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Bank–Firm Relationships and Innovation Outcomes: Evidence from Categories and Quality[*]

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Abstract

This study examines the impact of bank–firm relationships on innovation outcomes by utilizing patent data from Japanese firms. Our results reveal that compared with other firms, (1) firms with closer relationships with banks are less likely to engage in high-risk innovation and that (2) firms that receive board member appointments or equity investment from banks tend to pursue exploitative innovation rather than exploratory innovation. Conversely, firms with greater dependence on loans from specific banks tend to exhibit greater R&D investment but produce fewer patents than do other firms. These findings suggest that while banks with close relationships with firms may encourage higher levels of R&D investment, they simultaneously impede the pursuit of high-quality and exploratory innovation.

JEL classifications: O31, O32, G21
Keywords: Innovation, Ambidextrous Management, Bank–Firm Relationships, Main Bank

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1. Introduction

Innovation serves as a cornerstone for sustainable growth and competitive advantage in firms. However, owing to the high levels of uncertainty, severe information asymmetry, and limited collateral value associated with innovation and R&D investments, financing methods play a critical role in shaping innovation direction and quality (Arrow, 1962; Damanpour, 1987; Katila & Shane, 2005; Levin et al., 1987; Mansfield et al., 1981; Schumpeter, 1942; Teece, 1986).[1] In particular, different financial instruments, such as debt and equity, entail different contractual structures, monitoring mechanisms and intervention processes, thereby shaping corporate governance in different ways (Williamson, 1988). Moreover, differences in risk preferences among financial providers (Jensen & Meckling, 1976) have been shown to influence the trajectory and direction of corporate R&D activities and innovation (Long & Ravenscraft, 1993; Brown et al., 2009; Choi et al., 2016).

From a risk preference and corporate governance perspective, the literature generally suggests that the use of debt tends to suppress firm innovation (Balakrishnan & Fox, 1993; Vincente-Lorente, 2001). However, unlike “transaction lending” (e.g., corporate bonds), which constitutes one type of debt, “relationship lending,” which includes bank loans based on long-term relationships, can mitigate liquidity risk via active monitoring, intervention, and renegotiation, thereby promoting corporate R&D expenditure (David et al. 2008). While prior research has focused largely on how the capital structure of the focal firm and its relationships with financial institutions influence corporate R&D expenditure, how bank–firm relationships affect innovation outcomes remains underexplored, with a few exceptions, such as Herrera and Minetti (2007).[2]

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[1] In fact, many empirical studies on the impact of differences in corporate financing methods on R&D investment have been carried out (Aghion et al. 2004; Brown et al. 2009; Carpenter & Petersen, 2002; Hall & Lerner, 2010; Hsu 2004).

[2] One related paper is Herrera and Minetti (2007), which examines the impact of the main banks in Italy on product and process innovation, showing that long-term bank–firm relationships have a

This study aims to shed light on the impact of bank–firm relationships on the categorization and qualitative dimensions of innovation, drawing on the theoretical framework that distinguishes “exploratory” innovation from “exploitative” innovation. According to March's (1991) theoretical framework, R&D activities can be categorized into two distinct investment modes—"exploration" and "exploitation."[3] Exploratory innovation involves venturing into unfamiliar domains and integrating knowledge across fields to create new market value, often accompanied by significant risk and uncertainty. In contrast, exploitative innovation emphasizes the efficient use of existing resources and tends to produce more stable, short-term outcomes. Given these differences, financial institutions’ risk tolerance and governance roles can play a decisive role in guiding firms’ innovation strategies.

If banks promote the risk-averse allocation of resources, then firms' R&D activities may be biased toward exploitation-oriented investments. In contrast, if banks establish long-term relationships with firms and show a willingness to tolerate risk, then they may also promote risky "exploratory" investments. Therefore, understanding how the depth of a bank–firm relationship influences the direction and quality of innovation is an important theoretical and empirical research question. Specifically, this research reevaluates the quality of innovation through the lens of exploration and exploitation while defining the strength of bank–firm relationships from three different perspectives—

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positive effect on promoting product innovation. Our study differs in that it (1) examines the quality of innovation based on the theoretical framework of March (1991) and (2) conceptualizes and examines the relationship between banks and firms not as a one-dimensional monetary lending relationship but as a multifaceted and structural connection involving executive secondments and equity ownership. These different perspectives enable us to address a more advanced and nuanced research question—namely, how banks with multifaceted relationships influence firms’ innovation strategies, including the categories and quality of innovation—and thereby contributes to extending the literature.

[3] The theoretical framework of exploration/exploitation has been examined theoretically and empirically to determine how to balance the two and what mechanisms can be used to promote exploration from an organizational and governance perspective (e.g., Benner & Tushman 2003, Rosenkopf & Nerkar 2001, Rothaermel & Deeds 2004, Siggelkow & Levinthal, 2003; Manso, 2011).

(i) the degree of reliance on bank borrowing, (ii) the degree of bank involvement in corporate boards, and (iii) the level of bank ownership of corporate stock. Each of these aspects is empirically analyzed to assess its influence on innovation outcomes.

This study uses a large dataset of Japanese firms spanning approximately 25 years from the early 1990s. There are several advantages to using Japanese data in this study. First, the use of Japanese patent data allows us to capture the timing of innovation accurately. Japan has consistently adopted a first-to-file patent system in which patent rights are granted to the party that files the application first (Cohen et al., 2002). As a result, firms are incentivized to patent their own innovations promptly once their innovations are generated (Cohen et al., 2002; Ordover, 1991). In contrast, the U.S. operated under a first-to-invent system until the 2013 legal reform, meaning that the timing of patent filings did not always reflect the actual timing of innovation (e.g., Scotchmer and Green, 1990; Hall and Harhoff, 2012). Furthermore, Japanese firms are more likely to patent their innovation than are their U.S. counterparts, leading to a greater degree of coverage of technological activities in the Japanese patent data (Nagaoka et al., 2010). For these reasons, Japanese patent data provide a suitable and relatively comprehensive source for analyzing corporate innovation quantitatively.

Second, like Germany, France, Italy, and South Korea, Japan features a bank-based financial system in which banks play a more central role in corporate financing than do countries with market-based systems, such as the U.S. and U.K. (Sasaki and Suzuki, 2019). The relationships between banks and industrial firms have remained remarkably stable over the long term. Moreover, Japan offers a particularly rich setting for analysis, as comprehensive data on bank lending, equity ownership, and board representation have long been available, enabling a nuanced examination of the multifaceted ties between banks and firms and their implications for innovation quality.

The results of this study show that (1) the total number of patent citations decreases, (2) the number of patents with many citations from other companies decreases, (3) the percentage of patents with no citations from other companies increases, (4) the scope of patents narrows, (5) the adoption of new patent technology fields decreases, (6) self-citations increase relative to citations from other companies, (7) R&D expenses increase, and (8) the number of patent applications decreases. These results remain robust, even when the entropy balancing matching method is used to address endogeneity issues and when a lagged model that accounts for the time between patent application and grant is used. These results are consistent with the idea that bank–firm relationships increase R&D investment but discourage high-risk and exploratory innovation while simultaneously encouraging exploitative innovation.

2. Related Literature and Hypotheses

2.1 Exploratory and Exploitative Innovation

Innovation constitutes a core element in achieving sustainable growth and establishing competitive advantage for firms. As Holmstrom (1989) noted, innovation is inherently a high-risk activity characterized by outcome uncertainty and long-term returns. Nevertheless, many firms willingly embrace such uncertainty and commit substantial resources toward the creation of new technologies and products. Underlying such decision-making is the recognition that securing long-term competitive advantage and generating economic value can be achieved only through innovative efforts (Chemmanur et al., 2018, 2019). In this sense, innovation is not merely a means through which to enhance short-term performance but also serves as a strategic core that determines the future trajectory of the firm.

Innovation strategies can be broadly categorized into two types—exploratory innovation and exploitative innovation (March 1991). Exploratory innovation is characterized by a departure from existing knowledge and skills and is driven by the acquisition of knowledge in previously unknown domains and the integration of knowledge across different fields. The primary aim of exploratory innovation is to create unprecedented products or services and generate new market value (Fleming, 2001; Zhu et al., 2022). The R&D processes involved in generating exploratory innovation are inherently complex, marked by high uncertainty and a significant risk of failure, thus requiring a long-term perspective and a high tolerance for uncertainty.

In contrast, exploitative innovation seeks to enhance efficiency and functionality within known domains by leveraging existing resources and knowledge (March, 1991; Ahuja & Lampert, 2001). Consequently, R&D processes aimed at exploitative innovation are relatively lower risk, have higher success rates, and are more likely to yield short-term results and operational stability (Lavie et al., 2010).

While exploratory innovation holds the potential for substantial long-term benefits, it tends to require a longer time horizon for commercialization than does exploitative innovation. Exploitative innovation, in contrast, is generally easier to monetize in the short term and is often associated with immediate profitability (Choi et al., 2016; McGrath, 2001; Schumpeter, 1934; Cao et al., 2009; Darr et al., 1995; Winter and Szulanski, 2001). In particular, for exploratory innovation, lengthy development periods and elevated risks necessitate considerable organizational resource investment (Lavie et al., 2010).

Nevertheless, as Benner and Tushman (2002) and He and Wong (2004) demonstrate, it is insufficient for firms to pursue only short-term outcomes through exploitative activities to achieve sustainable growth in dynamic competitive environments; securing innovativeness through exploratory activities is also essential. In practice, however, while an inclination toward exploitative innovation represents a natural organizational tendency, exploratory innovation is often constrained by institutional and structural barriers. Under such circumstances, firms are required to develop strong organizational capabilities to appropriately manage their engagement in exploratory innovation (Gibson & Birkinshaw, 2004; Manso, 2011). Furthermore, effective governance mechanisms—including external resource provisioning and the design of incentive structures—play a critical role in facilitating the success of exploratory activities (Manso, 2011; Wen et al., 2020).

2.2. Hypotheses

2.2.1. Risk aversion hypothesis

According to the risk aversion hypothesis, creditors have strong incentives to limit firms' engagement in high-risk investments. Creditors receive fixed returns on predetermined debt contracts, whereas shareholders enjoy residual profits as dividends or capital gains after interest payments to creditors. If the project fails and goes bankrupt, then both creditors and shareholders suffer losses, whereas shareholders reap most of the profits if the project is successful. This asymmetry in profit structures leads to conflicts of interest between creditors and shareholders regarding the firm's risk preferences (Jensen and Meckling, 1976).[4] Shareholder-appointed managers have an incentive to pursue investments that expect high returns through excessive risk-taking, whereas creditors seek to limit such excessive risk-taking.

Moreover, creditors may seek to minimize risk even if management is not taking excessive risk. The lower the degree of risk taken by companies is, the lower the costs incurred by banks for management involvement and monitoring, and the more rent banks can earn (Weinstein and Yafeh, 1998). Therefore, banks may use their power to encourage firms to shift these R&D investments to risk-averse investments. Several papers have shown that Japanese banks use their power to generate

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[4] Jensen and Meckling (1976) pointed out the "risk-shifting problem," in which creditors and shareholders have conflicting interests, and creditors demand a high risk premium to account for the possibility of managers who pursue shareholder interests after providing funds taking high risks.

additional rent through compensating balances, investment banking services, cash management services, and other means (Weinstein and Yafeh, 1998; Pinkowitz and Willliamson, 2001; Suzuki, 2010; Yasuda, 2007).

Furthermore, creditors may be reluctant to invest due to the nature of the results of R&D, investments in which often produce intangible assets with low collateral value (e.g., Gonas, Highfield, and Mullineax, 2004; Herrera and Minetti 2007; Berger and Udell 1990; Almeida and Campello 2007). Unlike tangible assets, intangible assets have limited liquid value and cannot serve as reliable collateral, making creditors reluctant to invest in R&D (Williamson, 1988). This finding also suggests that creditors have inherent incentives to restrict high-risk R&D investments.

Debt can be broadly categorized into "transactional debt" with high-level marketability, such as corporate bonds, and "relational debt" involving long-term, relationship-based lending by banks. These distinctions influence the nature and timing of creditor intervention in corporate governance. In the case of transactional debt, creditors manage firms according to contractual rules and intervene only when violations occur, avoiding discretionary intervention (Williamson, 1988). In contrast, banks that provide relational debt establish long-term relationships with firms and have greater flexibility to renegotiate, for example, by extending repayment periods, offering additional loans, or adjusting interest rates. In addition, banks can intervene at various points beyond breach of contract, including rollover periods, where they can change loan amounts, tighten covenants, shorten or extend maturities, or require higher down payments for new financing. For this reason, banks providing related loans are likely to exert a strong influence on companies.

In Japan, long-term and stable business relationships have been established between firms and banks, and the bank that functions as the largest lender is positioned as the "main bank" (Aoki & Patrick, 1994). As the primary lender, the main bank maintains corporate settlement and payment accounts, monitors corporate activities, and acts as a delegated monitor for other banks. The main bank often leads restructuring efforts in cases of financial distress, thereby exercising considerable influence over firms' strategic and financial decisions (Aoki & Patrick, 1994). This extensive influence suggests that the main bank's risk-averse orientation may discourage high-risk or exploratory innovation investments and instead encourage low-risk or exploitative innovation investments.

The main bank not only provides the largest loans but also actively engages in monitoring and corporate governance, including participation on the board of directors (Hoshi et al., 1990; Kaplan and Minton, 1994; Ferreira and Matos, 2012). The appointment of bank directors to corporate boards provides an opportunity for banks to participate directly in corporate decision-making, thereby gaining information beyond the mere lending relationship (Ferreira and Matos, 2012). By participating in board discussions and voting, banks can influence decision-making processes and intervene flexibly and frequently, even outside rollover situations. In Japan particularly, there are numerous reports of major banks dispatching directors to client firms to conduct monitoring (Aoki and Patrick, 1994; Hoshi et al., 1990; Kaplan and Minton, 1994).

Such monitoring through the dispatch of directors by main banks, when combined with contractual obligations, selective enforcement, and flexible renegotiation within long-term relationships, is likely to reflect banks' risk-averse investment orientation in corporate decision making. Building on this perspective, Ghosh (2016) empirically examines the impact of bank-appointed directors on R&D expenditures and finds that the presence of bank directors is negatively associated with firms' R&D expenditures. However, the impact of bank-appointed directors on the categorization and quality of innovation remains unclear.

In Japan, banks are permitted to hold direct equity interests in companies. When a bank, as a lender, also becomes a large shareholder, it takes on a dual role as both a shareholder and a creditor. Compared with pure shareholders, banks are more likely to behave conservatively and limit risk-taking (Weinstein and Yafeh, 1998). Moreover, both theoretical and empirical studies suggest that creditor shareholding can mitigate conflicts of interest between shareholders and creditors by internalizing risk-shifting concerns, thereby constraining firms' risk-taking (Chava et al., 2019; Dewatripont and Tirole, 1994; John et al., 1994; Ono et al., 2024).

When banks act purely as creditors, their interventions are generally limited to situations involving breaches of contract. However, when banks also act as shareholders, they can influence the firm through voting rights and manager selection. Such bank ownership, combined with control through financial contracts, selective enforcement, and flexible renegotiation over long-term relationships, is expected to better reflect banks' risk-averse preferences in corporate governance.

Innovation quality, particularly that measured by highly cited patents, is often associated with high levels of risk and technological uncertainty. Furthermore, exploratory R&D, which involves entry into unfamiliar technological domains, is inherently riskier than is exploitative R&D, which is focused on incremental improvements in existing capabilities (Rosenkopf and Nerkar, 2001; Katila and Ahuja, 2002). Given the risk-averse tendencies of creditors, banks that have close relationships with firms, e.g., those that have high-level loan dependency, board membership, and equity holdings, are likely to discourage risky innovation and pursue exploitative innovation rather than exploratory innovation.

Hypothesis 1-1: The closer the relationship between banks and companies is, the more companies stifle high-quality innovation.

Hypothesis 1-2: The closer the relationship between banks and firms is, the more firms tend to suppress exploratory innovation than they do exploitative innovation.

2.2.2. Risk-taking hypothesis

According to the risk-taking hypothesis, relationship lending by banks incentivizes firms to engage in high-risk investments. In general, high-risk investments are characterized by limited historical performance data and insufficient information about future prospects, which can exacerbate information asymmetry problems such as adverse selection and moral hazard (Arrow, 1962; Hall & Lerner, 2010; Levin et al., 1987; Mansfield et al., 1981; Schumpeter, 1942). Therefore, such investments are prone to capital constraints and are likely to cause underinvestment problems.

Relationship lending plays a crucial role in mitigating information asymmetries by collecting firm-specific information over the course of long-term relationships, thereby providing a comparative advantage over other capital providers (Boot & Thakor, 2000; Petersen & Rajan, 1995). A main bank can maintain a firm's transaction and payment accounts and continuously gather information through monitoring before, during, and even after loan disbursement (Aoki & Patrick, 1994). Thus, banks, by gaining a more accurate understanding of a firm’s risk profile and future potential, are better positioned to support and accommodate high-risk, high-return exploratory projects that would typically be avoided. This information advantage allows the main bank to mitigate information asymmetries and potentially encourage riskier investments by firms (Hoshi et al. 1991).

The main bank, which establishes a relationship as a long-term lead lender, can facilitate the renegotiation of debt contracts, such as extending repayment periods and providing additional loans, and can attempt to provide relief even in the event of default (Hosh et al. 1990; Sheard, 1995).[5] As a result, the main bank, on which the firm is highly dependent for long-term financing, has a strong influence on the firm's management strategy and financial policy (Aoki & Patrick, 1994). Therefore, the greater the degree of dependence on the main bank is, the more likely it is to promote risky

[5] Caballero et al. (2008) and Peek and Rosengren (2005) argue that Japanese banks, after the collapse of the bubble economy, continued to lend to companies that were unable to repay their debts (zombie companies), thereby preventing them from exiting the market, hindering industrial renewal, and delaying the recovery of the Japanese economy as a whole.

investments. Davide et al. (2008) verify that "relationship lending" by banks increases firms' R&D spending by mitigating problems of information asymmetry and uncertainty through monitoring and renegotiation. However, the impact of the high-level dependence of banks on the categorization and quality of innovation remains unclear.

In addition, the provision of directors to companies that receive loans from banks and the holding of shares by banks may encourage firms to take risks. When banks send directors to a firm, they can participate directly in the firm's decision-making processes, thereby gaining information that cannot be captured through the lending relationship alone (Ferreira & Matos, 2012). By combining monitoring, control through financial contracts, and flexible renegotiation within long-term relationships, banks can encourage risky innovation activities over a longer time horizon.

Moreover, banks that hold shares in firms act not only as creditors but also as shareholders. From the shareholder perspective, they tend to favor high-risk investments to benefit from the residual profits of companies (Mahrt-Smith, 2006). Yin et al. (2024) argue that equity connections are advantageous for lending relationships to increase technological innovation efficiency.

Innovation that attracts substantial attention often has a low-level probability of success; however, its impact can be profound when such innovation succeeds. Consequently, investing in such innovation is characterized by severe information asymmetries and heightened uncertainty. Therefore, close and long-term investor support is essential for promoting these investments. The risk-taking hypothesis predicts that the presence of banks, which have close relationships with firms through high-level loan dependency, board membership, and equity holdings to mitigate information problems, is likely to have a positive effect on the firm's investment in risky and exploratory innovation.

Hypothesis 2-1: The closer the relationship between banks and companies is, the more firms promote high-quality innovation.

Hypothesis 2-2: The closer the relationship between banks and firms is, the more firms tend to promote exploratory innovation than they do exploitative innovation.

3. Data and Methodology

3.1 Data

To test our hypotheses, we use panel data on Japanese listed firms from 1992 to 2024. Patents, which represent legally recognized innovation, are commonly used to quantify the quantity (Griliches, 1990; Cornaggia et al., 2015), quality (Balsmeier et al., 2017), and categories of innovation (Balsmeier et al., 2017; Choi et al. 2016). Building on prior research (e.g., Balsmeier et al., 2017), we use Japanese patent data as a proxy for the quantity, quality, and categories of innovation. We rely on the Institute of Intellectual Property (IIP) patent database provided by the IIP and restrict our sample to firms with patent data available through 2019 to allow for five-year-forward citation windows.

To examine the relationship between banks and firms, we collect firm-level data on loan amounts by bank, shareholder composition, and board structure. Loan data are sourced from *Nikkei NEEDS FinancialQuest*. Shareholder composition data are obtained from both *Nikkei NEEDS FinancialQuest* and *Toyo Keizai Shimposha*'s *Ookabunushi Soran*, whereas board composition data are taken from *Toyo Keizai Shimposha*'s *Yakuin Shikiho*. Firms that do not disclose information on bank-specific borrowing are treated as missing observations.

For the analysis of firm–bank loan relationships over a five-year horizon, we limit our sample to firms with available loan data beginning in 1996. Financial statement data are obtained from *Nikkei NEEDS FinancialQuest*, and stock price data are sourced from *Financial Data Solution*s. After excluding observations with missing values, our final dataset for the primary analysis consists of 2,077 firms and 28,260 firm-year observations from 1996 to 2019.

3.2 Variables

3.2.1. Dependent variable: High-risk innovation

Since patents are legally recognized inventions, the number of patents serves as a quantitative measure of innovation. However, this indicator does not directly capture the quality of innovation itself. In our study, the quality of innovation is represented by firms' innovation strategies, specifically their pursuit of exploratory or exploitative innovation. These strategic orientations reflect a more complex dimension of innovation than can be captured by the simple number of patent applications (Balsmeier Fleming Manso 2017). Instead, we use the quality of innovation to capture these strategic orientations. The quality of innovation is better assessed by characteristics such as the number of patent citations. This indicator provides valuable insights into the importance and impact of innovation (Cornaggia et al., 2015). The number of patent citations is particularly important because it reflects the extent to which a given patent serves as foundational knowledge for subsequent R&D, thereby acting as a proxy for technological impact (Jaffe and Trajtenberg, 2002; Cornaggia et al., 2015). To examine the effect of bank–firm relationships on high-risk innovation, we employ three variables as proxies for innovation quality—*#Citation*, *#Top10_pat, and the noncitation ratio*.

#Citation. #Citation is calculated as the natural logarithm of one plus the number of nonself forward citations that a patent application filed in year *t* received within five years of filing (i.e., ln(1 + number of forward citations excluding self-citations)) (Balsmeier et al., 2017; Harhoff, Narin, Scherer, and Vopel, 1999; Hall, Jaffe, and Trajtenberg, 2001, 2005; Sunder et al., 2017). The number of forward citations is a widely used indicator of a patent's technological impact, as it reflects the extent to which a given patent forms the foundation for subsequent R&D by other firms (e.g., Jaffe and Trajtenberg, 2002; Cornaggia et al., 2015).

#Top10_pat. According to Phene, Fladmoe-Lindquist, and Marsh (2006), breakthrough innovation refers to innovation that disrupts existing technological paradigms and opens new technological trajectories. Such innovations are critical for business transformation, firm growth, and the creation of new ventures. In contrast, important innovations may not always involve radical technological breakthroughs such as breakthrough innovations but still play a central role in technological advancement and serve as a foundational basis for numerous subsequent innovations. As a proxy for important innovation, we use the variable *#Top10_pat*. Following Balsmeier et al. (2017), *#Top10_pat* is defined as the natural logarithm of one plus the number of patents filed in year t that fall within the top 10% of forward citations (excluding self-citations) within the same application year and technology class, measured within five years of application (i.e., ln(1 + number of top 10% most-cited patents)).

Noncitation ratio. Following Balsmeier et al. (2017), we incorporate the notion that not all patents reflect high-impact or valuable innovation. Specifically, we consider the subset of patents that receive few or no forward citations from other patents, which are generally interpreted as indicators of low-risk, incremental, or marginal innovation efforts. Such patents typically contribute little to technological progress or market disruption and are therefore seen as having limited economic or strategic value. The noncitation ratio captures the prevalence of these low-value patents within a firm's overall patent portfolio. The *noncitation ratio* is computed as the natural logarithm of the ratio of one plus patents that receive zero forward citations from other firms to one plus the total number of patents filed by the firm.

3.2.2. Dependent variables: Exploratory and exploitative innovation

In addition, the qualitative characteristics of patents, such as the number of claims and the ranges of technological areas covered and of past technologies being searched from, are influenced by the categories of innovation pursued by firms. Innovation can generally be divided into two distinct categories—exploration and exploitation (March 1991; Zhu Jia, and Li, 2022). According to the literature, the essence of innovation often lies in the novel recombination of existing knowledge (Fleming, 2001). Exploration-oriented innovation is achieved through the integration of knowledge from different domains, whereas exploitation-oriented innovation results from the accumulation and refinement of existing knowledge. Thus, to capture explorative innovation activities and exploitative innovation activities, we employ three variables as proxies for explorative or exploitative innovation—*#Claims*, *#New fields,* and *Self-citation ratio*.

#Claims. As a proxy for the scope of innovation, we use *#Claims*, calculated as the natural logarithm of one plus the number of claims in patents filed by firm i in year t (i.e., ln(1 + patent claims)) (e.g., Balsmeier et al., 2017). A greater number of patent claims indicates broader technological scope, suggesting that the firm is applying for patents in more diverse or novel areas. Exploratory innovation also affects the number of claims in a patent and is often associated with a broader range of claims due to the multifaceted development of technological ideas and the consideration of different potential applications. Since patent claims delineate the scope of technological coverage, a greater number of claims generally indicates greater technological diversity and broader applicability (Lerner, 1994). Therefore, firms that engage in exploratory innovation tend to file patents with a greater number of claims because they address a wider range of technological challenges and market demands (Fleming and Sorenson, 2001).

#New fields. For this variable, we need to develop a measure that taps into the degree to which a firm explores new technologies that it has not used previously. We compute this variable using the technology classification provided by the World Intellectual Property Organization (WIPO)

technological classification system. Each patent is assigned a technological classification term indicating the subject to which the innovation is related. On the basis of a firm's prior patent history, we compute this variable as the number of new technology classes entered by a firm in the focal year, following prior studies (e.g., Ahuja and Lampart, 2001; Yang, Grove and Li, 2024). A firm is considered to have entered a new technology class when it first applies for a patent in a class in which it had not patented in the previous year. The presumption is that if a firm has not patented in a technology in the previous year, then that technology represents an unfamiliar technology for the firm. In other words, the number of new technology fields entered by a firm in a year reflects the overall degree of exploratory innovation. The variable *#New fields,* which captures the extent of technological exploration, is calculated as the natural logarithm of one plus the number of technology classes that are newly introduced by firm i in patents filed in year t (i.e., ln(1 + number of newly entered technology fields)) (e.g., Balsmeier et al., 2017).

This conceptualization aligns with prior literature that distinguishes between exploratory and exploitative innovation. Exploratory innovation tends to manifest itself in patent applications in new technological domains, representing a firm's entry into previously unexplored areas (Rosenkopf and Nerkar, 2001; Katila and Ahuja, 2002). Conversely, exploitative innovation is reflected by the presence of patent applications within existing technological domains, signifying the further refinement or incremental development of established technologies. Thus, the different natures of exploratory and exploitative innovation exert distinct influences on the technological composition of a firm's patent portfolio. Accordingly, firms entering a greater number of new technology fields are considered as engaging more intensively in exploratory innovation than in exploitative innovation.

Self-citation ratio. Rosenkopf and Nerkar (2001) argue that patterns of backward citations offer insights into whether a firm’s innovation search is externally oriented—seeking knowledge beyond the firm's boundaries—or internally focused, building upon its own existing knowledge base. In this context, backward self-citations can be interpreted as evidence of internal knowledge reuse. Trajtenberg et al. (1997) further suggest that firms that cite their own prior patents effectively leverage previous R&D investments to generate new innovation. This internal reuse of knowledge is commonly associated with exploitative innovation, which emphasizes incremental improvement and path dependence.

Supporting this perspective, Benner and Tushman (2002) distinguish self-citations from external citations and contend that self-citations represent the reinforcement of a firm’s established technological trajectory—again signaling exploitation rather than exploration. Choi et al. (2016) extend this idea by showing that backward self-citations offer a particularly reliable measure of exploitation-focused innovation, as they directly reflect the extent to which a firm draws on its own prior patents when developing new patents.

Following Balsmeier et al. (2017) and Choi et al. (2016) and incorporating the conceptual framework proposed by Lavie, Stettner, and Tushman (2010), we operationalize the firm's tendency to pursue exploitative innovation using a ratio-based metric. Specifically, we calculate the natural logarithm of one plus the number of self-backward citations divided by one plus the total number of backward citations for patent applications filed by firm *i* in year *t*—that is, ln{(1 + number of self-backward citations)/(1 + total number of backward citations)}. This measure allows us to quantify the degree to which firms rely on their own prior knowledge in the innovation process, thereby capturing their strategic orientation toward exploitation.

3.3 Models

In this study, we conduct regression analyses using the innovation quality variables described in the previous section—*#Citation, #Top10_pat, Noncitation ratio, #Claims, #New fields, and Self-citation ratio*—as dependent variables. The specification is as follows:

$$Innovation_{i,t} = \alpha_i + \beta_1 Bank_{i,t} + \beta_2 Size_{i,t} + \beta_3 R\&D_{i,t} + \beta_4 Cash_{i,t} + \beta_5 Leverage_{i,t} + \beta_6 ROA_{i,t} + \beta_7 TobinQ_{i,t} + \beta_8 \#Board_{i,t} + \beta_9 IPO_{i,t} + u_{i,t}$$

Bank denotes a key set of variables used to capture the nature of bank–firm relationships, which is central to testing our hypotheses. We employ five proxy variables—*BankLoan*, *BankEquity*, *BankBoard*, *BankRelation*, and *BankRelationD*.

Consistent with previous studies (e.g., Giannetti, 2012), *BankLoan* is calculated as the share of loans provided by the firm's main bank over the past five years in the total loan amount received by firm *i* during the same period. If the main bank that lent to firm *i* in year *t* was involved in a merger and acquisition (M&A) within the past five years, we aggregate the loan amounts across merged entities. Rather than indicating the absolute level of borrowing, *BankLoan* captures the degree of dependence on a specific bank. A higher value of *BankLoan* implies a longer-term and stronger lending relationship with a particular bank. The average value of *BankLoan* in our sample is 0.273, and the median is 0.247.

Following Yin, Du, and Chen (2024), the variable *BankEquity* is defined as the equity ownership ratio of a firm's main bank in year *t*.[6]

[6] In Japan, shareholders with at least 3% ownership possess substantially greater legal rights than do those with less than 3%[6]. Specifically, such shareholders are granted the right to submit shareholder proposals (Article 303 of the Companies Act), to request the dismissal of directors and auditors (Article 339), to inspect accounting records (Article 433), and to request the appointment of an inspector (Article 358). Among these, the rights to submit proposals and to request dismissals are particularly powerful, as they enable shareholders to exert pressure on the board of directors and

BankBoard is a dummy variable equal to 1 if, at year *t*, a director dispatched from the firm's main bank serves on the board of firm *i* and 0 otherwise. We observe that 19.5% of the firms in our sample have a bank-affiliated board member.

Finally, in line with the relationship lending literature emphasizing the importance of considering multiple aspects of bank–firm ties jointly (e.g., Giannetti, 2012; Elsas, 2005; Presbitero and Zazzaro, 2010), we construct *BankRelation* by summing the standardized values of *BankLoan*, *BankEquity*, and *BankBoard*. *BankRelationD* is a dummy variable that equals 1 if *BankRelation* takes a value greater than or equal to zero and 0 otherwise.

We use the following variables as controls. $Size_{i,t}$ is the natural logarithm of the total assets of firm *i* at the end of year *t,* and $R\&D_{i,t}$ is calculated as the ratio of R&D expenditures to total sales for firm *i* at the end of year *t* since these two variables are naturally positively related to firms' innovation activities (e.g., Balsmeier et al., 2017). $Cash_{i,t}$ is the ratio of cash and cash equivalents plus short-term securities to total assets. $Leverage_{i,t}$ is defined as the ratio of interest-bearing debt to total assets. These two variables account for financial constraints that are known to influence corporate innovation (e.g., Balsmeier et al., 2017). $ROA_{i,t}$ is calculated as operating income divided by total assets. $TobinQ_{i,t}$ is measured as the sum of the firm's market value of equity and total debt divided by total assets since we control for differences in growth opportunities (e.g., Balsmeier et al., 2017). $\#Board_{i,t}$ is the natural logarithm of the number of directors on the board, as we want to insulate the effect of the board from contemporary changes in the number of directors (e.g., Balsmeier et al., 2017). $IPO_{i,t}$ is a dummy variable equal to 1 if the firm is within 10 years of its initial public offering (IPO)

demand managerial reform/improvement. As such, shareholders with 3% or more ownership can have a strong influence on corporate governance.

and 0 otherwise, as younger firms may search in newer technological areas for innovation (e.g., Balsmeier et al., 2017). Table 1 presents the descriptive statistics for the sample used in this study.

Given that our hypothesis assumes a causal effect of bank–firm relationships on corporate innovation, we employ a fixed effects model based on equation (1). The fixed effects approach helps mitigate concerns regarding omitted variable bias—particularly from firm-specific, time-invariant factors such as corporate culture, which are typically difficult to observe. By controlling for unobserved heterogeneity across firms over time, this model reduces the degree of correlation between the explanatory variables and the error term, thereby minimizing estimation bias and addressing potential endogeneity in causal inference.

4. Results

4.1. High-risk innovation

Table 2 presents the results of fixed effects regression analyses, with *#Citation* as the dependent variable measured at time *t*. Models 1 through 5 employ alternative model specifications to examine the effects of bank–firm relationships. Specifically, Models 1 and 4 include *BankLoan*, Models 2 and 4 include *BankEquity*, and Models 3 and 4 include *BankBoard*. Model 4 incorporates all three explanatory variables—*BankLoan*, *BankEquity*, and *BankBoard*—simultaneously. Model 5 estimates the effect of *BankRelation* as a composite index.

As shown in Table 2, the explanatory variables corresponding to our theoretical expectations—*BankEquity* ($\beta = -2.584$, $p < 0.01$ in Model 2; $\beta = -2.297$, $p < 0.05$ in Model 4), *BankBoard* ($\beta = -0.071$, $p < 0.05$ in Model 3; $\beta = -0.061$, $p < 0.05$ in Model 4), and *BankRelation* ($\beta = -0.028$, $p < 0.01$ in Model 5)—consistently have negative and significant effects on *#Citation*. Although *BankLoan* does not exhibit significance in either Model 1 (β = -0.139, p = n.s.) or Model 4 (β = -0.109, p = n.s.), the estimated coefficients are negative in both cases.

Table 3 reports the results when *#Top10_pat* is used as the dependent variable, maintaining an identical model structure to that of Table 2. The results indicate that *BankLoan* (β = -0.143, $p < 0.05$ in Model 2; β = -0.125, $p < 0.05$ in Model 4), *BankEquity* (β = -1.685, $p < 0.01$ in Model 3; β = -1.500, $p < 0.05$ in Model 4), and *BankRelation* (β = -0.018, $p < 0.01$ in Model 5) generally exert negative and significant effects on *#Top10_pat*. While *BankBoard* shows only weak significance (β = -0.034, $p < 0.10$ in Model 3) or no significance (β = -0.027, p = n.s. in Model 4), its coefficients also remain negative across specifications. Since patents with the top 10% citation counts serve as proxies for important innovations that significantly advance existing technologies or business models and have broad industry or market-level impacts, these findings support our hypothesis that firms with closer relationships with banks are less likely to engage in important innovations than are other firms, as measured by highly cited patents.

Table 4 presents the results of fixed effects regression analyses using *Noncitation ratio* as the dependent variable measured at time t and adopting the same model specifications as those in Table 2. The estimation results reveal that *BankBoard* (β = 0.017, $p < 0.05$ in Model 3; β = 0.016, $p < 0.05$ in Model 4) and *BankRelation* (β = 0.005, $p < 0.01$ in Model 5) are positively and significantly associated with the *Noncitation ratio*, which is consistent with our theoretical prediction. Although *BankLoan* (β = 0.024, p = n.s. in Model 1; β = 0.020, p = n.s. in Model 4) and *BankEquity* (β = 0.266, p = n.s. in Model 2; β = 0.199, p = n.s. in Model 4) do not reach significance, their coefficients remain positive across specifications, aligning with our expectations. Given that patents receiving no citations from other patents are often regarded as low-value or marginal innovations with negligible contributions to technological advancement or market transformation, these findings provide further support for our hypothesis that firms with stronger bank relationships are more likely to engage in low-risk, less impactful innovation activities than are other firms.

4.2. Exploratory and exploitative innovation

Table 5 reports the results of fixed effects regression analyses using *#Claim* as the dependent variable measured at time *t*, with Models 1 through 5 following the same model specifications as those employed in Table 2. As shown across the models, while *BankLoan* does not exert a significant effect ($\beta = 0.157$, p = n.s. in Model 1; $\beta = 0.212$, p = n.s. in Model 4), the key explanatory variables aligned with our hypothesis—*BankEquity* ($\beta = -5.058$, $p < 0.01$ in Model 2; $\beta = -4.978$, $p < 0.01$ in Model 4), *BankBoard* ($\beta = -0.086$, $p < 0.05$ in Model 3; $\beta = -0.071$, p = n.s. in Model 4), and *BankRelation* ($\beta = -0.029$, $p < 0.05$ in Model 5)—consistently exhibit negative and, in most cases, significant associations with *#Claim*. The number of patent claims serves as an indicator of the breadth of a patent's technological scope, with a greater number of claims typically reflecting more explorative innovation, particularly in new or diverse technological domains. Accordingly, the observed negative relationship between bank–firm ties and the number of patent claims suggests that close bank relationships may constrain firms' capacity to pursue explorative innovation, potentially because of more conservative investment preferences or risk-averse strategic guidance from financial stakeholders.

Table 6 reports the results of fixed effects regression analyses using *#New fields* as the dependent variable, measured at time *t*, and following the same model specifications as those in Table 2. As indicated in Models 1 through 5, *BankLoan* does not have a significant effect ($\beta = 0.018$, p = n.s. in Model 1; $\beta = 0.029$, p = n.s. in Model 4). In contrast, the variables aligned with our theoretical framework—*BankEquity* ($\beta = -0.738$, $p < 0.05$ in Model 2; $\beta = -0.667$, $p < 0.10$ in Model 4), *BankBoard* (β = -0.030, $p < 0.05$ in Model 3; β = -0.028, $p < 0.05$ in Model 4), and *BankRelation* (β = -0.007, $p < 0.05$ in Model 5)—demonstrate consistently negative and significant effects.

Table 7 presents the results of fixed effects regression analyses using *Self-citation ratio* as the dependent variable, also measured at time *t*, with identical model specifications. As shown in Models 1 to 5, *BankLoan* again fails to yield a significant effect (β = -0.006, *p* = n.s. in Model 1; β = -0.026, *p* = n.s. in Model 4). Conversely, the other key variables—*BankEquity* (β = 1.650, $p < 0.01$ in Model 2; β = 1.548, $p < 0.05$ in Model 4), *BankBoard* (β = 0.042, $p < 0.05$ in Model 3; β = 0.036, $p < 0.10$ in Model 4), and *BankRelation* (β = 0.013, $p < 0.05$ in Model 5)—consistently exhibit positive and significant associations with the *Self-citation ratio*.

These findings suggest that closer bank–firm relationships—particularly those involving equity holdings and board representation—are associated with a reduced likelihood of entering new technological domains and a greater emphasis on exploitative innovation strategies. This situation implies that firms with stronger institutional ties to banks tend to favor innovation activities that build upon existing technological competencies rather than venturing into unexplored or emergent areas. In contrast, firms engaged in lending-only relationships with banks do not exhibit a clear shift toward exploitative innovation, implying that loan-based connections alone may not provide banks with sufficient leverage or incentives to influence the firm's strategic innovation orientation meaningfully.

4.3. R&D and quantity of innovation

R&D expenditure is an essential component of innovation-oriented investment. Table 8 presents the empirical results examining the impact of bank–firm relationships on R&D intensity. The dependent variable is defined as the ratio of R&D expenditure to sales in year *t*, multiplied by 100 to express it as a percentage. As shown in Models 1 and 4, a higher level of bank loans is significantly associated with increased R&D intensity (β = 0.387, p < 0.01 in Model 1; β = 0.406, p < 0.01 in Model 4). In contrast, the coefficients for *BankEquity* (β = –1.509, p=n.s. in Model 2; β = –1.747, p<0.10 in Model 4), *BankBoard* (β = –0.020, p=n.s. in Model 3; β = –0.020, p=n.s. in Model 4), and *BankRelation* (β = 0.006, p=n.s. in Model 5) are nonsignificant or very weakly significant. These findings suggest that a greater reliance on bank loans is associated with a greater allocation of financial resources toward R&D activities. This result is consistent with the argument of David et al. (2008), who emphasize the role of relational lending in alleviating firms' financial constraints.

The quantity of innovation can also be captured by the number of patent applications. Table 8 reports the empirical results examining the impact of bank–firm relationships on the quantity of innovation. The dependent variable is defined as the number of patent applications in year *t*. As shown in Models 6 and 10, the coefficients of *BankEquity* (β = –3.419, p<0.01. in Model 7; β = –3.288, p<0.01 in Model 9), *BankBoard* (β = –0.065, p<0.05 in Model 8; β = –0.055, p<0.10 in Model 9), and *BankRelation* (β = -0.024, p<0.01 in Model 10) are negatively significant. In contrast, a higher level of bank loans is not significantly associated with patent applications (β = 0.031, p =n.s. in Model 6; β = 0.068, p=n.s. in Model 9).

However, when viewed alongside the results reported in Tables 2 through 8—where bank–firm relationships are found to have a negative effect on the quality and quantity of innovation—these findings imply that an increase in R&D spending facilitated by bank loans does not necessarily translate into high-quality or exploratory innovation. In other words, while relationship-based bank financing may expand the scale of innovation input, it does not guarantee corresponding improvements in the strategic direction or impact of innovation output.

5. Robustness Checks

In addition to examining the effects of bank–firm relationships on dependent variables measured at time *t*, we also investigate their impact on outcomes observed at time *t+2*. The use of the *t+2* specification accounts for the potential lag between the establishment of bank–firm ties and the realization of R&D outcomes, which often requires a substantial amount of time due to the time-consuming nature of patent application and approval processes (e.g., Cornaggia et al., 2015). In this estimation, *#Citation*, *#Top10_pat*, *Noncitation ratio*, *#Claims*, *#New fields*, and *Self-citation ratio* are used as the dependent variables in Models 1 to 6, respectively. As shown in *Table 9*, *BankRelation* shows significant effects with the expected signs in most models—except when *Self-citation ratio* is used as the dependent variable—($\beta = -0.026$, $p < 0.01$ in Model 1; $\beta = -0.014$, $p < 0.05$ in Model 2; $\beta = 0.004$, $p < 0.05$ in Model 3; $\beta = -0.025$, $p < 0.05$ in Model 4; $\beta = -0.006$, $p < 0.10$ in Model 5; $\beta = 0.008$, p = n.s. in Model 6). These findings are consistent with the main results presented in the previous section. Please note, however, that ordinary least squares (OLS) regression results using *Bank* variables other than *BankRelation* are not reported here.

While the fixed effects models used in the previous section can control for firm-specific characteristics that remain constant over time, they are limited in addressing unobserved characteristics that vary over time. In addition, if observable covariates are systematically unbalanced between firms with high and low values of the *Bank* variables, then endogeneity bias may still arise. Therefore, fixed effects models alone cannot fully address the endogeneity associated with the *Bank* variables.

To mitigate concerns related to time-varying omitted variables and selection bias, our study employs the entropy balancing approach proposed by Hainmueller (2012). Specifically, we compare firms with close bank–firm relationships (treatment group) to those with weaker bank–firm ties (control group). The treatment group is defined as firms for which *BankRelationD* equals 1, whereas the control group consists of firms for which *BankRelationD* equals 0. *BankRelationD* is a dummy variable coded as 1 if *BankRelation* takes a value greater than or equal to zero and 0 otherwise. Entropy balancing optimally reweights the control group to match the covariate distribution of the treatment group, providing more precise adjustment than can conventional matching methods such as propensity score matching (Hainmueller, 2012).

The covariates used for entropy balancing matching include *the natural logarithm of assets*, *the ratio of tangible fixed assets*, *the ratio of cash holdings*, *ROA*, *Tobin's Q*, *leverage*, *R&D expenditures to assets*, *the natural logarithm of firm age*, and year fixed effects. To avoid simultaneity bias, we use covariate values measured at time $t-1$.

Table 10 reports the results of OLS regression analyses using the matched sample obtained through entropy balancing, where *#Citation*, *#Top10_pat*, *Noncitation ratio*, *#Claims*, *#New fields*, and *Self-citation ratio* are used as the dependent variables in Models 1 to 6, respectively. As shown in Table 10, in most cases—except for Model 4, where *#Claims* is used as the dependent variable—*BankRelationD* shows significant effects with the expected signs ($\beta = -0.068$, $p < 0.01$ in Model 1; $\beta = -0.048$, $p < 0.01$ in Model 2; $\beta = 0.017$, $p < 0.01$ in Model 3; $\beta = -0.056$, p = n.s. in Model 4; $\beta = -0.019$, $p < 0.10$ in Model 5; $\beta = 0.041$, $p < 0.05$ in Model 6). These results are consistent with the main findings provided in the previous section, even after potential endogeneity concerns are addressed via entropy balancing. Please note that OLS regression results using other *Bank* variables in place of *BankRelationD* are not reported here.

6. Discussion and conclusions

While prior research has emphasized primarily the quantitative dimension of bank financing—specifically, how loans support corporate R&D investment (e.g., Brancati 2015; David et al. 2008)—this study takes a step further by focusing on the categories and quality of corporate innovation, incorporating a typological perspective that distinguishes high-risk innovation from low-risk innovation and exploratory innovation from exploitative innovation. Specifically, we examine how lending relationships with specific banks and more involved governance mechanisms, such as equity ownership and board representation by specific banks, affect innovation outcomes.

The empirical findings reveal that firms with stronger ties to banks are significantly less likely to pursue high-risk, high-impact, and exploratory innovation, as indicated by the lower number of highly cited patents and reduced activity in novel technological domains. Instead, those firms are more likely to pursue low-impact and exploitative innovation, as indicated by the ratio of zero-count forward citations from others and the ratio of self-backward citations. These results suggest that a risk-averse stance by banks encourages firms to adopt risk-averse, exploitative innovation strategies.

Furthermore, these effects are equally evident when banks hold substantial equity stakes and appoint directors to the firm's board. This suggests that direct involvement in corporate governance, through ownership and board representation, enhances banks' influence over firms' strategic innovation decisions. These results remain robust even after entropy balancing matching techniques that control for observable firm-level covariates, such as firm size, financial structure, governance attributes, and performance, are employed.

Conversely, firms with greater reliance on bank debt tend to exhibit greater R&D spending but fewer patents. This finding suggests that relational lending alleviates financial constraints and facilitates resource allocation toward innovation activities. However, the lack of corresponding improvement in innovation quality or exploratory output indicates a potential disjunction between the quantity of financing and the quality of innovation outcomes. In other words, increased access to capital does not necessarily translate into bold or disruptive innovation, especially under conditions of bank-centered governance oversight.

Our contributions are twofold. The first theoretical contribution of this study lies in its empirical identification and conceptual integration of two competing hypotheses traditionally debated in the finance and corporate governance literature—namely, the view that "banks are risk-averse creditors that tend to suppress high-risk investment behavior by borrowing firms" (Jensen & Meckling, 1976; Weinstein & Yafeh, 1998) and the opposing view that "banks, by leveraging their informational advantage, can support and even encourage high-risk investments undertaken by their borrowers" (Boot & Thakor, 2000; Petersen & Rajan, 1995; Hoshi et al., 1991). This study distinguishes between these competing perspectives by focusing on the qualitative characteristics of innovation and the strategic orientation of firms toward exploratory versus exploitative innovation.

While prior studies have examined predominantly the impact of bank relationships on aggregated and undifferentiated innovation inputs, such as R&D expenditure (e.g., David et al. 2008), the risk profile and novelty of the innovation cannot be inferred merely from the amount spent (Choi et al., 2016; Lavie et al., 2010). The effect predicted by banks' informational advantage is theoretically more likely to manifest in the direction of resource allocation and preference for innovation risk profiles than in the overall volume of financing provided (Boot & Thakor, 2000). Therefore, assessing the validity of these competing hypotheses solely through changes in R&D spending is inherently limited.

Accordingly, this study argues that understanding how bank–firm relationships influence corporate innovation activities requires shifting the analytical focus from the "quantity" of investment toward the "quality" of innovation outcomes and the strategic "direction" of firms' innovation efforts (Balsmeier et al., 2017; Cornaggia et al., 2015).

Second, previous studies have focused primarily on the loan-based dimension of bank–firm relationships when their effects on corporate outcomes are analyzed (Brancati, 2015; Herrera &

Minetti, 2007). These studies have demonstrated that relationship lending can alleviate firms' financial constraints and enhance monitoring by banks (David et al., 2008). However, such analyses are theoretically limited in that they conceptualize bank–firm relationships solely within a lender–borrower framework. While more recent studies suggest that the stable and long-term nature of relationship lending may have a positive effect on firms (Herrera & Minetti, 2007; Boot & Thakor, 2000), they fall short in capturing the active governance roles that banks may play within corporate structures.

To address these limitations, our study redefines bank–firm relationships as a comprehensive construct that includes not only credit ties but also the extent of governance involvement—such as equity ownership and the appointment of bank-affiliated directors. Specifically, this research highlights the role of banks not only as providers of external capital but also as influential actors in corporate governance and decision-making. This study further quantifies these roles and empirically investigates their relationship with firms' innovation outcomes (Hoshi et al., 1990; Kaplan & Minton, 1994; Ferreira & Matos, 2012). This framework advances our understanding of governance mechanisms in bank-centered economies and reveals the multifaceted roles of banks—beyond capital provision—that are overlooked in traditional financial models (Jensen & Meckling, 1976; Boot & Thakor, 2000; Aoki & Patrick, 1994).

This study has a wide range of practical implications. For firms, maintaining long-term relationships with banks presents certain advantages, particularly in securing the stable funding necessary for R&D investments (Petersen & Rajan, 1994; 1995). However, it is also important to recognize that banks' strong emphasis on risk aversion may hinder firms' growth opportunities and the attainment of competitive advantage (Hall and Lerner, 2010; Kerr & Nanda, 2009). This concern becomes especially salient when banks engage deeply in corporate decision-making through board appointments or substantial equity holdings, as such governance involvement may suppress high-risk, exploratory innovation and impose strategic constraints that limit the scope of technological choices.

From the banks' perspective, developing a framework for assessing not only the quantitative dimensions of innovation and the size of R&D investments but also the qualitative outcomes and the long-term value creation potential of innovation activities is becoming increasingly important (e.g., Amore et al., 2013). In knowledge-intensive industries, where intangible assets such as patents constitute key value drivers, conventional collateral-based evaluations are insufficient. Instead, insights into the future potential of technologies and firms' exploratory capabilities are essential. This situation necessitates a departure from traditional lending practices that prioritize tangible collateral and calls for the development of new evaluation standards capable of capturing the latent value of intellectual assets. To support such a transformation, financial institutions must also revisit their talent development and performance evaluation systems. A fundamental shift, from frameworks centered on minimizing credit risk to those that emphasize an understanding of corporate strategy and foresight into innovation potential, is required. Additionally, the establishment of institutional mechanisms that facilitate information sharing and the formation of a common understanding of risk between corporate managers and bank officers are likely critical factors in fostering innovation (Petersen & Rajan, 1995).

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Table 1. Summary statistics

	Variable	Mean	SD	1	2	3	4	5	6	8	10	11	13	14	15	16	17	18	19
1.	*#Citation*	1.48	1.85																
2.	*#Top10_pat*	0.78	1.25	.96															
3.	*#Claims*	2.72	2.57	.92	.84														
4.	*New fields*	0.56	0.61	.63	.54	.73													
5.	*Withdrawn fields*	0.56	0.62	.56	.49	.61	.47												
6.	*BankLoan*	0.27	0.16	-.31	-.32	-.26	-.19	-.19											
7.	*BankEquity*	0.03	0.02	.08	.04	.09	.12	.11	.03										
8.	*BankBoard*	0.22	0.41	.01	.00	.00	.00	.01	.06	.27									
9.	*BankRelation*	0.00	1.93	-.11	-.14	-.09	-.04	-.04	.57	.67	.69								
10.	*Size*	9.81	1.73	.52	.53	.49	.32	.30	-.41	-.08	-.04	-.27							
11.	*R&D*	0.02	0.02	.33	.30	.37	.20	.20	.00	-.01	-.01	-.01	.13						
12.	*Cash*	0.15	0.11	-.13	-.13	-.13	-.12	-.13	.20	-.14	-.03	.02	-.14	.14					
13.	*Leverage*	0.26	0.17	.04	.06	-.01	.01	.02	-.24	.01	.07	-.08	.02	-.09	-.31				
14.	*ROA*	0.04	0.05	.01	.02	.01	-.02	-.04	-.01	-.13	-.05	-.10	.24	-.05	.14	-.26			
15.	*TobinQ*	1.10	0.58	.00	.02	-.02	-.04	-.06	.03	-.21	-.05	-.12	.26	.10	.26	.00	.33		
16.	*#Board*	2.19	0.46	.37	.37	.32	.25	.24	-.32	.18	.11	-.01	.54	-.03	-.21	.14	-.03	-.04	
17.	*IPO*	0.19	0.39	-.19	-.18	-.22	-.18	-.18	.14	-.24	-.05	-.08	-.25	.00	.20	-.02	.12	.21	-.24

N=28,260.

Table 2. Effect of bank–firm relationships on the number of forward patent citations

	$\#Citation_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	-0.139			-0.109	
	(-1.449)			(-1.134)	
BankEquity		-2.584***		-2.297**	
		(-2.668)		(-2.369)	
BankBoard			-0.071**	-0.061**	
			(-2.346)	(-2.000)	
BankRelation					-0.028***
					(-3.424)
Size	0.288***	0.290***	0.290***	0.286***	0.284***
	(5.484)	(5.519)	(5.468)	(5.460)	(5.411)
R&D	2.808**	2.684**	2.722**	2.727**	2.772**
	(2.489)	(2.381)	(2.410)	(2.415)	(2.452)
Cash	-0.318**	-0.302**	-0.316**	-0.315**	-0.321**
	(-2.079)	(-1.968)	(-2.056)	(-2.058)	(-2.096)
Leverage	-0.249**	-0.223*	-0.234*	-0.220*	-0.227*
	(-2.021)	(-1.806)	(-1.905)	(-1.778)	(-1.847)
ROA	-0.404**	-0.410**	-0.395**	-0.398**	-0.394**
	(-2.023)	(-2.054)	(-1.974)	(-1.989)	(-1.975)
TobinQ	0.033	0.031	0.032	0.030	0.031
	(1.584)	(1.516)	(1.555)	(1.486)	(1.502)
#Board	0.102**	0.109**	0.110***	0.115***	0.113***
	(2.393)	(2.567)	(2.581)	(2.694)	(2.653)
IPO	-0.088**	-0.093***	-0.089**	-0.093***	-0.092***
	(-2.508)	(-2.681)	(-2.533)	(-2.679)	(-2.618)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.107	0.108	0.108	0.109	0.109
Observations	28,260	28,260	28,260	28,260	28,260

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 3. Effect of bank–firm relationships on important innovations

	$\#Top10\_pat_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	-0.143**			-0.125**	
	(-2.484)			(-2.193)	
BankEquity		-1.685***		-1.500**	
		(-2.665)		(-2.375)	
BankBoard			-0.034*	-0.027	
			(-1.682)	(-1.311)	
BankRelation					-0.018***
					(-3.362)
Size	0.158***	0.161***	0.161***	0.156***	0.157***
	(4.607)	(4.680)	(4.648)	(4.581)	(4.565)
R&D	2.209***	2.104***	2.132***	2.161***	2.161***
	(2.933)	(2.803)	(2.833)	(2.870)	(2.870)
Cash	-0.190*	-0.176*	-0.184*	-0.186*	-0.188*
	(-1.860)	(-1.722)	(-1.797)	(-1.830)	(-1.846)
Leverage	-0.128	-0.110	-0.119	-0.111	-0.113
	(-1.599)	(-1.364)	(-1.485)	(-1.376)	(-1.406)
ROA	-0.227*	-0.232*	-0.224*	-0.225*	-0.222*
	(-1.779)	(-1.816)	(-1.750)	(-1.760)	(-1.736)
TobinQ	0.013	0.012	0.012	0.011	0.012
	(0.972)	(0.904)	(0.956)	(0.880)	(0.891)
#Board	0.099***	0.103***	0.103***	0.105***	0.106***
	(3.374)	(3.551)	(3.499)	(3.602)	(3.625)
IPO	-0.072***	-0.075***	-0.073***	-0.075***	-0.074***
	(-3.197)	(-3.386)	(-3.216)	(-3.376)	(-3.315)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.074	0.075	0.074	0.075	0.075
Observations	28,260	28,260	28,260	28,260	28,260

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 4. Effect of bank–firm relationships on the noncitation ratio

	Noncitation ratio$_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	0.024			0.020	
	(1.070)			(0.864)	
BankEquity		0.266		0.199	
		(1.241)		(0.918)	
BankBoard			0.017**	0.016**	
			(2.561)	(2.390)	
BankRelation					0.005***
					(2.799)
Size	-0.029***	-0.030***	-0.030***	-0.029***	-0.029***
	(-3.007)	(-3.062)	(-3.024)	(-2.973)	(-2.951)
R&D	0.168	0.185	0.184	0.178	0.174
	(0.641)	(0.707)	(0.703)	(0.679)	(0.663)
Cash	0.078**	0.076**	0.078**	0.078**	0.078**
	(2.152)	(2.092)	(2.147)	(2.167)	(2.170)
Leverage	0.050*	0.047*	0.047*	0.046	0.047*
	(1.785)	(1.676)	(1.673)	(1.637)	(1.652)
ROA	0.062	0.063	0.060	0.060	0.060
	(1.016)	(1.030)	(0.977)	(0.978)	(0.988)
TobinQ	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*
	(-1.821)	(-1.800)	(-1.798)	(-1.778)	(-1.775)
#Board	-0.014	-0.015	-0.016*	-0.016*	-0.016*
	(-1.564)	(-1.643)	(-1.779)	(-1.812)	(-1.780)
IPO	0.017*	0.017*	0.017*	0.017*	0.017*
	(1.729)	(1.789)	(1.746)	(1.787)	(1.792)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.075	0.075	0.075	0.076	0.076
Observations	28,185	28,185	28,185	28,185	28,185

t Statistics with firm-clustered standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

Table 5. Effect of bank–firm relationships on the number of patent claims

	#Claims$_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	0.157			0.212	
	(1.121)			(1.512)	
BankEquity		-5.058***		-4.978***	
		(-3.672)		(-3.594)	
BankBoard			-0.086**	-0.071	
			(-1.977)	(-1.629)	
BankRelation					-0.029**
					(-2.506)
Size	0.613***	0.604***	0.606***	0.609***	0.600***
	(8.404)	(8.328)	(8.263)	(8.411)	(8.247)
R&D	7.085***	7.050***	7.138***	6.932***	7.193***
	(4.395)	(4.389)	(4.412)	(4.333)	(4.448)
Cash	-0.530**	-0.526**	-0.546***	-0.518**	-0.552***
	(-2.575)	(-2.558)	(-2.654)	(-2.526)	(-2.683)
Leverage	-0.434**	-0.397**	-0.426**	-0.381**	-0.421**
	(-2.463)	(-2.251)	(-2.414)	(-2.168)	(-2.381)
ROA	-0.808***	-0.811***	-0.790***	-0.804***	-0.792***
	(-2.744)	(-2.765)	(-2.685)	(-2.734)	(-2.693)
TobinQ	0.071**	0.068**	0.070**	0.067**	0.069**
	(2.079)	(1.989)	(2.050)	(1.972)	(2.025)
#Board	-0.001	0.011	0.008	0.019	0.009
	(-0.017)	(0.182)	(0.138)	(0.323)	(0.162)
IPO	0.134***	0.124**	0.133***	0.124**	0.131***
	(2.666)	(2.499)	(2.660)	(2.492)	(2.615)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.037	0.039	0.038	0.040	0.038
Observations	28,174	28,174	28,174	28,174	28,174

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 6. Effect of bank–firm relationships on new technology fields

	New fields$_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	0.018			0.029	
	(0.523)			(0.821)	
BankEquity		-0.738**		-0.667*	
		(-2.079)		(-1.856)	
BankBoard			-0.030**	-0.028**	
			(-2.486)	(-2.297)	
BankRelation					-0.007**
					(-2.428)
Size	0.111***	0.110***	0.110***	0.110***	0.108***
	(7.397)	(7.360)	(7.299)	(7.390)	(7.262)
R&D	0.628	0.621	0.629	0.601	0.645
	(1.453)	(1.438)	(1.454)	(1.390)	(1.491)
Cash	-0.106*	-0.106*	-0.110*	-0.106*	-0.111*
	(-1.858)	(-1.843)	(-1.920)	(-1.854)	(-1.933)
Leverage	-0.105**	-0.099**	-0.101**	-0.095**	-0.101**
	(-2.297)	(-2.175)	(-2.214)	(-2.090)	(-2.207)
ROA	-0.189**	-0.190**	-0.184**	-0.185**	-0.185**
	(-2.069)	(-2.076)	(-2.011)	(-2.031)	(-2.029)
TobinQ	0.011	0.010	0.011	0.010	0.010
	(1.232)	(1.180)	(1.198)	(1.158)	(1.178)
#Board	-0.016	-0.014	-0.013	-0.012	-0.013
	(-1.058)	(-0.945)	(-0.854)	(-0.760)	(-0.883)
IPO	0.015	0.013	0.014	0.013	0.014
	(1.125)	(1.021)	(1.110)	(1.015)	(1.064)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.011	0.011	0.011	0.012	0.011
Observations	28,185	28,185	28,185	28,185	28,185

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 7. Effect of bank–firm relationships on the self-citation ratio

	Self-citation ratio$_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
BankLoan	-0.006			-0.026	
	(-0.083)			(-0.368)	
BankEquity		1.650***		1.548**	
		(2.596)		(2.425)	
BankBoard			0.042**	0.036*	
			(2.048)	(1.778)	
BankRelation					0.013**
					(2.481)
Size	-0.173***	-0.171***	-0.171***	-0.171***	-0.169***
	(-5.970)	(-5.930)	(-5.893)	(-5.945)	(-5.831)
R&D	-0.722	-0.689	-0.714	-0.669	-0.740
	(-1.006)	(-0.957)	(-0.995)	(-0.931)	(-1.031)
Cash	0.112	0.107	0.116	0.109	0.118
	(1.084)	(1.039)	(1.121)	(1.057)	(1.142)
Leverage	0.101	0.087	0.095	0.082	0.093
	(1.174)	(1.013)	(1.105)	(0.956)	(1.076)
ROA	0.437**	0.439***	0.430**	0.433**	0.431**
	(2.573)	(2.588)	(2.533)	(2.553)	(2.538)
TobinQ	-0.023	-0.022	-0.023	-0.022	-0.022
	(-1.141)	(-1.090)	(-1.121)	(-1.077)	(-1.099)
#Board	-0.008	-0.012	-0.012	-0.016	-0.013
	(-0.302)	(-0.453)	(-0.479)	(-0.603)	(-0.496)
IPO	-0.046*	-0.043	-0.046*	-0.043	-0.045*
	(-1.735)	(-1.623)	(-1.722)	(-1.617)	(-1.682)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.012	0.013	0.013	0.013	0.013
Observations	28,260	28,260	28,260	28,260	28,260

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 8. Effect of bank–firm relationships on R&D intensity and patent applications

	$R\&D_t*100$					$\#Patent_t$				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
BankLoan	0.387***			0.406***		0.031			0.068	
	(3.498)			(3.648)		(0.313)			(0.703)	
BankEquity		-1.509		-1.747*			-3.419***		-3.288***	
		(-1.426)		(-1.662)			(-3.440)		(-3.296)	
BankBoard			-0.020	-0.020				-0.065**	-0.055*	
			(-0.610)	(-0.615)				(-2.102)	(-1.736)	
BankRelation					0.006					-0.024***
					(0.659)					(-2.872)
Size	-0.023	-0.035	-0.035	-0.024	-0.032	0.411***	0.407***	0.408***	0.408***	0.403***
	(-0.434)	(-0.669)	(-0.659)	(-0.459)	(-0.619)	(7.441)	(7.383)	(7.325)	(7.435)	(7.308)
R&D						5.069***	5.010***	5.067***	4.966***	5.111***
						(4.394)	(4.356)	(4.379)	(4.327)	(4.422)
Cash	0.493**	0.474**	0.468**	0.497**	0.472**	-0.323**	-0.316**	-0.330**	-0.316**	-0.335**
	(2.348)	(2.241)	(2.213)	(2.376)	(2.237)	(-2.187)	(-2.136)	(-2.231)	(-2.145)	(-2.267)
Leverage	-0.469***	-0.468***	-0.478***	-0.451***	-0.485***	-0.261**	-0.234*	-0.253**	-0.226*	-0.248**
	(-3.187)	(-3.158)	(-3.228)	(-3.058)	(-3.268)	(-2.129)	(-1.905)	(-2.057)	(-1.834)	(-2.015)
ROA	-5.269***	-5.272***	-5.268***	-5.266***	-5.274***	-0.544***	-0.548***	-0.533***	-0.540***	-0.533***
	(-11.899)	(-11.881)	(-11.872)	(-11.892)	(-11.890)	(-2.857)	(-2.884)	(-2.795)	(-2.840)	(-2.803)
TobinQ	0.108***	0.107***	0.108***	0.107***	0.108***	0.032	0.029	0.031	0.029	0.030
	(3.353)	(3.343)	(3.356)	(3.322)	(3.379)	(1.619)	(1.513)	(1.584)	(1.492)	(1.542)
#Board	0.007	0.010	0.008	0.013	0.004	0.033	0.041	0.040	0.047	0.042
	(0.189)	(0.264)	(0.222)	(0.362)	(0.105)	(0.764)	(0.956)	(0.929)	(1.095)	(0.968)
IPO	0.073*	0.071*	0.073*	0.069*	0.074*	0.048	0.042	0.048	0.042	0.046
	(1.909)	(1.868)	(1.926)	(1.827)	(1.948)	(1.426)	(1.251)	(1.415)	(1.245)	(1.356)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

R-squared	0.106	0.104	0.104	0.106	0.104	0.041	0.044	0.042	0.044	0.043
Observations	28,260	28,260	28,260	28,260	28,260	28,185	28,185	28,185	28,185	28,185

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 9. Effect of bank–firm relationships on innovation outcomes at t+2

	T+2					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	*#Citation$_{t+2}$*	*#Top10_pat$_{t+2}$*	*Noncitation ratio$_{t+2}$*	*#Claims$_{t+2}$*	*#New fields$_{t+2}$*	*Self-citation ratio$_{t+2}$*
BankRelation	-0.026***	-0.014**	0.004**	-0.025**	-0.006*	0.008
	(-3.037)	(-2.435)	(2.362)	(-2.183)	(-1.953)	(1.540)
Size	0.162***	0.077**	-0.012	0.526***	0.089***	-0.175***
	(3.406)	(2.504)	(-1.337)	(7.891)	(6.355)	(-6.257)
R&D	1.182	1.055	0.221	5.772***	0.390	-0.499
	(0.965)	(1.262)	(0.892)	(3.355)	(0.970)	(-0.690)
Cash	-0.335**	-0.203*	0.086**	-0.416**	-0.047	0.145
	(-2.158)	(-1.943)	(2.378)	(-2.056)	(-0.876)	(1.394)
Leverage	-0.194	-0.131	0.031	-0.475***	-0.133***	0.093
	(-1.597)	(-1.577)	(1.174)	(-2.918)	(-3.050)	(1.148)
ROA	-0.168	-0.207	0.091	0.220	-0.178**	0.246
	(-0.850)	(-1.535)	(1.613)	(0.784)	(-2.016)	(1.493)
TobinQ	0.046**	0.027**	-0.011**	0.064**	0.017**	-0.030*
	(2.432)	(2.197)	(-2.140)	(2.199)	(2.109)	(-1.898)
#Board	0.145***	0.134***	-0.014	-0.042	-0.021	0.040
	(3.408)	(4.539)	(-1.550)	(-0.716)	(-1.377)	(1.585)
IPO	-0.195***	-0.144***	0.028***	0.095**	0.009	-0.014
	(-5.829)	(-6.608)	(3.111)	(2.023)	(0.670)	(-0.517)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.176	0.122	0.117	0.028	0.010	0.024
Observations	28,186	28,186	28,109	28,100	28,109	28,186

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.

Table 10. Effect of bank–firm relationships on innovation outcomes after entropy balancing matching

	After entropy balancing matching					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	*#Citation$_t$*	*#Top10_pat$_t$*	*Noncitation ratio$_t$*	*#Claims$_t$*	*#New fields$_t$*	*Self-citation ratio$_t$*
BankRelationD	-0.068***	-0.048***	0.017***	-0.056	-0.019*	0.041**
	(-2.708)	(-3.011)	(2.777)	(-1.587)	(-1.815)	(2.299)
Size	0.227***	0.122***	-0.022**	0.570***	0.105***	-0.161***
	(4.667)	(4.045)	(-2.055)	(8.512)	(6.596)	(-5.237)
R&D	1.867*	1.458**	0.082	5.886***	0.558	-0.474
	(1.806)	(2.110)	(0.296)	(4.074)	(1.212)	(-0.603)
Cash	-0.322**	-0.201**	0.080**	-0.587***	-0.106*	0.153
	(-2.081)	(-2.044)	(1.994)	(-2.921)	(-1.742)	(1.384)
Leverage	-0.201*	-0.107	0.052*	-0.492***	-0.132***	0.142
	(-1.681)	(-1.474)	(1.663)	(-2.861)	(-2.705)	(1.534)
ROA	-0.561***	-0.314**	0.092	-1.245***	-0.253**	0.618***
	(-2.682)	(-2.493)	(1.339)	(-4.102)	(-2.431)	(3.364)
TobinQ	0.053**	0.027*	-0.016**	0.076**	0.015	-0.016
	(2.326)	(1.895)	(-2.150)	(2.072)	(1.460)	(-0.708)
#Board	0.114***	0.101***	-0.017*	0.020	0.003	-0.015
	(3.042)	(4.213)	(-1.785)	(0.372)	(0.175)	(-0.525)
IPO	-0.078**	-0.058***	0.012	0.116**	0.005	-0.046
	(-2.441)	(-3.063)	(1.094)	(2.557)	(0.356)	(-1.642)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.844	0.829	0.473	0.842	0.515	0.622
Observations	27,879	27,879	27,806	27,795	27,806	27,879

t Statistics with firm-clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, and * p<0.1.