated strategic insights: While these ownership types show positive associations with customer and process capital, a significant negative relationship emerges between multi-level ownership structures and innovation capital. This novel finding highlights how distinct ownership types adopt divergent strategies for managing intangible assets. The research provides valuable insights for policymakers, investors, and corporate managers aiming to optimize ownership structures and enhance intellectual capital management in emerging markets.

Keywords: intellectual capital; ownership structures; accounting; Iran

JEL Codes: M40, M41, M42, M49

1. Introduction

In the contemporary knowledge-based economy, intellectual capital is recognized as one of the most valuable organizational assets and a key source of value creation and sustainable competitive advantage (Wang & Ahmed, 2007; Salvi et al., 2020). However, the effective management and disclosure of these intangible assets face significant challenges, as they are often not reflected in financial statements due to conventional accounting limitations (Hoss et al., 2000). This ambiguity makes it difficult for stakeholders, especially investors and shareholders, to identify, measure, and optimally manage intellectual capital (Appuhami & Bhuyan, 2015). In this context, corporate governance mechanisms, which act as the governance and control systems of companies, play a crucial role in the management and disclosure of these vital assets (Al-Sartawi & Abdalmuttaleb, 2018; Madhani, 2014). At the heart of these mechanisms is the ownership structure, which, by defining the distribution of power and control rights among shareholders, shapes their incentives and ability to monitor management and influence strategic decisions, including decisions related to investment in intellectual capital (Braendle & Noll, 2006; Feng et al., 2020).

Although researchers have examined the relationship between certain types of ownership (such as family and institutional) and intellectual capital (e.g., Nassar et al., 2018; Acuña-Opazo & González, 2021; Ulfah et al., 2021), the findings in this area remain inconsistent and inconclusive. For example, while some researchers report a positive relationship between these types of ownership and intellectual capital performance (e.g., Jamei, 2017; Shahveisi et al., 2017), others have documented negative or non-significant relationships (Mohd-Saleh & Che Abdul Rahman, 2009; Nassar et al., 2018). This heterogeneity in findings may be due to contextual factors, different operationalizations of variables, or a lack of attention to more complex forms of ownership.

One form of ownership that has received less attention from intellectual capital scholars, despite its importance in developing economies with centralized corporate structures, is pyramidal ownership. In these structures, an ultimate controller exercises control over downstream firms through a chain of legal entities, which can create unique incentives and capacities for intellectual capital management (Mindzak & Zeng, 2018; Liang et al., 2021). On the one hand, such structures may enhance intellectual capital by providing access to cheaper financing and broader networks of knowledge and expertise (Holmén & Högfeldt, 2009). On the other hand, the separation of control rights from the cash flow rights inherent in these structures can reduce the incentive of controlling shareholders to invest in long-term intangible assets and may even lead to opportunistic behaviors that harm the interests of minority shareholders (Claessens et al., 2000; Hsieh et al., 2020). Therefore, the nature of the relationship between pyramidal ownership and intellectual capital is inherently ambiguous and deserves empirical investigation.

In this study, we focus on the emerging market of Iran, which has distinctive characteristics, including a high degree of ownership concentration, the prominent role of family firms and business groups, and evolving regulatory and governance frameworks. These characteristics provide fertile ground for examining the complexities of the relationship between ownership structure and intellectual capital. However, few researchers conducting studies in Iran have simultaneously examined the roles of family, institutional, and, in particular, pyramidal ownership on intellectual capital (a recent systematic review also emphasizes the dominance of single-country studies, especially in developed countries (Abdallah et al., 2025)). Our main goal of this article is to fill this research gap by providing a comprehensive analysis of the relationship between the three types of

ownership structures (family, institutional, and pyramidal) with the efficiency of intellectual capital and its components (human capital, structural capital, customer capital, process capital, and innovation capital) in companies listed on the Tehran Stock Exchange. The central research question of this study is: “Does the type of ownership structure (family, institutional, and pyramidal) significantly affect the performance and efficiency of knowledge-based resources and intellectual capital of Iranian companies, and is this effect more pronounced in which specific components of intellectual capital and under which ownership structure?”

The contribution of this research goes beyond a simple empirical analysis and, within a complex theoretical and operational framework, generates knowledge in the field of corporate governance and intellectual capital in the Iranian economic context. Here, we simultaneously examine the role of pyramidal ownership alongside family and institutional ownership and provide a more complete understanding of the impact of ownership mix on total intellectual capital and separately on each of its micro-components (human, structural, customer, process, and innovation) in an economy with concentrated ownership. By combining agency theory and a resource-based perspective, a new framework is proposed to explain the behavior of controlling shareholders in concentrated ownership structures (family, institutional, and pyramidal) toward intellectual capital. This framework examines the question of whether, in the Iranian economy, with the significant presence of the state, quasi-state corporations and large industrial-financial groups (as forms of institutional and pyramidal ownership), these institutions contribute to the development of intellectual capital by injecting resources, knowledge, and communication networks (in line with the resource-based view), or become a factor in the destruction or neglect of intellectual capital by intensifying principal-principal conflict and pursuing macro-political-economic goals (in line with the extended agency theory). This approach offers a dynamic understanding of the dual role of institutions in transition economies.

We test the hypothesis that in complex multi-layered ownership structures, the ultimate owner replaces direct “ownership control” with “intellectual capital control”. In other words, do these shareholders prefer to create an effective but indirect control mechanism by investing in shared intellectual capital (e.g., group R&D centers, integrated branding, and knowledge management systems)? Examining this phenomenon within large Iranian industrial groups shows how intellectual capital strategies in these groups can reflect their macro-control and risk management strategies (as studies such as Tonelli et al. (2025) have also emphasized the role of intellectual capital disclosure in attracting concentrated institutional ownership in Europe).

By decomposing structural capital into its components (process, innovation, and customer), we explore whether different types of ownership have distinct investment priorities in different dimensions of intellectual capital. It is argued that family ownership in Iran, given the generational perspective and interest in preserving the legacy, may have a stronger focus on “customer capital” (brand loyalty) and “process capital” (operational efficiency). In contrast, institutional ownership (such as pension funds) under pressure for short-term profitability may avoid “innovation capital,” while pyramidal structures, benefiting from access to extensive financial resources, may make riskier investments in “innovation capital.”

Focusing on Iran, we provide a context-based understanding of how corporate governance mechanisms and intellectual capital interact in an emerging market with specific institutional characteristics. We also address the issue of reverse causality by employing the GMM methodology of the Poyle data and lagged effects modeling, providing a more robust answer to the question:

“Does concentrated ownership lead to superior intellectual capital, or are firms with higher intellectual capital more attractive to concentrated owners?”

Our findings of this study can benefit a wide range of stakeholders, including managers, shareholders, investors, and capital market regulators. The structure of the paper is as follows: After this introduction, the second section is devoted to a review of the theoretical literature and the development of hypotheses. In the third section, we describe the research methodology, including the statistical population, regression models, and measurement of variables. In the fourth section, we present and analyze the findings from the estimation of the models. Finally, in the fifth section, we provide conclusions, a discussion of the implications, and limitations of the research.

2. Theoretical framework and hypothesis development

2.1. Intellectual capital

Intellectual capital transcends mere terminology, representing a synergistic constellation of intangible assets whose interaction generates sustainable value-creation capacity for the firm (Teece, 2000). Since the mid-1980s, researchers have been looking for hidden factors that display the difference between a company’s market value and book value (Sardo & Serrasqueiro, 2017). Edvinsson and Malone (1997) referred to this difference as intellectual capital. Galbraith (1969) first coined the term intellectual capital or intangible assets that created value for companies and believed that intellectual capital is the difference between market value and book value. Hall (1992) considered intellectual capital a factor and motivator of value. Stewart and Ruckdeschel (1998) stated that intellectual capital is an integrated intellectual force reflected in various forms such as knowledge, important information, company intellectual property, and experience. Sullivan (2000) stated that intellectual capital represents knowledge converted into profit. Hsu and Fang (2009) considered intellectual capital as a set of a company’s capabilities, knowledge, culture, strategy, process, intellectual property, and relationship networks. These resources create value or competitive advantage and achieve goals. Forte et al. (2017) considered intellectual capital a significant “hidden value” not directly identifiable from financial statements. On the other hand, intellectual capital represents knowledge-based activities and processes that contribute to innovation, value creation, competitive advantage, and corporate benefits by creating added value for corporate stakeholders (Sardo & Serrasqueiro, 2017). Cuzzo et al. (2017) and Corvino et al. (2019) also stated that intellectual capital includes the reputation and credibility of the organization, the motivation and ability of employees to innovate and introduce new products and services to the market, and establish a stable relationship with customers and suppliers. It can be acknowledged that intellectual capital is an essential resource for future profit (value) from innovation, unique designs in an organization and human resources (Lari Dashtbayaz et al., 2020). Although there is no consensus on the definition of intellectual capital, most scholars agree that the major components of intellectual capital include human capital, structural capital (domestic capital), customer capital, process capital, and innovation capital (Bontis et al., 2015; Mohd-Saleh & Che Abdul Rahman, 2009). Human capital refers to an organization’s tacit knowledge, including skills, experience, competence, ability, and capacity to innovate personnel, employee behavior, and learning. It refers to the knowledge and skills that employees will take with them when leaving the company (Beattie & Smith, 2010; Oliveira et al., 2010). Additionally, human capital is the most crucial element in creating long-term competitive

advantage (Amankwah-Amoah, 2018; Torres et al., 2018). In this regard, managers of any organization should pay attention to maintaining and improving the knowledge of their employees because valuable human capital is available to employees (Mansoor et al., 2021).

Structural capital refers to business processes, organizational systems, software, databases, patents, copyrights, trademarks, and tools that ensure the circulation of knowledge in an organization, as well as the tangible and intangible assets created by the organization (such as inventions and certifications) along with processes, infrastructure, etc. it is also referred to as the knowledge that remains in the company when employees leave (Salehi et al., 2014; Denicolai et al., 2015) and includes the infrastructure assets that form the basis of activities (Buenechea-Elberdin et al., 2018).

Customer capital is external capital that includes all company relations with stakeholders, such as customers, creditors, investors, suppliers, and business partners (Bchini, 2015). Customer capital is knowledge gained through communication with external stakeholders (Yu et al., 2015) that will contribute to the financial performance of companies. The management of these assets necessitates long-term and high-risk investment commitments. Within the context of emerging markets, such as Iran, these investments encounter compounded challenges, including economic volatility, deficiencies in intellectual property rights protection, and pressures for short-term profitability (ElGammal et al., 2018). In such an environment, the ownership structure functions as a pivotal governance mechanism that fundamentally shapes the firm's strategic orientation toward these critical investments.

2.2. Family ownership

To identify a family-controlled company, the company must meet at least one of the following criteria: The founder of the family member of the founder must own at least 20% or more of the company's common stock of the company individually and be the largest shareholder, and the CEO or chairman must be a member of the founding family (Villalonga & Amit, 2006). Andres (2008) argues that family shareholders are incentivized to spend time and money overseeing managers to reduce agency costs and improve company performance. On the other hand, in family companies, the problems of representation between minority and majority shareholders are more than the problems of representation between owners and managers (Pukthuanthong et al., 2013).

2.3. Institutional ownership

Institutional owners refer to large investors such as foundations, banks, insurance companies, investment companies, pension funds, and limited liability companies (PTs). Institutional owners can usually control most stocks because they have more resources than other stakeholders; in this regard, they can oversee and influence management policies more than other stakeholders (Nurleni et al., 2018; Victoravich et al., 2012). Institutional investors prevent managers' non-optimal decision-making and opportunistic behavior by actively monitoring the performance and decisions of managers, such as policies, periodically reviewing the effectiveness and efficiency of the company, and voting and initiative in board selection (Darmadi and Sodikin, 2013). Hence, it is believed that institutional owners, as controlling shareholders, influence strategic goals and decisions to improve and use the company's intellectual capital.

2.4. Multi-level ownership

A multi-level structure is a business group of firms or entities representing a top-down control chain. A multi-level structure is one way to acquire major stock and centralized ownership that enables controlling shareholders at the top of the pyramid to control companies on the lower floors of the structure (Mindzak & Zeng, 2018). The presence of major shareholders and centralized ownership leads to close oversight of managers and thus reduces the first type of agency conflicts between shareholders and managers (Mindzak & Zeng, 2018; Kaplan & Minton, 1994). At the top of the pyramid, the controlling shareholders can participate in strategic decisions, including intellectual capital. In addition, shareholders receive property rights in return for investing in companies, which, on the one hand, includes the cash right and, on the other hand, includes the right of control by exercising voting rights (Braendle & Noll, 2006). Since the multi-level ownership structure leads to the separation of voting rights and cash flow, it increases the power of controlling shareholders to harm the interests of minority shareholders (Claessens et al., 2000; Liang et al., 2021).

To comprehend the complexities of the relationship between ownership structure and intellectual capital, we employ an integrated theoretical framework combining three principal approaches: Agency Theory, the Resource-Based View, and Resource Dependence Theory. This synthesized framework enables us to analyze not only the inherent agency conflicts within each ownership structure but also their distinctive capabilities for mobilizing the requisite resources for intellectual capital development. Furthermore, this framework explicitly acknowledges the role of Iran's specific institutional context characterized by the prominent role of the state, institutional voids, and the significance of informal networks as a contingent factor in this relationship (North, 1990; Peng & Heath, 1996). Utilizing the aforementioned integrated framework, we provide a theoretical analysis of the motivations and capabilities inherent to each ownership structure in the following section.

2.5. The relationship between family ownership and intellectual capital efficiency

Family ownership represents a distinct form of corporate governance structure where family members or relatives hold significant shares in the company and often play an active role in managing and supervising operations. This ownership type is typically characterized by a longer-term horizon, strong commitment to preserving family legacy, and sustainable value creation. From an Agency Theory perspective, the principal conflict in family firms is Type 2 (between controlling and minority shareholders) (Villalonga and Amit, 2006). This could lead to reduced investment in intellectual capital, as families might expropriate these investments for private benefits (Mohd-Saleh & Che Abdul Rahman, 2009). However, the Resource-Based View offers a more balanced perspective. Families often possess "generational commitment" and "socioemotional wealth," meaning they are interested in preserving reputation, business continuity, and intergenerational transfer (Berrone et al., 2010). This long-term orientation creates strong incentives for investing in enduring assets like intellectual capital. Moreover, families may invest in maintaining strong customer relationships (customer capital) and developing efficient processes (structural capital), but due to conservatism, might approach riskier areas like innovation capital more cautiously (Pukthuanthong et al., 2013).

In the Iranian context, where family networks and in-group trust are highly significant, these effects may be amplified. Studies such as those by Berrone et al. (2010) and Pukthuanthong et al.

(2013) indicate that family firms exhibit a greater tendency to maintain and develop human and structural capital, as these assets secure not only financial performance but also the family's long-term reputation and standing. Furthermore, research by Assakaf et al. (2025) and Qasem et al. (2025) in emerging markets emphasizes that family ownership structures are associated with higher commitment to corporate social and environmental responsibility (CSR/ESG/SDG), which constitutes part of intellectual capital.

Conversely, some researchers like Mohd-Saleh and Che Abdul Rahman (2009) and Nassar et al. (2018) report a negative relationship between family ownership and intellectual capital efficiency. This could stem from excessive focus on family interests and neglect of intangible asset investment. However, in the context of emerging markets like Iran, where family relationships and trust networks play a prominent role in business, family ownership might act as a mechanism to reduce information asymmetry and enhance intellectual capital efficiency. Research by ElGammal et al. (2018) and Akrouf & Othman (2016) in the MENA region also shows that family firms, due to their reliance on reputation and long-term relationships, have greater motivation for the disclosure and efficient management of intellectual capital.

Based on the logic of “socioemotional wealth” and generational commitment, family ownership is expected to have a positive relationship with overall intellectual capital efficiency due to its long-term perspective and the importance placed on preserving reputation and relationships. However, this effect is not uniform across all components. Therefore, the main hypothesis is:

H1: There is a significant relationship between family ownership and the efficiency of intellectual capital.

A positive and significant relationship between family ownership and human capital efficiency is anticipated. Families have the motivation and capability to invest in preserving the tacit knowledge, loyalty, and skills of their workforce, who are often considered part of the firm's “extended family” (Claver-Cortés et al., 2015). Therefore:

H1-1: There is a significant relationship between family ownership and human capital efficiency.

A positive and significant relationship between family ownership and the efficiency of process and structural capital is expected. Families invest in creating stable and appropriate processes and structures that guarantee business continuity. Therefore:

H1-2: There is a significant relationship between family ownership and the efficiency of structural capital.

A significant relationship is expected between family ownership and the efficiency of customer, process, and innovation capital. Families invest in long-term relationships with loyal and stable customers, which ensures business continuity. However, the relationship with innovation capital remains ambiguous. Although innovation is crucial for long-term survival, its risky and costly nature might conflict with the conservative ethos of some family businesses. Therefore, this relationship requires empirical testing.

H1-3: There is a significant relationship between family ownership and Customer, Process, and Innovation capital efficiency.

2.6. Relationship between institutional ownership and intellectual capital efficiency

From the perspective of Agency Theory, institutional ownership can mitigate managerial opportunism and enhance reporting transparency. This active monitoring, particularly concerning

intellectual capital, may promote optimal resource allocation toward intangible assets like human, structural, and customer capital. Institutional shareholders, equipped with significant resources and expertise, can function as “active monitors.” By reducing Type 1 agency conflicts (between managers and shareholders), they can steer managers toward long-term, value-creating investments, including those in intellectual capital (Shahveisi et al., 2017; Darmadi & Sodikin, 2013). A segment of institutional investors, often termed “active investors,” can effectively oversee long-term corporate decisions through board representation. Furthermore, according to Shahveisi et al. (2017), ownership concentration is conducive to improving intellectual capital performance. It is posited that when a high percentage of shares is held by organizations and institutions, they are more motivated to enhance firm performance and value by improving human, structural, customer, and innovation capital.

However, Resource Dependence Theory cautions that not all institutional shareholders are homogenous. Pressures for short-term performance can drive them toward “short-termism,” potentially discouraging investment in long-term intellectual capital projects (Nassar et al., 2018). Emerging literature on the Middle East indicates that the role of institutional shareholders is heavily influenced by political connections and national development objectives (Barbar, 2025; Qasem et al., 2025). For instance, in Iran, state-owned or quasi-state institutions might promote intellectual capital not solely for profit maximization but also to achieve broader technological goals or enhance national self-sufficiency (Assakaf et al., 2025). Here, by considering this dual and context-specific role, we delve into the performance of institutional ownership within Iran.

Considering the dual role of institutional shareholders (active monitoring versus short-termism) and their specific function within the Iranian economy, a generally positive relationship with intellectual capital efficiency is expected, as the benefits of active monitoring and resource access are anticipated to outweigh the tendency toward short-termism.

Researchers such as Shahveisi et al. (2017) and Jamei (2017) have reported a positive and significant relationship between institutional ownership and intellectual capital efficiency. Ulfah et al. (2021) also found that intellectual capital has a positive relationship with ownership concentration. These researchers argue that institutions, due to their long-term perspective and desire to increase firm value, encourage investment in innovation and human resource development. Furthermore, research by Qasem et al. (2022) and Al Fadli et al. (2022) shows that institutional ownership in emerging markets like Saudi Arabia is associated with higher levels of ESG and intellectual capital disclosure.

Nonetheless, some studies, like those by Nassar et al. (2018) and Ulfah et al. (2021), have indicated a negative relationship between institutional ownership and intellectual capital efficiency. This could stem from institutional focus on short-term profits and pressure for immediate financial results, leading to neglect of investments in intangible assets. However, within the context of emerging markets where institutions often play a stronger monitoring role, institutional ownership is expected to lead to improved intellectual capital efficiency. Research by Barbar (2025) and Alobaid et al. (2024) also emphasizes the complementary role of institutional ownership in enhancing governance and investment efficiency in MENA region firms.

H2: There is a significant relationship between institutional ownership and intellectual capital efficiency.

A positive and significant relationship between institutional ownership and human capital efficiency is anticipated. Institutional shareholders, with their expertise and resources, can facilitate investment in workforce training and riskier research and development projects (Assakaf et al., 2025). Therefore:

H2-1: There is a significant relationship between institutional ownership and human capital efficiency.

Furthermore, a positive and significant relationship between institutional ownership and process capital efficiency is expected. These institutions emphasize standardization and operational efficiency to improve profitability. Therefore:

H2-2: There is a significant relationship between institutional ownership and structural capital efficiency.

Conversely, the relationship between institutional ownership and the efficiency of customer and innovation capital is predicted to be weaker or ambiguous. Moreover, managing customer relationships and investing in innovation often requires a long-term commitment that may not fully align with the time horizons of some institutional shareholders. Therefore:

H2-3: There is a significant relationship between institutional ownership and Customer, Process, and Innovation capital efficiency.

2.7. Relationship between multi-level ownership and intellectual capital efficiency

Multi-level or pyramidal ownership refers to a structure where an ultimate controller exercises control over multiple firms through a chain of subsidiary companies. This structure enables the separation of control rights from cash flow rights, potentially amplifying the power of controlling shareholders while diminishing the rights of minority shareholders.

From an Agency Theory perspective, multi-level ownership can simultaneously mitigate Type 1 conflicts (between managers and shareholders) and exacerbate Type 2 conflicts (between majority and minority shareholders). Regarding intellectual capital, this structure may create incentives for long-term investment in intangible assets while increasing the risk of resource expropriation. These structures, prevalent in Iran's economy, present a theoretical paradox. On one hand, from a Resource-Based View, these pyramids provide affiliated firms access to extensive financial resources, distribution networks, technical knowledge, and skilled human resources, all forms of intellectual capital (Holmén & Högfeldt, 2009). This could enhance overall intellectual capital efficiency. On the other hand, Agency Theory, emphasizing the separation of control from cash flow rights, warns that controlling shareholders at the pyramid's apex may have incentives to transfer resources from downstream firms (including intellectual assets) to their own benefit at the expense of minority shareholders (Claessens et al., 2000; Liang et al., 2021).

The multi-level structure also enables controlling shareholders to over-invest due to access to relatively cheaper capital sources compared to foreign capital markets (Holmén & Högfeldt, 2009). Consequently, they may access greater knowledge and experience in human resources, enhanced reputation through acquiring established companies, and strengthen their relationships with suppliers and lenders through affiliated firms. Therefore, the key question is not whether pyramidal ownership is "good" or "bad," but rather what the net outcome is for intellectual capital given the balance between these opposing forces. By testing this paradox in the Iranian context, this study provides significant theoretical and empirical contributions.

Researchers such as Hsieh et al. (2020) and Liang et al. (2021) reported a non-linear relationship between multi-level ownership and intellectual capital efficiency. Controlling shareholders might encourage investment in innovation and human capital to increase firm value and achieve a competitive advantage. Conversely, they might tend to over-invest in risky projects due to

access to cheap internal financing within the group, which does not necessarily enhance intellectual capital efficiency.

In emerging markets like Iran, where concentrated and family ownership structures are common, multi-level ownership might serve as a tool for controlling resources and creating value through intellectual capital. However, the risk of resource misuse and reduced innovation efficiency also exists. Research by Holmén & Högfeldt (2009) and Mindzak & Zeng (2018) also indicates that multi-level ownership can improve access to knowledge resources and communication networks, yet may simultaneously lead to reduced investment in research and development. Studies by Al-Duais et al. (2021) and ElGammal et al. (2018) further emphasize the complex role of multi-level ownership in the governance and reporting of intellectual capital in the MENA region.

It is argued, based on the aforementioned theories, that firms with higher levels of multi-level ownership might possess more desirable intellectual capital. However, given the paradox between resources and distorted incentives, the overall direction of the relationship between multi-level ownership and intellectual capital efficiency remains an open empirical question. Nevertheless, considering the scale and resources available to these groups in Iran, it is hypothesized that the resource-based benefits may outweigh the agency challenges.

H3: There is a significant relationship between multi-level ownership and intellectual capital efficiency.

A positive and significant relationship between multi-level ownership and human capital efficiency is expected. These groups can benefit from “economies of scale” in attracting and training talent. Therefore:

H3-1: There is a significant relationship between multi-level ownership and human capital efficiency.

Furthermore, a positive and significant relationship between multi-level ownership and structural capital efficiency is anticipated. Standardizing processes at the group level and utilizing integrated distribution networks and branding create clear advantages. Therefore:

H3-2: There is a significant relationship between multi-level ownership and structural capital efficiency.

Firms with multi-level ownership are expected to potentially perform more strongly in launching large innovation projects due to their better and more extensive connections. Therefore:

H3-3: There is a significant relationship between multi-level ownership and Customer, Process, and Innovation capital efficiency.

3. Research methodology

3.1. Research models

The statistical population comprises all listed firms on the Tehran Stock Exchange except banks, financial intermediaries, leasing, and other investment firms with no more than 6 months of transaction halt. The statistical sample includes 172 listed firms on the Tehran Stock Exchange for 8 years, from 2013 to 2020, with 1376 year-company. The Stata software is used to conduct statistical tests and data analysis. The Pulic value-added coefficient (2000, 2004) and Nazari (2010) are used as criteria for calculating intellectual capital efficiency and examining the regression models; the GMM and fixed effects methods are employed.

3.2. Hierarchical logic and regression model structure

The analytical framework of this research follows a predefined, systematic, hierarchical, and multi-level structure. This structure not only tests the major hypotheses at the macro level but also enables the investigation of underlying mechanisms and precisely identifies the level at which ownership structure exerts its influence. The logic for employing eight separate regression models is as follows:

Level 1: Macro-Level analysis (Models 1 and 2).

Models 1 (value-added coefficient of the intellectual capital (VAIC)) and 2 (intellectual capital efficiency (ICE)) serve as the major models, providing an overarching answer to the research question and testing the core hypotheses regarding the relationship between ownership structure and overall intellectual capital efficiency. This level represents the starting point and outlines the broad picture of whether a significant relationship exists.

Level 2: Micro-Level and mechanistic analysis (Models 3 to 8).

Models 3 through 8 are designed to dissect the findings from the macro level and test the sub-hypotheses. These models are directly derived from the conceptual VAIC model and the theoretical literature on intellectual capital, which emphasizes the decomposability of intellectual capital into its constituent parts. Each of these models addresses a distinct piece of the research puzzle:

Model 3 (HCE): Examines whether different ownership types affect the efficiency of converting investment in human resources into value added.

Model 4 (SCE): Measures the impact of ownership on the efficiency of capital that remains within the firm (such as processes and knowledge bases).

Models 5, 6, and 7 (CCE, INCE, and PCE, respectively): These models test the impact of ownership on three key components of structural capital: customer capital, innovation capital, and process capital. This level of analysis is crucial for understanding whether different owners have distinct strategic priorities in allocating resources to marketing, research and development, or process improvement.

Model 8 (CEE): Serves as a control benchmark, ensuring that the observed effects are specific to intellectual capital and not merely a result of the firm's overall efficiency in using tangible assets.

This hierarchical approach enables the research to progress from a general conclusion toward operational and precise insights regarding how ownership structure influences aspects of value creation within the firm.

To enhance the validity, reliability, and depth of the major findings reported in the previous section, supplementary analyses are conducted. The purpose of these analyses is not “data mining” to discover new relationships, but rather to conduct Robustness Checks and examine an additional dimension (time) within the study's predefined framework. These analyses primarily include two categories:

Robustness tests using alternative measures: In this section, the major models are re-estimated using alternative operational definitions for the key ownership variables: family ownership (FOWN1, FOWN2) and multi-level ownership (MLOWN). The objective is to ensure that the core results and interpretations are not sensitive to the choice of a specific measurement metric and remain stable when other valid indicators are used.

Lag analysis: For this, we investigate the effects of the ownership variables lagging by one period on the dependent variables. Our goal of this analysis is to address the complementary question

of whether the impact of ownership structure on intellectual capital efficiency is persistent and continues into the subsequent financial period, or if it is merely a short-term, immediate effect. This analysis aids in understanding the temporal dynamics of the relationship.

The results of these supplementary analyses are presented in the relevant tables and are briefly discussed in the text. These results generally support the robustness of the major findings.

The following multivariate regression models are used for testing the hypotheses:

Model (1) is used for testing the major hypotheses 1, 2, and 3, as follows:

Model (1):

$$VAIC = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (2):

$$ICE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (3):

$$HCE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (4):

$$SCE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (5):

$$CCE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (6):

$$INCE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (7):

$$PC = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

Model (8):

$$CEE = \alpha + \alpha_1 FOWN + \alpha_2 INS + \alpha_3 MLOWN + \alpha_4 LEV + \alpha_5 ROA + \alpha_6 SIZE + \alpha_7 CR + \alpha_8 AGE + \alpha_9 MTB + \alpha_{10} LTDR + \alpha_{11} BIND + \alpha_{12} BUSY + \alpha_{13} YEAR + \alpha_{14} INDUSTRY$$

3.3. Research variables and their measurement manner

3.3.1. Dependent variable

Intellectual Capital: In this paper, the value added model of Pulic (2000, 2004) and Nazari (2010) is the difference between input and output and is used to measure intellectual capital as follows: The main method used to obtain data from archival sources that enable the measurement of structures is the VAIC model. The methods used to measure the different structures in the VAIC model and the extended structures are explained below:

According to the VAIC model, value added is the difference between output and input.

$$VA = OUT - IN \quad (1)$$

where VA = Value Added to the Company; OUT = Total Sales (Revenues); IN = Cost of Purchased Materials, Components, and Services.

Value added can be calculated from the information in the annual reports as follows:

$$VA = OP + EC + D + A \quad (2)$$

where OP = Operating Profit; EC = Employee Costs; D = Depreciation; A = Amortization.

According to the literature, the value added in the VAIC model is the sum of labor costs, corporate taxes, dividends, interest expenses, depreciation and amortization, minority shareholders, and retained earnings.

The VAIC model calculates the efficiency of intellectual capital and financial capital. The model, which is partly based on the “Scandia Navigator” (a well-known conceptual model for measuring intellectual capital), includes human and structural capital.

3.3.2. Human capital (HC)

The VAIC model does not consider employee-related costs as part of the input. This means that employee-related costs are not considered an expense but an investment. For this reason, human capital efficiency (HCE) is calculated as follows:

$$HCE = VA/HC \quad (3)$$

where HCE = Human Capital Efficiency Coefficient for the Firm; VA = Value Added; HC = Total Salary and Wages for the Firm.

Using the VAIC approach, the measure that can be used to assess the value of human capital (HC) is the total compensation paid to employees. Compensation as a measure of human capital is based on compensation theories. If the labor market is efficient, then employees will be paid based on the value of their human capital.

3.3.3. Structural capital (SC)

Structural capital, the second component of intellectual capital, is calculated as follows:

$$SC = VA - HC \quad (4)$$

where SC = Structural capital for the firm; VA = Value added; HC = Total wages and salaries paid.

Structural capital cannot be measured directly, but the remaining value of value added is minus human capital. Based on the above calculations, structural capital efficiency (SCE) is as follows:

$$SCE = SC/VA \quad (5)$$

where SCE = Structural capital efficiency for the firm; SC = Structural capital; VA = Value added.

ICE is calculated as the sum of the partial coefficients of human capital and structural capital:

$$ICE = HCE + SCE \quad (6)$$

where ICE = Intellectual capital efficiency coefficient; HCE = Human capital efficiency coefficient; SCE = Structural capital efficiency coefficient.

3.3.4. Decomposition of structural capital into customer capital, process capital, and innovation capital

As explained earlier, the VAIC model assumes that structural capital is equal to value added minus human capital (or residual).

According to the Scandia Navigator model, structural capital comprises customer and organizational capital. Alternatively:

$$SC = CC + OC \quad (7)$$

where CC = Customer Capital; OC = Organizational Capital.

Moving down the scale, organizational capital comprises innovation and process capital.

$$OC = InC + PC \quad (8)$$

where InC = Innovation Capital; PC = Process Capital.

Therefore:

$$SC = CC + InC + PC \quad (9)$$

In the VAIC model, structural capital efficiency (SCE) is calculated using the following formula:

$$SCE = SC/VA \quad (10)$$

An alternative expression of the above formula using structural capital sub-categories is as follows:

$$SCE = \frac{CC + INC + PC}{VA} \quad (11)$$

Therefore, structural capital efficiency equals the sum of the efficiencies of customer capital, innovation capital, and process capital.

$$SCE = \frac{CC}{VA} + \frac{INC}{VA} + \frac{PC}{VA} \quad (12)$$

Or

$$SCE = CCE + INCE + PCE \quad (13)$$

where CCE = Customer Capital Efficiency; INCE = Innovation Capital Efficiency; PCE = Process Capital Efficiency.

3.3.5. Customer capital efficiency

Marketing is concerned with the task of developing and managing relationships with customers. Therefore, marketing expenses are used as a measure of customer capital. To standardize this measure of customer capital and determine what percentage of value added is created through marketing, marketing expenses are divided by value added.

$$CCE = \frac{CC}{VA} = \frac{\text{Marketing Costs}}{VA} \quad (14)$$

3.3.6. Innovation capital efficiency

Research and development (R&D) expenditure has been widely used in the literature to measure innovation capacity (Bosworth and Rogers, 2001). Innovation efficiency is calculated as follows:

$$INCE = \frac{INC}{VA} = \frac{R\&D}{VA} \quad (15)$$

3.3.7. Process capital efficiency

Process capital efficiency equals structural capital efficiency minus customer capital efficiency minus innovation capital efficiency.

$$SCE = CCE + INCE + PCE \quad (16)$$

Then:

$$PCE = SCE - INCE - CCE \quad (17)$$

3.3.8. Financial capital (FP)

Pulic (2004) argued that to have a comprehensive picture of the efficiency of value creation resources, it is important to consider financial and physical capitals. The efficiency of financial capital employed can be obtained using the following formula:

$$CEE = VA/CE \quad (18)$$

where CEE = Efficiency of capital employed; VA = Value added; CE = Book value of the firm's net assets.

Overall value creation efficiency is simply the sum of all value creation efficiency indices:

$$VAIC = ICE + CEE \quad (19)$$

Or

$$VAIC = [(VA/HC) + (SC/VA)] + VA/CA \quad (20)$$

where VAIC = Added intellectual capital coefficient; ICE = Efficiency of intellectual capital (HCE + SCE); CEE = Efficiency of capital employed.

3.3.9. Independent variables

Family ownership (FOWN): The family index of Achleitner et al. (2010), the opinion of scholars, and previous studies are used to define family firms. Hence, the family firm is one in which at least 20% of its shares belong to a family and relatives or one of the family members on the board and has at least 5% ordinary stock. Thus, firms with family ownership status will assign 1; otherwise, 0 will be considered.

FOWN1: If the investors in the company are family members and have invested more than 20% in the company, their investment percentages are added together and considered as the family ownership percentage 1.

FOWN2: If the board members are family members and their percentage is higher than 5%, their membership percentages are added together and considered the percentage of family ownership.

The selection of this composite framework is based on two fundamental pillars defining a family firm: ownership and control. The first criterion (20% ownership) focuses on the ability to exert influence and control through voting rights, while the second criterion (board presence and 5% ownership) emphasizes the integration of ownership and managerial control, a distinctive characteristic of family businesses. This approach ensures that the selected firms are under family influence in terms of ownership and strategic direction, thereby benefiting from the “family control effect.” This composite criterion (used in the major models under the code FOWN_MAIN) is considered the most accurate and comprehensive indicator for identifying family firms within the framework of this study.

To test the robustness of the results and examine their sensitivity to the definition of family ownership, two alternative indicators are calculated:

- FOWN1: The percentage of shares owned by family members, provided their collective ownership exceeds 20%.
- FOWN2: The percentage of shares owned by family members who serve on the board of directors, provided each member holds at least 5%.

The results from estimating the models using these alternative indicators are presented separately in the “Supplementary Analyses” section. The purpose of this is to ensure that our major findings of the research are not dependent on the specific choice of one conventional indicator over another.

Institutional ownership (INS): Two methods are considered for measuring institutional ownership: 1) If the firm has several big investors, including banks, insurance firms, investment firms, and retirement funds, 1; otherwise, 0 will be assigned; 2) A percentage is considered given the above feature. According to Ulfah et al. (2021), institutional ownership is expressed as a stock percentage belonging to institutional investors.

Multi-level ownership (MLOWN): According to Liang et al. (2021), the levels of the pyramid chain between the final controller and the firm are mentioned, and if firms have subsidiary units, 1, otherwise 0.

MLOWN: If the parent company has subsidiaries at levels 1 and 2, the number is 1; otherwise, the number is zero.

MLOWNTOTAL: Total number of subsidiaries under the parent company

Our objective of this study is to examine the existence and strength of the relationship between being embedded in corporate group structures and intellectual capital efficiency. Grounded in theoretical foundations (e.g., Mindzak & Zeng, 2018; Liang et al., 2021), the presence of subsidiaries is considered the fundamental building block for forming these multi-layered (pyramidal) structures. However, we are fully aware that a complete pyramidal structure is measured by dimensions such as the number of ownership layers, the ultimate control percentage, and the separation between control and cash flow rights. Unfortunately, accessing precise and structured data to fully map these ownership chains for all sample firms over the study period faces informational constraints within the context of the Iranian capital market. Consequently, the indicators employed in this research (MLOWN and MLOWNTOTAL) are regarded as practical and valid proxies for measuring the extent of a firm's involvement in a complex group structure. This approach has been utilized in similar studies in other emerging markets. While these proxies may not capture all the intricacies of an ownership pyramid, they unequivocally signal the existence of a concentrated and extensive control structure, which is the essence of multi-layered ownership. Furthermore, using the number of subsidiaries (MLOWNTOTAL) as a continuous variable enables an analysis of how the results are sensitive to the "scale" or "breadth" of this group structure.

3.3.10. Control variables

According to the studies of Shahveisi et al. (2017), Tejedo-Romero and Araujo (2021), Dalwai and Mohammadi (2020), and Hsieh et al. (2020), the following are selected as the control variables. LEV (financial leverage): total liabilities to total assets of the firm; ROA (rate of return on assets): net profit to total assets; SIZE (firm size): natural logarithm of sample firm assets, CR (current ratio): by dividing current assets into current liabilities, BUSY: if the fiscal year is set on March 1; otherwise, zero; MTB: market value to book value of equity of the firm i in the year under study; AGE (firm age): natural logarithm of the number of years from the date of establishment; BIND (board independence): independent managers to all managers' ratio; LTDR (long-term debt ratio): long-term debt ratio to total assets; YEAR: dummy variable for controlling the year effects; and INDUSTRY: dummy variable for controlling the type of industry of selected firms.

3.3.11. Conceptual model

Based on the content of the article, the following conceptual model shows the relationship between ownership structure and intellectual capital efficiency, considering the theoretical and contextual framework of the Iranian economy (Figure 1).

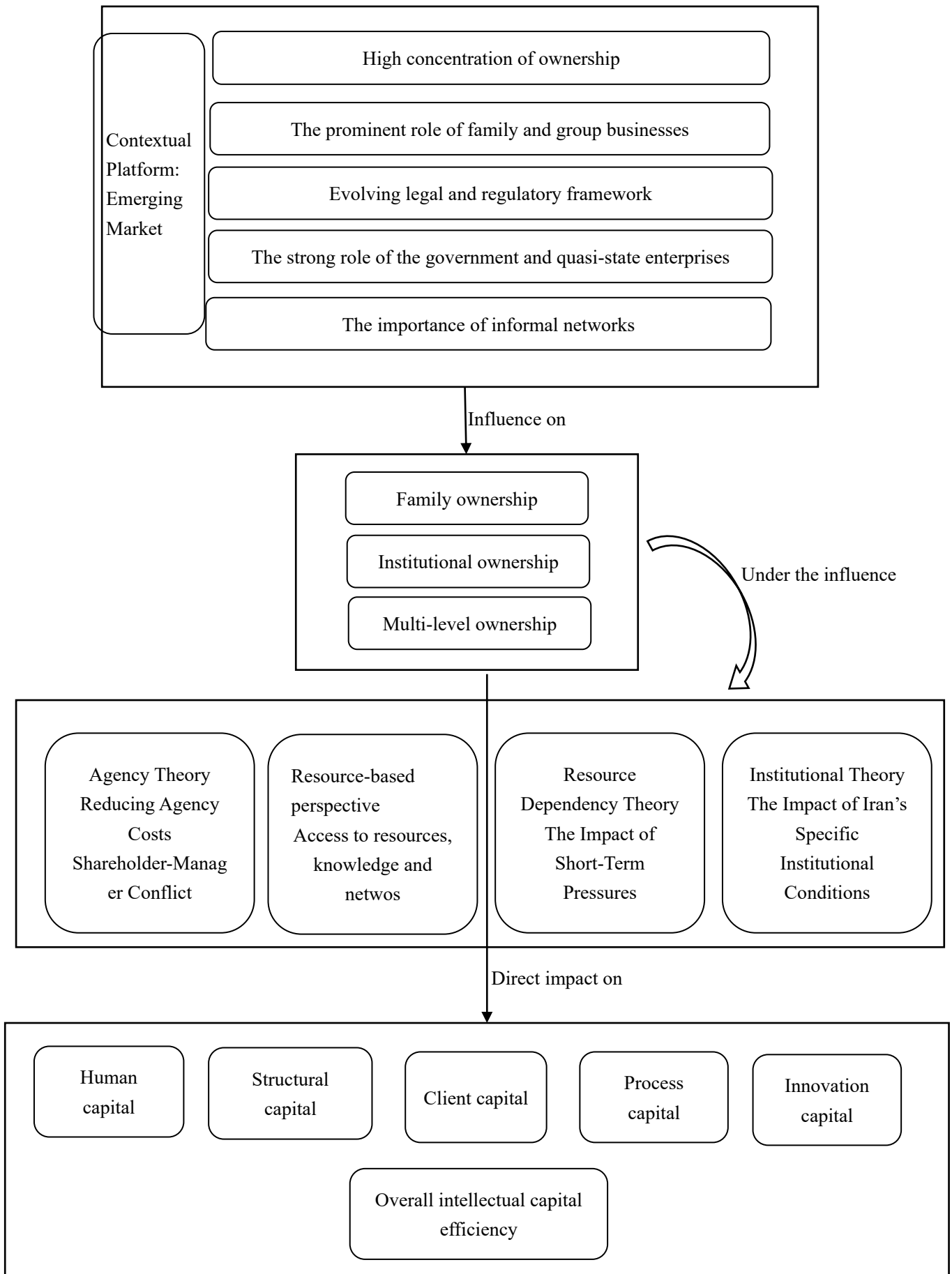


Figure 1. The conceptual model.

4. Results of research model testing

4.1. Descriptive statistics

The data of this study are related to 166 companies in the period from 2013 to 2019. Table 1 shows the information related to the study's quantitative variables, including the number of observations, mean, standard deviation, minimum, and maximum.

Table 1. Descriptive statistics of quantitative research variables.

| Variables | Variables Name | Obs | Mean | Std. Dev. | Min | Max |
|------------|--|-------|--------|-----------|---------|--------|
| VAIC | Added intellectual capital coefficient | 1,328 | 5.325 | 5.173 | -1.824 | 51.255 |
| ICE | Intellectual capital efficiency coefficient | 1,328 | 4.939 | 5.158 | -1.876 | 51.025 |
| HCE | Human capital efficiency coefficient | 1,328 | 4.304 | 5.032 | -1.844 | 50.045 |
| SCE | Structural capital efficiency coefficient | 1,328 | 0.638 | 0.298 | -1.372 | 3.223 |
| CCE | Customer capital efficiency | 1,328 | 0.010 | 0.041 | -0.019 | 0.523 |
| INCE | Efficiency of innovation capital | 1,328 | 0.001 | 0.004 | -0.006 | 0.063 |
| PCE | Process capital efficiency | 1,328 | 0.625 | 0.326 | -2.554 | 3.257 |
| CEE | Financial capital employed efficiency ratio | 1,328 | 0.387 | 0.184 | -0.211 | 1.188 |
| FOWN1 | Family ownership - 20% of shares | 1,328 | 0.038 | 0.132 | 0 | 0.9 |
| FOWN2 | Family ownership - Board of Directors 5% of shares | 1,328 | 0.016 | 0.082 | 0 | 0.951 |
| INS | Institutional ownership | 1,328 | 0.317 | 0.303 | 0 | 0.897 |
| MLOWNTOTAL | Total number of subsidiaries | 1,328 | 1.514 | 4.093 | 0 | 44 |
| LEV | Financial Leverage | 1,328 | 0.562 | 0.210 | 0 | 1.825 |
| ROA | Rate of Return on Assets | 1,328 | 0.134 | 0.155 | -0.581 | 0.682 |
| SIZE | Firm Size | 1,328 | 14.595 | 1.594 | 10.533 | 20.769 |
| CR | Current Ratio | 1,328 | 1.685 | 1.694 | 0.262 | 27.095 |
| AGE | Firm Age | 1,328 | 40.569 | 12.960 | 13 | 69 |
| MTB | Market value to Book value | 1,328 | 6.643 | 9.928 | -28.368 | 56.851 |
| LTDR | Long-term Debt Ratio | 1,328 | 0.068 | 0.082 | 0 | 0.939 |
| BIND | Board Independence | 1,328 | 0.684 | 0.183 | 0 | 1.167 |

Table 2 shows the descriptive statistics of the qualitative variables that have the nature of zero and one. It should be noted that the data used are winsurized at a 95% confidence level, and outliers are removed. In addition, the significance level is considered at a 95% confidence level. In order to examine the normality of the variables, according to the central limit theorem, whether the sample under study is selected from a normal or an abnormal population, despite the number of observations

greater than 30 within the sample (1328 observations in this study for each variable), the selected sample has a normal distribution.

Table 2. Descriptive statistics of qualitative research variables.

| Variables | Variables Name | Obs | Mean | Std. Dev. | No. 0 | No. 1 |
|-----------|-----------------------|-------|-------|-----------|-------|-------|
| FOWN | Family Ownership | 1,328 | 0.099 | 0.298 | 1,197 | 131 |
| MLOWN | Multi-level ownership | 1,328 | 0.359 | 0.480 | 881 | 447 |
| BUSY | Fiscal year | 1,328 | 0.922 | 0.269 | 104 | 1224 |

4.2. Collinearity test

The research models are fitted once by considering the variable of the number of subsidiaries (MLOWNTOTAL), and then the qualitative variable of presence or absence of subsidiaries (MLOWN) is considered. If each firm has a subsidiary at levels 1 and 2, the MLOWN variable is considered one; otherwise, zero. Despite these two types of variables and the existence of three levels of family ownership, the explanatory variables are considered in different ways. Therefore, the results of their collinearity test are also different. In order to examine the collinearity of the model, the variance inflation factor (VIF) test is used. Table 3 shows the results of the VIF collinearity test for these regression models. According to the obtained statistics, the VIF for all variables of the models is calculated to be less than 5, and the index calculated for all regressions is less than 5. Hence, there is no collinearity between any of the variables of the models. Therefore, there is no problem with collinearity in the considered regressions.

Table 3. Results of the collinearity test of the research models.

| Variables | MLOWNTOTAL Models | | | | | |
|---------------|-------------------|-------|------|-------|------|-------|
| | Vif | 1/Vif | Vif | 1/Vif | Vif | 1/Vif |
| LEV | 2.18 | 0.458 | 2.18 | 0.460 | 2.18 | 0.458 |
| ROA | 1.71 | 0.585 | 1.71 | 0.586 | 1.72 | 0.581 |
| SIZE | 1.65 | 0.608 | 1.63 | 0.612 | 1.59 | 0.630 |
| CR | 1.44 | 0.695 | 1.46 | 0.685 | 1.45 | 0.691 |
| LTDR | 1.19 | 0.839 | 1.19 | 0.837 | 1.18 | 0.845 |
| INS | 1.15 | 0.871 | 1.14 | 0.879 | 1.13 | 0.883 |
| BIND | 1.07 | 0.931 | 1.07 | 0.931 | 1.07 | 0.932 |
| AGE | 1.06 | 0.945 | 1.06 | 0.944 | 1.06 | 0.940 |
| MTB | 1.06 | 0.947 | 1.05 | 0.948 | 1.05 | 0.949 |
| BUSY | 1.04 | 0.962 | 1.04 | 0.962 | 1.04 | 0.961 |
| MLOWNTOTAL | 1.44 | 0.696 | 1.43 | 0.698 | 1.43 | 0.702 |
| <i>FOWN</i> | 1.14 | 0.873 | | | | |
| <i>FOWN 1</i> | | | 1.13 | 0.883 | | |

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| Variables | MLOWNTOTAL Models | | | | | |
|---------------|-------------------|-------|------|-------|------|-------|
| | Vif | 1/Vif | Vif | 1/Vif | Vif | 1/Vif |
| <i>FOWN 2</i> | | | | | 1.06 | 0.939 |
| Mean ViF | 1.34 | | 1.34 | | 1.33 | |
| Variables | MLOWN Models | | | | | |
| | Vif | 1/Vif | Vif | 1/Vif | Vif | 1/Vif |
| LEV | 2.25 | 0.444 | 2.25 | 0.445 | 2.26 | 0.443 |
| ROA | 1.71 | 0.586 | 1.7 | 0.587 | 1.72 | 0.581 |
| SIZE | 1.44 | 0.696 | 1.36 | 0.737 | 1.32 | 0.759 |
| CR | 1.37 | 0.733 | 1.46 | 0.686 | 1.45 | 0.691 |
| LTDR | 1.19 | 0.838 | 1.2 | 0.836 | 1.18 | 0.845 |
| INS | 1.14 | 0.873 | 1.13 | 0.882 | 1.13 | 0.886 |
| BIND | 1.07 | 0.932 | 1.07 | 0.932 | 1.07 | 0.932 |
| AGE | 1.07 | 0.938 | 1.07 | 0.938 | 1.07 | 0.934 |
| MTB | 1.06 | 0.943 | 1.06 | 0.944 | 1.06 | 0.945 |
| BUSY | 1.05 | 0.956 | 1.05 | 0.956 | 1.05 | 0.954 |
| MLOWN | 1.22 | 0.818 | 1.22 | 0.819 | 1.23 | 0.815 |
| <i>FOWN</i> | 1.14 | 0.875 | | | | |
| <i>FOWN 1</i> | | | 1.13 | 0.885 | | |
| <i>FOWN 2</i> | | | | | 1.07 | 0.931 |
| Mean ViF | 1.31 | | 1.31 | | 1.30 | |

4.3. Correlation matrix results

Family ownership types have a positive and significant correlation with intellectual capital components. In addition, subsidiaries have a positive and significant correlation with intellectual capital components. Other Pearson correlation coefficients and their significance levels are shown in Table 4.

Table 4. Results of the correlation matrix of the research model variables.

| <i>Variables</i> | <i>VAIC</i> | <i>ICE</i> | <i>HCE</i> | <i>SCE</i> | <i>CCE</i> | <i>INCE</i> | <i>PCE</i> | <i>CEE</i> | <i>FOWN</i> | <i>FOWN 1</i> | <i>FOWN 2</i> | <i>INS</i> |
|-------------------|-------------|------------|------------|------------|------------|-------------|------------|------------|-------------|---------------|---------------|------------|
| <i>VAIC</i> | 1 | | | | | | | | | | | |
| <i>ICE</i> | 0.999*** | 1 | | | | | | | | | | |
| <i>HCE</i> | 0.997*** | 0.998*** | 1 | | | | | | | | | |
| <i>SCE</i> | 0.439*** | 0.437*** | 0.382*** | 1 | | | | | | | | |
| <i>CCE</i> | -0.085*** | -0.081*** | -0.073*** | -0.144*** | 1 | | | | | | | |
| <i>INCE</i> | 0.036 | 0.037 | 0.035 | 0.038 | -0.010 | 1 | | | | | | |
| <i>PCE</i> | 0.422*** | 0.419*** | 0.364*** | 0.982*** | -0.275*** | 0.022 | 1 | | | | | |
| <i>CEE</i> | 0.127*** | 0.092*** | 0.088*** | 0.103*** | -0.129*** | -0.006 | 0.125*** | 1 | | | | |
| <i>FOWN</i> | 0.077*** | 0.078*** | 0.075*** | 0.080*** | 0.085*** | 0.006 | 0.088*** | 0.014 | 1 | | | |
| <i>FOWN 1</i> | 0.069** | 0.072*** | 0.070** | 0.060** | 0.133*** | 0.010 | 0.070** | 0.062** | 0.834*** | 1 | | |
| <i>FOWN 2</i> | 0.050 | 0.050 | 0.048 | 0.062** | 0.023 | 0.016 | 0.054 | 0.008 | 0.588*** | 0.548*** | 1 | |
| <i>INS</i> | 0.155*** | 0.158*** | 0.153*** | 0.151*** | -0.018 | 0.026 | 0.137*** | -0.054** | -0.218*** | -0.187*** | -0.123*** | 1 |
| <i>MLOWNTOTAL</i> | 0.079*** | 0.087*** | 0.084*** | 0.107*** | -0.019 | -0.038 | 0.094*** | -0.216*** | -0.043 | -0.045 | -0.051 | 0.073*** |
| <i>MLOWN</i> | 0.054** | 0.063** | 0.061** | 0.074*** | 0.009 | -0.069** | 0.064** | -0.235*** | 0.010 | 0.010 | -0.094*** | 0.049 |
| <i>LEV</i> | -0.239*** | -0.231*** | -0.227*** | -0.142*** | 0.100*** | 0.033 | -0.143*** | -0.227*** | -0.134*** | -0.125*** | -0.088*** | 0.015 |
| <i>ROA</i> | 0.508*** | 0.493*** | 0.482*** | 0.390*** | -0.065** | 0.037 | 0.376*** | 0.498*** | -0.026 | -0.012 | -0.055** | 0.090 |
| <i>SIZE</i> | 0.340*** | 0.347*** | 0.337*** | 0.336*** | -0.052 | 0.081*** | 0.313*** | -0.172*** | -0.236*** | -0.212*** | -0.108*** | 0.260*** |
| <i>CR</i> | 0.093*** | 0.090*** | 0.088*** | 0.082*** | -0.056** | 0.001 | 0.085*** | 0.079*** | 0.156*** | 0.195*** | 0.150*** | -0.074*** |
| <i>AGE</i> | -0.128*** | -0.127*** | -0.130*** | -0.008 | 0.073*** | 0.050 | -0.019 | -0.048 | -0.0003 | 0.051 | -0.067** | -0.116*** |
| <i>MTB</i> | -0.046 | -0.050 | -0.050 | -0.038 | 0.013 | -0.010 | -0.040 | 0.130*** | 0.066** | 0.059** | 0.001 | -0.109*** |
| <i>LTDR</i> | -0.116*** | -0.115*** | -0.109*** | -0.150*** | -0.056** | -0.003 | -0.127*** | -0.049 | -0.101*** | -0.105*** | -0.033 | -0.046 |
| <i>BIND</i> | 0.093*** | 0.092*** | 0.087*** | 0.084*** | 0.025 | 0.069** | 0.071*** | 0.042 | 0.059** | 0.060** | 0.030 | -0.075*** |
| <i>BUSY</i> | 0.033 | 0.030 | 0.031 | 0.015 | 0.026 | 0.030 | 0.008 | 0.082*** | -0.043 | -0.042 | -0.044 | 0.072*** |

Continued on next page

| <i>Variables</i> | <i>MLOWNTOTAL</i> | <i>MLOWN</i> | <i>LEV</i> | <i>ROA</i> | <i>SIZE</i> | <i>CR</i> | <i>AGE</i> | <i>MTB</i> | <i>LTDR</i> | <i>BIND</i> | <i>BUSY</i> |
|-------------------|-------------------|--------------|------------|------------|-------------|-----------|------------|------------|-------------|-------------|-------------|
| <i>MLOWNTOTAL</i> | 1 | | | | | | | | | | |
| <i>MLOWN</i> | 0.494*** | 1 | | | | | | | | | |
| <i>LEV</i> | 0.047 | -0.143*** | 1 | | | | | | | | |
| <i>ROA</i> | -0.031 | 0.046 | -0.596*** | 1 | | | | | | | |
| <i>SIZE</i> | 0.519 | 0.340*** | 0.009 | 0.176*** | 1 | | | | | | |
| <i>CR</i> | -0.052*** | 0.080*** | -0.530*** | 0.315*** | -0.010 | 1 | | | | | |
| <i>AGE</i> | 0.063** | 0.107*** | -0.007 | 0.037 | 0.021 | 0.026 | 1 | | | | |
| <i>MTB</i> | -0.042 | -0.059** | -0.053 | 0.072*** | -0.018 | 0.113*** | 0.123*** | 1 | | | |
| <i>LTDR</i> | -0.036 | -0.022 | 0.374*** | -0.281*** | -0.053 | -0.152*** | 0.033 | -0.042 | 1 | | |
| <i>BIND</i> | -0.117*** | -0.050 | -0.173*** | 0.113*** | -0.137*** | 0.063** | -0.040 | -0.087*** | -0.030 | 1 | |
| <i>BUSY</i> | -0.004 | -0.072*** | 0.003 | 0.060** | 0.085*** | 0.052 | -0.138*** | -0.009 | -0.006 | 0.004 | 1 |

4.4. Model estimation and interpretation of results

To estimate the research models and ensure the validity of the results, a multi-stage strategy based on theoretical foundations and diagnostic tests is used. The final selection of each estimation method is made by considering the nature of the data and the characteristics of the regression models.

In the first step, for all models, the F-Limer Test is used to choose between the Pooled OLS estimator and the panel data model. Then, the Hausman Test is used as the final selection criterion between the Fixed Effects (FE) and Random Effects (RE) models. In cases where the null hypothesis of the Hausman test (indicating the superiority of random effects) is rejected, the fixed effects model is selected as the base model for the analysis, because this model controls for the presence of individual company-specific effects that are correlated with the independent variables.

For all estimated models, the Wald test for heteroscedasticity and the Wooldridge test for serial autocorrelation are performed. In case of heteroscedasticity or autocorrelation, the generalized method of moments (GMM) estimator or the robust form of Huber-White standard errors, which are resistant to these two problems, are used. It should be noted that these methods are mainly used to correct statistical inference (such as standard deviations and t-statistics), but cannot solve the endogeneity problem.

One of the major concerns in this study is the endogeneity problem, which can be caused by reverse causality (for example, the possibility that a high level of intellectual capital efficiency in the past has affected the current ownership structure of the company). Additionally, it is possible that some effective variables that are correlated with the independent and dependent variables have been omitted. To address this challenge, the GMM estimator is used. Specifically:

- System GMM is used. This method uses both the surface equation and the first difference equation simultaneously, and by using the lagged surfaces of the variables as instruments for the differential equation and the lagged differences as instruments for the surface equation, it reduces the problem of the dependence of the instrumental variables on the individual effects.
- The main reason for choosing GMM in this study is to solve the endogeneity problem, not the heteroscedasticity of variance. Although the GMM estimator is also robust to heteroscedasticity of variance, the goal of using it is to obtain consistent estimates in the presence of the lagged dependent variable and other sources of endogeneity.
- To ensure the accuracy of the model specification and the validity of the instruments, the Sargan Test is used to check the validity of the overidentifying restrictions assumption. The results of the Sargan test are presented in Table 5.

Table 5. Sargan test.

| Model | Level Statistics | P-Value |
|-------|------------------|---------|
| 1 | 21.180 | 0.210 |
| 2 | 6.550 | 0.760 |
| 3 | 2.300 | 0.806 |
| 4 | 7.500 | 0.186 |
| 5 | 4.500 | 0.105 |
| 6 | 25.440 | 0.655 |
| 7 | 1.480 | 0.224 |
| 8 | 0.190 | 0.651 |

In Table 5, the Sargan test is used to examine the validity of the instrumental variables defined in the models. As can be seen, the probability values (P-Value) of the Sargan test statistic for all models are greater than 0.05. This indicates that the null hypothesis of the test that the instrumental variables are valid is not rejected. Therefore, it can be confidently concluded that the instruments used in estimating the models meet the necessary conditions, and the estimation results have sufficient validity.

To test the hypotheses, eight regression models are used using the GMM method and fixed effects. To ensure the robustness of the results, sensitivity analyses are conducted using alternative measures for family ownership (FOWN1, FOWN2) and pyramidal ownership (MLOWN), as well as lag analyses, all of which confirm the major results (Appendix A).

4.4.1. Estimation of the first model

The results of these diagnostic tests are reported at the end of Table 6. According to the test results, the regression model should be estimated using the panel data method at a 99% confidence level. Also, by performing the Hausman test, it is determined that to achieve the best regression estimate, given the rejection of the null hypothesis of the Hausman test at a 99% confidence level, the fixed effects data method is used. The Woodridge test is used to examine serial correlation. According to the results obtained, the model does not have serial correlation. On the contrary, the residuals of this model are heterogeneous at a 99% confidence level using the Brosch-Pagan variance heterogeneity test. For this purpose, the estimated model is a robust model type, and the GMM method is used. The results of the model specification test also show that the omitted variable model does not have a significant effect. Moreover, the residuals of the first model have a normal distribution according to the results of the Kolmogorov-Smirnov test.

According to the estimation of the robust fixed effects models and the GMM model, family ownership positively and significantly affects the added intellectual capital coefficient. The coefficient of this variable in the two estimated methods is calculated to be 0.030 at the 99% confidence level and 0.024 at the 95% confidence level, respectively. Institutional ownership also positively and significantly affects the added intellectual capital coefficient at the 99% confidence level. The presence of subsidiaries also significantly increases the added intellectual capital coefficient. Among the control variables, return on assets, company size, and long-term debt ratio increase, and company age decreases the added intellectual capital coefficient. In addition, the dummy variables of year and industry are included to examine the existence of a difference in the added intellectual capital coefficient in the years under study and the industries considered. However, they are not significant and are removed from the model. Both models are significant at 99% confidence, but the GMM model has greater explanatory power.

In economic terms, family ownership (FOWN) with a coefficient of 0.024 in the GMM model indicates that converting a non-family firm to a family firm (changing the dummy variable from 0 to 1) adds an average of 0.024 units to its overall intellectual capital value added coefficient (VAIC). Given the average VAIC (5.325), this increase is equivalent to an approximate 0.5% improvement in the firm's overall efficiency of using intellectual and financial resources. This indicates a positive but moderate effect of family ownership on overall efficiency.

Institutional ownership (INS) with a coefficient of 0.086 indicates that a 10% increase in the share of institutional ownership (e.g., from 30% to 40%) increases VAIC by an average of 0.86 units. This

increase is equivalent to 16.6% of one standard deviation of VAIC (5.173), which is considered a strong and economically significant effect.

Table 6. Estimation results of the first model.

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.030 | 0.000 | 0.024 | 0.030 |
| <i>INS</i> | 0.085 | 0.002 | 0.086 | 0.000 |
| <i>MLOWNTOTAL</i> | 0.222 | 0.006 | 0.132 | 0.024 |
| <i>LEV</i> | -0.554 | 0.550 | 1.103 | 0.061 |
| ROA | 12.529 | 0.000 | 16.733 | 0.000 |
| SIZE | 1.357 | 0.000 | 0.932 | 0.000 |
| CR | -0.134 | 0.110 | -0.096 | 0.199 |
| AGE | -0.299 | 0.000 | -0.057 | 0.000 |
| MTB | 0.000 | 0.993 | -0.024 | 0.000 |
| LTDR | 4.256 | 0.008 | 1.532 | 0.156 |
| BIND | 1.379 | 0.051 | 2.048 | 0.000 |
| BUSY | -0.182 | 0.957 | -0.792 | 0.002 |
| <i>Constant</i> | -5.080 | 0.232 | -9.366 | 0.000 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 19.95 | | 36.09 | |
| <i>F/Wald Test</i> | 24.81 | 0.000 | 346.76 | 0.000 |
| <i>Leamer Test</i> | 6.87 | | 0.000 | |
| <i>Hausman Test</i> | 35.99 | | 0.000 | |
| <i>Autocorrelation Test</i> | 3.417 | | 0.066 | |
| <i>Heteroskedasticity Test</i> | 1127.41 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 2.01 | | 0.107 | |
| <i>Normality of Resid</i> | 0.963 | | | |

The multilayer ownership structure (MLOWNTOTAL) with a coefficient of 0.132 indicates that the formation of a new subsidiary by the studied company (a one-unit increase) improves VAIC by an average of 0.132 units. For a company with an average number of subsidiaries (1.5), expanding the group to 4 subsidiaries can increase VAIC by about 0.396 units (about 7.4% of the average). This finding confirms the existence of economies of scale and network advantages in business groups.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.1 and A.2 in Appendix A.

4.4.2. Estimation of the second model

According to the integration and Hausman test results, the second regression model should be estimated at the 99% confidence level using the panel data fixed effects method. According to the results, the model does not have a serial correlation. On the contrary, the residuals of this model are heterogeneous at the 99% confidence level. For this purpose, the robust fixed effects methods and the GMM method are used. The results of the model specification test also show that the model

does not have a significant omitted variable. Additionally, the residuals of this model have a normal distribution.

According to the estimation of the robust fixed effects models and the GMM model, family ownership positively and significantly affects the intellectual capital efficiency coefficient. The coefficients of this variable in the two estimated methods are calculated to be 0.087 and 0.097 at the 99% confidence level, respectively. Institutional ownership also positively and significantly affects the intellectual capital efficiency coefficient. The presence of subsidiaries also significantly increases the intellectual capital efficiency coefficient. Among the control variables, return on assets, company size, board independence, and long-term debt ratio are factors that increase, and company age is a factor that decreases the intellectual capital efficiency coefficient. In addition, the dummy variables of year and industry are included to examine the existence of differences in the intellectual capital efficiency coefficient in the years under study and the industries considered. However, they are not significant and are removed from the model. Both models are significant at 99% confidence, but the GMM model has greater explanatory power.

Table 7. Estimation results of the second model.

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.087 | 0.000 | 0.097 | 0.000 |
| <i>INS</i> | 0.026 | 0.001 | 0.025 | 0.019 |
| <i>MLOWNTOTAL</i> | 0.220 | 0.007 | 0.745 | 0.000 |
| <i>LEV</i> | -0.610 | 0.510 | 1.022 | 0.083 |
| ROA | 11.862 | 0.000 | 15.992 | 0.000 |
| SIZE | 1.464 | 0.000 | 0.959 | 0.000 |
| CR | -0.147 | 0.079 | -0.088 | 0.223 |
| AGE | -0.316 | 0.000 | -0.056 | 0.000 |
| MTB | -0.001 | 0.923 | -0.026 | 0.000 |
| LTDR | 4.206 | 0.009 | 1.396 | 0.195 |
| BIND | 1.394 | 0.048 | 2.095 | 0.000 |
| BUSY | -0.167 | 0.960 | -0.834 | 0.001 |
| <i>Constant</i> | -6.209 | 0.143 | -10.052 | 0.000 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 18.79 | | 35.00 | |
| <i>F/Wald Test</i> | 23.39 | 0.000 | 330.41 | 0.000 |
| <i>Leamer Test</i> | 7.06 | | 0.000 | |
| <i>Hausman Test</i> | 36.92 | | 0.000 | |
| <i>Autocorrelation Test</i> | 3.360 | | 0.066 | |
| <i>Heteroskedasticity Test</i> | 1141.38 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 1.73 | | 0.160 | |
| <i>Normality of Resid</i> | 0.941 | | | |

The coefficient on family ownership (0.097) in the GMM model suggests that family firms have approximately 0.1 point higher net ICE compared to non-family firms. Given the standard deviation of

ICE (5.158), this is equivalent to 1.9% of a standard deviation, suggesting that the main advantage of family firms is in managing purely intangible assets, not necessarily in combining them with financial assets. The coefficient on institutional ownership (0.025) suggests that a 10-point increase in the share of institutional ownership improves ICE by approximately 0.25 points. Although statistically significant, this improvement is economically smaller than its effect on VAIC, suggesting that institutions may be more focused on combined (financial and intellectual) efficiency.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.3 and A.4 in Appendix A.

4.4.3. Estimation of the third model

The integration and Hausman test results show that the third regression model should be estimated using the panel data fixed effects method. According to the result, the model does not have a serial correlation. On the contrary, the residuals of this model are of unequal variance. Therefore, the robust fixed effects and GMM methods are also used. The results of the model specification test also show that the model does not have a significant omitted variable. Additionally, the residuals of this model have a normal distribution.

Table 8. Estimation results of the third model.

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.519 | 0.031 | 0.326 | 0.000 |
| <i>INS</i> | 0.382 | 0.033 | 0.014 | 0.000 |
| <i>MLOWNTOTAL</i> | 0.217 | 0.007 | 0.050 | 0.000 |
| <i>LEV</i> | -0.764 | 0.404 | 0.883 | 0.118 |
| ROA | 11.346 | 0.000 | 15.282 | 0.000 |
| SIZE | 1.439 | 0.000 | 0.910 | 0.000 |
| CR | -0.168 | 0.042 | -0.088 | 0.202 |
| AGE | -0.312 | 0.000 | -0.056 | 0.000 |
| MTB | -0.002 | 0.855 | -0.025 | 0.000 |
| LTDR | 4.473 | 0.005 | 1.648 | 0.118 |
| BIND | 1.218 | 0.080 | 1.894 | 0.001 |
| BUSY | -0.173 | 0.959 | -0.792 | 0.002 |
| <i>Constant</i> | -6.283 | 0.134 | -9.705 | 0.000 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 17.94 | | 33.51 | |
| <i>F/Wald Test</i> | 22.20 | 0.000 | 301.86 | 0.000 |
| <i>Leamer Test</i> | 7.01 | | 0.000 | |
| <i>Hausman Test</i> | 35.92 | | 0.000 | |
| <i>Autocorrelation Test</i> | 3.716 | | 0.056 | |
| <i>Heteroskedasticity Test</i> | 1226.29 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 0.97 | | 0.404 | |
| <i>Normality of Resid</i> | 0.827 | | | |

According to the estimation of the robust fixed effects models and the GMM model, family ownership positively and significantly affects human capital efficiency. The coefficients of this variable in the two estimated methods are calculated to be 0.519 and 0.326, respectively. Institutional ownership also has a positive and significant effect on human capital efficiency. The presence of subsidiaries also significantly increases human capital efficiency. Among the control variables, return on assets, firm size, board independence, and long-term debt ratio are factors that increase, and firm age is a factor that decreases human capital efficiency. The dummy variables, year, and industry are removed from the model due to their lack of significance. Both models are significant at 99% confidence, but the GMM model has greater explanatory power.

The coefficient of 0.326 for family ownership in the GMM model is very economically meaningful. This means that family firms can convert every 1 Rial of labor costs into 0.326 Rials more value added than comparable non-family firms. Assuming average labor costs, this could mean billions in savings or value creation at the firm level. This finding strongly supports the “extended family” hypothesis and investment in workforce loyalty and skills.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.5 and A.6 in Appendix A.

4.4.4. Estimation of the fourth model

According to the results of the diagnostic tests explained earlier, the fourth model is also estimated using the robust fixed effects and GMM methods. According to the estimates, family and institutional ownership and subsidiaries significantly increase structural capital efficiency. Among them, family ownership has a higher intensity of impact. Among the control variables, financial leverage, return on assets, company size, and current ratio increase the dependent variable, and board independence decreases structural capital efficiency. The dummy variables of year and industry are removed from the model due to their lack of significance. Both models are significant at the 99% confidence level, but the GMM model has greater explanatory power.

The large coefficient of family ownership on SCE (0.755) indicates that family firms consider structures, processes, and organizational knowledge as the cornerstone of business continuity from generation to generation and invest heavily in them. This creates a sustainable competitive advantage for them.

The positive and persistent effect of institutional ownership on structural and process capital demonstrates the role of these institutions as promoters of efficiency and operational standardization. A 10% increase in institutional ownership improves process efficiency by about 0.4 points. In industries with low profit margins, such an improvement in efficiency can be decisive for the survival or profitability of the firm.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.7 and A.8 in Appendix A.

Table 9. Estimation results of the fourth model.

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.381 | 0.029 | 0.755 | 0.000 |
| <i>INS</i> | 0.089 | 0.022 | 0.051 | 0.013 |
| <i>MLOWNTOTAL</i> | 0.097 | 0.000 | 0.045 | 0.000 |
| <i>LEV</i> | 0.213 | 0.002 | 0.206 | 0.019 |
| ROA | 0.520 | 0.000 | 0.747 | 0.000 |
| SIZE | 0.066 | 0.001 | 0.053 | 0.000 |
| CR | 0.019 | 0.002 | 0.005 | 0.383 |
| AGE | -0.009 | 0.071 | 0.000 | 0.483 |
| MTB | 0.000 | 0.978 | -0.001 | 0.289 |
| LTDR | -0.258 | 0.032 | -0.263 | 0.075 |
| BIND | 0.134 | 0.012 | 0.155 | 0.002 |
| BUSY | -0.003 | 0.991 | -0.045 | 0.066 |
| <i>Constant</i> | -0.280 | 0.380 | -0.401 | 0.000 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 14.48 | | 33.51 | |
| <i>F/Wald Test</i> | 10.14 | 0.000 | 301.86 | 0.000 |
| <i>Leamer Test</i> | 2.52 | | 0.000 | |
| <i>Hausman Test</i> | 26.27 | | 0.010 | |
| <i>Autocorrelation Test</i> | 1.743 | | 0.189 | |
| <i>Heteroskedasticity Test</i> | 688.43 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 0.73 | | 0.532 | |
| <i>Normality of Resid</i> | 0.541 | | | |

4.4.5. Estimation of the fifth model

According to the results of the diagnostic tests explained earlier, unlike the other models, the robust and dynamic GMM random effects methods estimate the fifth model. According to the estimates, family ownership, institutional ownership, and the existence of subsidiaries significantly increase the efficiency of customer capital. Among them, institutional ownership has a higher intensity of impact.

In the dynamic GMM model, the CCE variable lag is included as an explanatory variable. The coefficient of this variable is estimated to be 0.681 at the 99% confidence level. Therefore, 68% of the customer capital efficiency level in each period is determined by the level in the previous period. Both models are significant at 99% confidence, but the dynamic GMM model has greater explanatory power.

The positive impact of family ownership on customer capital suggests that these firms spend money to build and maintain long-term customer loyalty. This is a revenue risk reduction strategy that is consistent with the family's long-term horizon. The high coefficient of institutional ownership (0.219) also suggests that institutions may leverage their institutional relationships to access larger markets or government customers, thereby increasing the efficiency of customer capital.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.9 and A.10 in Appendix A.

Table 10. Estimation results of the fifth model.

| Variables | RE Model | | Dynamic GMM Model | |
|--------------------------------|----------|-------|-------------------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>CEE_{t-1}</i> | | | 0.681 | 0.000 |
| <i>FOWN</i> | 0.293 | 0.016 | 0.098 | 0.005 |
| <i>INS</i> | 0.308 | 0.003 | 0.219 | 0.032 |
| <i>MLOWNTOTAL</i> | 0.089 | 0.022 | 0.928 | 0.000 |
| <i>LEV</i> | 0.011 | 0.157 | 0.009 | 0.265 |
| ROA | -0.013 | 0.131 | -0.008 | 0.298 |
| SIZE | 0.0004 | 0.727 | -0.0004 | 0.568 |
| CR | -0.0005 | 0.506 | -0.0002 | 0.607 |
| AGE | 0.0003 | 0.139 | 0.0001 | 0.221 |
| MTB | -0.00005 | 0.602 | -0.00003 | 0.627 |
| LTDR | -0.028 | 0.040 | -0.034 | 0.014 |
| BIND | 0.011 | 0.053 | 0.009 | 0.108 |
| BUSY | 0.005 | 0.529 | 0.003 | 0.107 |
| <i>Constant</i> | -0.021 | 0.313 | -0.005 | 0.705 |
| <i>Obs</i> | 1328 | | 1162 | |
| <i>R² Adj.</i> | 2.70 | | 45.82 | |
| <i>F/Wald Test</i> | 19.88 | 0.069 | 115.87 | 0.000 |
| <i>Leamer Test</i> | 9.23 | | 0.000 | |
| <i>Hausman Test</i> | 12.56 | | 0.402 | |
| <i>Autocorrelation Test</i> | 8.393 | | 0.004 | |
| <i>Heteroskedasticity Test</i> | 759.82 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 1.81 | | 0.145 | |
| <i>Normality of Resid</i> | 0.948 | | | |

4.4.6. Estimation of the sixth model

According to the results of diagnostic tests, this model is estimated using robust random effects and GMM methods. According to the estimates, family and institutional ownership are the factors that increase, and the existence of subsidiaries significantly reduces innovation capital. Among them, family ownership has a higher intensity of impact.

The negative coefficient of multi-tier ownership on innovation capital (-0.001), although numerically small, is very important in terms of direction and strategic consequence. This finding shows that for every 1000 units increase in group scale (number of subsidiaries), innovation efficiency decreases by 1 unit. This illustrates the unpleasant trade-off between “economies of scale” and “innovation agility” in pyramidal structures. For a large group with 40 subsidiaries (the maximum sample), this could mean a 4% reduction in innovation efficiency, which, in the long run, is a serious strategic threat to the group’s survival.

The robustness of the results and sensitivity analyses using alternative criteria are presented in Tables A.11 and A.12 in Appendix A.

Table 11. Estimation results of the sixth model.

| Variables | RE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.108 | 0.019 | 0.001 | 0.041 |
| <i>INS</i> | 0.020 | 0.042 | 0.033 | 0.000 |
| <i>MLOWNTOTAL</i> | -0.0001 | 0.052 | -0.0001 | 0.003 |
| <i>LEV</i> | 0.001 | 0.237 | 0.002 | 0.016 |
| ROA | 0.001 | 0.482 | 0.001 | 0.097 |
| SIZE | 0.0004 | 0.003 | 0.0004 | 0.006 |
| CR | 0.00002 | 0.809 | 0.0001 | 0.266 |
| AGE | 0.00002 | 0.204 | 0.00002 | 0.020 |
| MTB | -0.00001 | 0.196 | -0.00001 | 0.290 |
| LTDR | -0.001 | 0.423 | -0.001 | 0.361 |
| BIND | 0.001 | 0.189 | 0.002 | 0.005 |
| BUSY | 0.0004 | 0.574 | 0.0003 | 0.012 |
| <i>Constant</i> | -0.007 | 0.001 | -0.009 | 0.002 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 12.16 | | 33.51 | |
| <i>F/Wald Test</i> | 26.56 | 0.009 | 301.86 | 0.000 |
| <i>Leamer Test</i> | 3.48 | | 0.000 | |
| <i>Hausman Test</i> | 15.18 | | 0.232 | |
| <i>Autocorrelation Test</i> | 0.893 | | 0.346 | |
| <i>Heteroskedasticity Test</i> | 2025.11 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 1.31 | | 0.270 | |
| <i>Normality of Resid</i> | 0.827 | | | |

4.4.7. Estimation of the seventh model

According to the results of diagnostic tests, this model is estimated using robust fixed effects and GMM methods. According to the estimates in Table 12, family ownership, institutional ownership and the number of subsidiaries significantly increase the efficiency of process capital. Among them, the number of subsidiaries has a higher impact intensity.

Table 12. Results of the seventh model estimation.

| Variables | FE Model | | GMM Model | |
|-------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>FOWN</i> | 0.216 | 0.034 | 0.073 | 0.000 |
| <i>INS</i> | 0.099 | 0.025 | 0.043 | 0.000 |
| <i>MLOWNTOTAL</i> | 1.323 | 0.022 | 0.027 | 0.000 |
| <i>LEV</i> | 0.226 | 0.004 | 0.191 | 0.070 |
| ROA | 0.560 | 0.000 | 0.784 | 0.000 |
| SIZE | 0.051 | 0.021 | 0.054 | 0.000 |

Continued on next page

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| CR | 0.025 | 0.000 | 0.006 | 0.334 |
| AGE | -0.008 | 0.176 | -0.001 | 0.207 |
| MTB | 0.000 | 0.931 | -0.002 | 0.251 |
| LTDR | -0.241 | 0.075 | -0.195 | 0.210 |
| BIND | 0.123 | 0.040 | 0.137 | 0.009 |
| BUSY | 0.001 | 0.996 | -0.056 | 0.024 |
| <i>Constant</i> | -0.151 | 0.674 | -0.383 | 0.000 |
| <i>Obs</i> | 1328 | | 1328 | |
| <i>R² Adj.</i> | 14.06 | | 22.39 | |
| <i>F/Wald Test</i> | 8.72 | 0.000 | 547.79 | 0.000 |
| <i>Leamer Test</i> | 2.32 | | 0.000 | |
| <i>Hausman Test</i> | 26.65 | | 0.009 | |
| <i>Autocorrelation Test</i> | 1.793 | | 0.182 | |
| <i>Heteroskedasticity Test</i> | 788.62 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 1.51 | | 0.209 | |
| <i>Normality of Resid</i> | 0.243 | | | |

The positive and significant coefficient of multi-tier ownership on process capital (0.027) confirms that business groups can significantly improve process efficiency by standardizing processes at the group level and creating operational synergies. This is a key competitive advantage for these groups in competition with independent companies.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.13 and A.14 in Appendix A.

4.4.8. The estimation of the eighth model

According to the results of the diagnostic tests, this model is estimated using robust fixed effects and dynamic GMM methods. According to the estimates made in Table 13, family ownership, institutional ownership, and the number of subsidiaries significantly increase the efficiency coefficient of capital employed. Among them, the number of subsidiaries has a higher impact intensity.

Table 13. Results of the estimation of the eighth model.

| Variables | FE Model | | GMM Model | |
|--------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| <i>CEE_{t-1}</i> | | | 0.675 | 0.000 |
| <i>FOWN</i> | 0.068 | 0.002 | 0.173 | 0.001 |
| <i>INS</i> | 0.258 | 0.000 | 0.258 | 0.000 |
| <i>MLOWNTOTAL</i> | 0.746 | 0.019 | 1.228 | 0.000 |
| <i>LEV</i> | 0.049 | 0.039 | 0.058 | 0.030 |
| <i>ROA</i> | 0.696 | 0.000 | 0.409 | 0.000 |

Continued on next page

| Variables | FE Model | | GMM Model | |
|--------------------------------|----------|-------|-----------|-------|
| | Coef. | Prob | Coef. | Prob |
| SIZE | -0.110 | 0.000 | -0.013 | 0.000 |
| CR | 0.012 | 0.000 | -0.003 | 0.433 |
| AGE | 0.017 | 0.000 | -0.001 | 0.024 |
| MTB | 0.001 | 0.000 | 0.001 | 0.041 |
| LTDR | 0.074 | 0.073 | 0.197 | 0.000 |
| BIND | -0.008 | 0.660 | -0.036 | 0.041 |
| BUSY | -0.014 | 0.872 | 0.019 | 0.103 |
| <i>Constant</i> | 1.152 | 0.000 | 0.244 | 0.000 |
| <i>Obs</i> | 1328 | | 1162 | |
| <i>R² Adj.</i> | 10.96 | | 70.26 | |
| <i>F/Wald Test</i> | 95.97 | 0.000 | 1840.50 | 0.000 |
| <i>Leamer Test</i> | 18.94 | | 0.000 | |
| <i>Hausman Test</i> | 139.47 | | 0.009 | |
| <i>Autocorrelation Test</i> | 32.144 | | 0.000 | |
| <i>Heteroskedasticity Test</i> | 125.70 | | 0.000 | |
| <i>Ramsey Reset Test</i> | 0.97 | | 0.404 | |
| <i>Normality of Resid</i> | 0.565 | | | |

The significant coefficient of multi-layer ownership (1.228) indicates that companies in business groups are also more efficient in using financial capital (tangible assets). This is likely due to access to cheaper internal financial resources, centralized treasury management, and the possibility of optimal asset allocation at the group level. This finding emphasizes the competitive advantage of business groups in managing tangible assets.

The robustness of the results, sensitivity analyses using alternative criteria, is presented in Tables A.15 and A.16 in Appendix A.

5. Conclusions

With the increasing expansion of companies and significant technological advancements, the role of financial and physical capital in maintaining and enhancing corporate standing has diminished. One of the most important ways to achieve sustainable competitive advantage and proper organizational performance is to focus on intellectual capital or intangible assets. Al-Sartawi and Abdalmutaleb (2018) state that while intellectual capital is related to an organization's value creation processes, corporate governance plays a vital role in preserving this value. Furthermore, implementing effective corporate governance procedures can contribute to intellectual capital development through the participation of managers and decision-makers (Madhani, 2014). Accordingly, it can be said that investing in intellectual capital depends on the goals, decisions, and logic of corporate controllers within any ownership structure. The goal of all owners (controllers and minorities) is to create value for the organization. Controlling shareholders prefer to invest in the company's intellectual capital because it improves the company's value (Anifowose et al., 2018; Maji & Goswami, 2016), and minority shareholders will also benefit from the increased value. However, controlling shareholders influence the company's strategic goals and decisions. Thus,

controlling stakeholders can play their supervisory role in advising managers on strategic decisions. Hence, controlling shareholders, as the major actors in corporate governance and proper oversight of company management, have the motivation and power to manage resources, including intellectual capital (Keenan & Aggestam, 2001; Hsieh et al., 2020).

In this study, we aimed to investigate the relationship between ownership structures (family, institutional, and multi-level) and the efficiency of intellectual capital and its components in companies listed on the Tehran Stock Exchange. Empirical analyses based on data from 172 companies over the period 2013 to 2020 revealed several key findings with statistical and economic significance. While researchers have primarily focused on linear and one-dimensional relationships, our findings of this research present a more complex and richer picture, confirming not only the existence of a relationship but also revealing the distinct mechanisms and intensities of influence for each of these ownership structures.

The results of this study, after employing robust econometric methods and considering numerous sensitivity analyses, indicate that the type of ownership plays a determinant role in guiding intellectual capital efficiency. However, this influence is not uniform, and significant differences are observed at the level of various intellectual capital components.

- **Family Ownership:** Consistent with the findings of Acuña-Opazo and González (2021) and contrary to Mohd-Saleh and Che Abdul Rahman (2009) and Nassar et al. (2018), family ownership has a positive and statistically significant relationship with overall intellectual capital efficiency (VAIC). In terms of economic impact, a one standard deviation increase in family ownership leads to an average increase in VAIC. The coefficient for family ownership (FOWN) in the main model (Table 6) is 0.030 with a significance level of 0.01. This coefficient increases to 0.024 with a significance level of 0.05 in the GMM model. In supplementary models (Table A.1), the coefficient for FOWN1 (ownership of more than 20% of shares) is 0.026 and for FOWN2 (board membership with more than 5% ownership) is 0.086. Therefore, the presence of family ownership, on average, leads to a 2.4% to 8.6% increase in intellectual capital efficiency, indicating the significant impact of this ownership type on managing intangible assets. This relationship is particularly stronger for the components of human capital (HCE) and customer capital (CCE), aligning with the theory of Tagiuri and Davis (1996) regarding non-economic goals such as building trust-based relationships with key stakeholders. It appears that family-owned firms with a long-term perspective not only invest in retaining high-quality human resources but also place a high value on maintaining and developing customer relationships as a strategic asset.
- **Institutional Ownership:** Our findings support a positive relationship between institutional ownership and intellectual capital efficiency, consistent with the results of Wei and Varela (2003), Shahveisi et al. (2017), and Jamei (2017). The coefficient for institutional ownership (INS) in the main model (Table 6) is estimated at 0.085 with a significance level of 0.01. This coefficient reaches 0.086 with a significance level of 0.01 in the GMM model. Across models, the range of the institutional ownership coefficient fluctuates between 0.012 and 0.130. Moreover, a 10% increase in the share of institutional ownership leads, on average, to a 0.86% to 1.30% increase in intellectual capital efficiency. Economically, a strong presence of institutional owners is associated with improved efficiency in structural capital (SCE) and in process capital (PCE). This finding can be attributed to the supervisory and specialized role of these institutions, which emphasize process standardization, infrastructure improvement, and operational optimization to

increase productivity (Nurleni et al., 2018).

- **Multi-level Ownership Structures:** Multi-level ownership structures also show a positive relationship with overall intellectual capital efficiency. The coefficient for MLOWNTOTAL in the main model is estimated at 0.222 with a significance level of 0.01. The coefficient for MLOWN (the dummy variable for the existence of subsidiaries) ranges between 2.616 and 2.623 across models. This could be due to these business groups' access to cheaper financial resources, technical knowledge, and broader networks (Holmén & Högfeldt, 2009). However, a noteworthy point is the negative and significant impact of this structure on innovation capital (INCE), with a coefficient of -0.001. Thus, the presence of a pyramidal ownership structure can add up to 2.6 units to intellectual capital efficiency but simultaneously causes a 0.1% decrease in innovation capital efficiency. A possible explanation for this finding is the short-termism arising from pressure for quick profits or inefficient allocation of resources within the group in Iranian companies, which affects the budgeting for risky and long-term R&D projects. Perhaps the reason is the existence of subsidiaries; as the number of subsidiaries increases, the parent company uses more of the subsidiaries' facilities and spends less on research and development. This conclusion aligns with the argument of Hsieh et al. (2020) regarding the potential prioritization of short-term interests by controlling shareholders.

This study shows that ownership structure is not only a governance variable but also a determining factor in the management of intangible assets, capable of explaining variations in intellectual capital efficiency.

Furthermore, control variables such as financial leverage (with a coefficient ranging from 1.532 to 4.549, showing a positive effect), return on assets (with the strongest positive effect, coefficient 12.529 to 16.733), and firm size (with a positive and significant effect, coefficient 0.932 to 1.464) are growth factors for intellectual capital and its components, while firm age and BUSY are factors reducing it. Additionally, board independence increases intellectual capital efficiency. With the increase in company size, which reflects the total value of the company's assets, and return on assets, which indicates high efficiency in using human, structural, customer, and innovation capital, it is expected that intangible assets and the efficiency of such capital will also increase. On the other hand, companies with high debt solvency have lower intellectual capital efficiency. Additionally, the amount of intellectual capital reported in the company decreases over time.

5.1. Theoretical and practical implications

This study contributes to the corporate governance and intellectual capital literature in several ways:

1. It provides evidence from Iran, which has a concentrated ownership structure and a different institutional environment compared to developed economies.
2. Unlike many researchers that address only the overall relationship, this research, by decomposing intellectual capital into its components, shows how each type of ownership has its own path of influence.
3. By employing the GMM method to address endogeneity and providing extensive sensitivity analyses, it attempts to offer more robust and reliable estimates.

The findings of this research have important implications for investors, managers, and regulators:

- **For Family Shareholders:** Given the coefficient of 0.086 for FOWN2, active presence on the board of directors can be an effective strategy for improving intellectual capital.

- **For Investors:** By considering the company's ownership composition and its strategy toward different components of intellectual capital (e.g., family firms for human capital and customer relationship-based strategies, and firms with strong institutional ownership for process optimization strategies), they can make more informed decisions. Attention to control variables, such as return on assets (with a maximum coefficient of 16.733), can be the most important lever for improving intellectual capital.

- **For Managers:** By understanding the priorities of major shareholders, they can adjust their intellectual capital management strategies to align with their expectations and gain their support.

In family-owned companies, managers (often family members) should recognize and strengthen the social capital and long-term credibility of loyal "human capital" and strong "customer capital" as a core competitive advantage. However, they should always be wary of the "risk of conservatism." Moreover, they should establish clear mechanisms (such as allocating a fixed percentage of profits to R&D or forming independent innovation advisory boards) to ensure that risk aversion does not come at the cost of neglecting investment in "innovation capital" and jeopardizing the company's long-term competitiveness.

In companies with significant institutional ownership, managers should expect close focus and oversight from institutional shareholders on operational efficiency and "process capital." Transparent reporting on process efficiency and standardization is key to gaining the trust of these stakeholders. Managers can provide long-term justifications to persuade these stakeholders of the importance of complementary investments in "innovation capital" and to strike a balance between short-term efficiency and long-term growth.

In companies belonging to pyramidal business groups, the main challenge for managers is to deal with the "innovation dilemma". They must be able to maximize the benefits of intra-group resources and networks for overall efficiency while designing protection mechanisms for innovation budgets. This can be achieved by preparing transparent and independent business plans for innovative projects and by engaging directly with small institutional investors to gain their support against possible short-term pressures from the ultimate controller. The role of the manager here is not only that of an executor, but also that of an ambassador and advocates for innovation within the complex structure of the group.

- **For Institutional Investors:** The coefficient of 0.086 for institutional ownership indicates that these institutions can influence the improvement of intellectual capital efficiency by increasing their ownership share.

- **For Policymakers and Regulators in Emerging Markets:** These findings provide important practical insights for policymakers and regulators in emerging markets, such as Iran, which are faced with high ownership concentration and extensive group structures:

The strong negative finding on the relationship between pyramidal ownership and innovation capital is a wake-up call for policymakers. Regulators can mitigate this risk by designing targeted incentives. For example, granting tax breaks or preferential foreign exchange facilities could be conditional on spending a certain percentage of the group's operating profit (and not just the shell company) on domestic research and development (R&D). Also, requiring separate disclosure of R&D expenses at the level of the group's parent and consolidated companies would increase transparency and enable better monitoring of resource allocation to innovation.

While family firms perform well in preserving human and customer capital, policymakers should strengthen corporate governance mechanisms to protect minority shareholders' rights from

potential conflicts of family interest. Developing corporate governance guidelines for family firms that emphasize board independence, transparency in related party transactions, and the establishment of audit committees with independent members could be helpful.

Capital market regulators can reduce the information gap by requiring or encouraging companies to make standardized and detailed disclosures of intellectual capital (according to a framework such as the one used in this study) in annual reports or governance reports. This enables all stakeholders, especially institutional investors, to assess not only the overall performance but also the specific strategies and vulnerabilities of each company in managing intangible assets and to make more informed investment decisions.

Given the significant contribution of government entities to institutional ownership, this study emphasizes the need to monitor the quality of oversight by these institutions. Macro-policymakers should ensure that these institutions, in their role as active shareholders, emphasize improving process efficiency and long-term investment in human capital and innovation of the companies they cover, rather than simply pushing for short-term dividends.

5.2. Limitations and suggestions for future research

- This study is not without limitations. However, given the time frame from 2013 to 2020 and since the statistical population is limited to companies listed on the Tehran Stock Exchange, generalization of the results to other companies should be done with caution. On the other hand, we did not examine banks, financial institutions, credit, or insurance institutions in this study. Also, the number of listed companies with multi-layer structures was low among the statistical population, which limited the statistical population. In addition, although the value-added coefficient of the intellectual capital (VAIC) model is widely used due to its reliance on available accounting data and comparability, its criticisms cannot be ignored. This model mainly focuses on the efficiency of converting costs into value added and may not be able to fully measure the stock or potential of intellectual capital (such as the quality of knowledge networks or thought leadership). Additionally, using marketing and R&D expenditures as proxies for customer capital and innovation, although practical, can limit the scope of these complex constructs. Researchers could address this measurement gap by combining VAIC with non-financial indicators (such as employee satisfaction, brand strength, number of patents, balanced scorecards, and rational models) or by employing qualitative methods and case studies to deepen quantitative findings. The operationalization of ownership variables, especially multi-level ownership, although based on the literature, is considered simplistic and does not reflect the full complexity of pyramidal ownership chains. Although an attempt was made to address endogeneity to some extent using the GMM method, the possibility of omitted variables and reverse causality remains a limitation.
- In future research, similar models could be tested in several emerging economies with different levels of institutional development, minority shareholder protection, and government presence to reveal the role of contextual variables. Such comparative studies can clarify whether the negative finding on innovation in pyramidal ownership is specific to Iran or a broader phenomenon in economies with concentrated ownership.

It is suggested that researchers:

- Use mixed methods (qualitative-quantitative) or qualitative indicators to measure intellectual capital more comprehensively.

- Focus on more detailed mapping of ownership chains and calculate indicators such as the separation between control rights and cash flow.
- Use more robust identification methods (such as robust instrumental variables or quasi-experimental designs) to infer causality.

In this study, we focused on the relationship between ownership and intellectual capital efficiency. The next logical step is to examine the interaction between ownership, intellectual capital, and Environmental, Social, and Governance (ESG) reporting or the Sustainable Development Goals (SDGs). Interesting future questions could include: Do companies with more efficient intellectual capital also have higher quality ESG reporting? Does the type of ownership (e.g., family versus institutional) affect this relationship? Additionally, one could examine whether intellectual capital disclosure can act as a corporate governance mechanism, influencing the preferences or behavior of large shareholders.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Author contributions

Mahdi Salehi: Conceptualization, investigation, supervision, draft writing, result interpretation, data collection, data analysis, original draft writing. Sahar Jabbari: Conceptualization, investigation, draft writing, result interpretation, data collection, data analysis, original draft writing. Grzegorz Zimon: Conceptualization, supervision, draft writing, data analysis and editing.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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