Investor experience and innovation performance : the mediating role of external cooperation

Boh, Wai Fong; Huang, Cheng‑Jen; Wu, Anne

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Investor Experience and Innovation Performance:

The Mediating Role of External Cooperation

Wai Fong Boh*
Nanyang Technological University
Nanyang Business School
S3-B2A-14, Nanyang Avenue
Singapore 639798
Singapore
Email: awfboh@ntu.edu.sg
Tel : (65) 6790-6196
Fax : (65) 6792-4217

Cheng-Jen Huang
Tunghai University
Department of Accounting
Box 979, No. 1727, Sec. 4, Xitun Dist., Taiwan Boulevard
Taichung 40744
Taiwan (R.O.C)
Email: cj0623@thu.edu.tw
Tel : (886) 42703-7156
Fax : (886) 42359-8765

Anne Wu
National Chengchi University
Department of Accounting
NO.64, Sec.2, ZhiNan Rd.,Wenshan District
Taipei City 11605
Taiwan (R.O.C)
Email: anwu@nccu.edu.tw
Tel : (886) 22939-3091
Fax : (886) 229387104

*Corresponding Author

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Two-Part Abstract

Research Summary:

We add to the literature examining the ownership-innovation relationship by examining two major investor types: corporate investors and family investors. We use organizational environmental scanning as a new perspective to understand how these investors' capabilities influence firms' external cooperation and innovation performance. We found that corporate investors with broad investment experience strengthen a firm's environmental scanning, enhancing innovation performance by increasing the number of external cooperation activities the firm engages in. Conversely, family investors' broad investment experience tend to be negatively associated with the number of external cooperations and with firm innovation. Our results show that investors influence firm innovation not simply through a monitoring role but also by affecting firms' abilities to innovate, once we factor in the types of investors and their capabilities.

Managerial Summary:

We investigate how two different types of investors, corporate and family, influence the innovation performance of publicly-traded high-tech firms in Taiwan. We found that the presence of major corporate investors with broad investment experience enhances firms' innovation performance by increasing external cooperation activities firms engage in. Corporate investors appear to enhance organizations' environmental scanning abilities and, in turn, their innovation performance. Conversely, family investors' broad investment experience is negatively associated with firm innovation because such firms engage in fewer external cooperation activities. A focus on control and social cohesion in family firms appears to decrease the emphasis on external knowledge acquisition when family investors have broad investment experience. In summary, our results show that investors' breadth of investment experience influences firms' ability to innovate.

Keywords：Environmental scanning; Investor experience; External cooperation; Innovation performance; Family ownership.

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INTRODUCTION

Recognizing the importance of innovation to a firm's growth and performance, prior research has examined determinants of innovation ranging from industry structure and institutional contexts to firm characteristics and intra-organizational attributes (e.g., Ahuja *et al.*, 2008). At the firm level, prior research has examined how the firm's ownership structure influences innovation (Hill *et al.*, 1988; Hoskisson *et al.*, 2002). This research tends to be dominated by the premise that investors and managers have different risk preferences, propagating problems of agency, which results from the separation of ownership and control (Ahuja *et al.*, 2008). Accordingly, institutional investors serve a key monitoring role to mitigate agency issues (Aghion *et al.*, 2013; Bushee, 1998). Our research demonstrates that this focus on agency theory may be overly narrow and should be expanded for the following reasons.

The emphasis on agency theory is the result of the current literature's narrow focus on financial institutional investors, when examining the ownership-innovation relationship (Bushee, 1998; Kochhar *et al.*, 1996). Even when Hoskisson *et al.* (2002) differentiated between different types of institutional investors, they still focused on financial investors: pension funds vs investment funds. Financial institutional investors invest for financial reasons: to gain investment returns on their investment portfolios (Douma *et al.*, 2006). Their investment strategies focus primarily on maximizing the market value and dividend payouts of their investments (Aguilera *et al.*, 2003). They pay careful attention to financial returns and, depending on their investment horizons, may have different liquidity emphases (Hoskisson *et al.*, 2002). Agency theory was highly relevant for these studies because financial institutional investors have good monitoring capabilities that address agency conflicts (Douma *et al.*, 2006).

However, other types of investors are just as dominant and significant, especially in non-

US markets, and they differ in fundamental ways from financial investors. We focus on two key investor types: corporate investors and family investors. Both groups have fundamentally different investment objectives than do financial investors, and their investment goals do not always emphasize financial returns. **Corporate investors** may invest for strategic or non-financial reasons, such as gaining control rights or developing sustainable competitive advantages. As a result, corporate investors may be willing to forego short-term financial gains as they seek to fulfill their strategic interests (Aguilera *et al.*, 2003). **Family investors** have different goals. Their investment decisions are driven largely by the desire to preserve their families' socioemotional wealth. They focus on social and emotional ties within the family and on control to preserve the reputation and legacy of the family firm for subsequent generations (Gómez-Mejía *et al.*, 2011). Their desire to preserve their families' socioemotional wealth may result in less emphasis on short-term economic goals or financial returns (Villalonga *et al.*, 2006) than financial investors.

Both corporate and family investors represent important investor groups (Douma *et al.*, 2006; La Porta *et al.*, 1999), but, so far, we have a limited understanding of their role in influencing firm innovation. Hence, we pose the following research question: *How do corporate and family investors – investors whose dominant interest in investing is not predominantly for financial returns – influence the innovation performance of corporations?*

Because corporate and family investors take an active and strategic interest in their investments, it is useful to expand beyond the agency perspective, which assumes that investors take on primarily monitoring roles. The motivation and willingness of corporate and family investors to help the firms they invest in underlines a need to consider their capabilities and how they may bring resources and knowledge that would affect a firm's *ability* to innovate. Hence, we use an organizational learning perspective, with its focus on how knowledge is created, retained, and shared within organizations, to help us understand how corporate and family investors may play a role in environmental scanning, a critical aspect of organizational learning.

Context. We examine the influence of corporate and family investors on innovation performance in publicly-traded Taiwanese electronics firms. Unlike some markets where investment in the stock market is dominated by financial institutional investors, investors of publicly-traded Taiwanese electronics firms include corporate investors, financial institutional investors, and also family investors. This broad range enables us to examine how corporate and family investors contribute to firms' abilities to improve their innovation performance. Furthermore, the Taiwanese electronics industry is recognized as highly innovative. The 2018 Global Competitiveness Report released by the World Economic Forum (WEF, 2018) ranked Taiwan's innovation fourth in the world and classified it as a "super innovator". The United States Patent and Trademark Office (USPTO) granted Taiwan the largest number of patents on a per capita basis. Taiwanese electronics firms are active in the global patenting community, accounting for most of the patents filed with the USPTO by Taiwanese firms (Kempler, 2018; WEF, 2018).

We focus our research on investors who hold a large and significant number of shares in a firm, because major investors have considerably more power and influence over the management of a firm than do small investors (Baysinger *et al.*, 1991). They can wield significant influence through threats to exit or to liquidate their equity positions, which would reduce the firm's value (Connelly *et al.*, 2010). Managers care about an accurate and stable share price, as it is an essential resource for expansion, for raising capital, and also to ensure effectiveness of their incentive schemes and to maintain staff morale (Hendry *et al.*, 2006). Large investors have greater incentives and are more capable of investing the resources to help a firm, and also to understand complex information about firms they invest in (Connelly *et al.*, 2010). Their larger stakes, compared with small investors, give them both incentives and opportunities to play a bigger role in affecting the firms they invest in.

THEORETICAL BACKGROUND – ENVIRONMENTAL SCANNING

Drawing on organizational learning theory, we propose that the experience of corporate and

family shareholders influence organizations' ability to innovate. Organizational learning refers to ways in which organizations gain behavioral capacities through better knowledge and understanding, enabling them to continuously learn and adapt by interacting with their environments (Fiol *et al.*, 1985). While corporate and family investors are unlikely to influence how organizations use knowledge within firms because they do not directly engage in management decision-making, they are linchpins that help organizations interface with their environments. Hence, these investors can influence how firms acquire external knowledge beyond organizational boundaries. Organizations have a tendency to engage in local search, in domains that they are knowledgeable about and familiar with, as it yields the most stable returns (Rosenkopf *et al.*, 2001; Stuart *et al.*, 1996). However, breadth of search increases the variety and diversity of information available (Katila, 2002), increasing innovation performance by allowing firms to create new combinations of technologies and knowledge (Fleming, 2001; Rosenkopf *et al.*, 2001).

We examine the extent to which corporate and family investors contribute to firms' search for external knowledge. We draw on the perspective of environmental scanning, which refers to a wide-ranging sensing of the organization's external environment by collecting information about events and trends in an organization's environment (Bhardwaj *et al.*, 2014; Huber, 1991). Scanning strengthens firm performance by ensuring organizations adapt to continuous changes in the environment (Dollinger, 1984; Hambrick, 1982; Thomas *et al.*, 1993). It is especially important for firms in high-tech industries to keep up with their environment through active scanning (Elenkov, 1997), as they operate in high velocity environments characterized by short product life cycles and frequent emergence of new technological and market trends (Barringer *et al.*, 1999).

Scanning is intricately linked to innovation in many ways. Through scanning, firms gather clues about changing market trends, technological developments and even emerging threats (Velu *et al.*, 2013), which could necessitate changes in their innovation strategy (Sutcliffe, 1994). Broad search and environmental scanning are, therefore important aspects of organizational innovation

(Katila, 2002). Further, as the locus of innovation expands from the individual firm to the organization's ecosystem, organizations that actively scan their environments are better able to identify scarce and valued resources available from the ecosystem, which can help them to cope with threats and opportunities (Daft *et al.*, 1988).

A firm's managers play the most critical role in environmental scanning, as their perceptions of key external events and trends influence decisions that drive the firm's innovation pathways and directions. However, the environmental uncertainty, the bounded rationality, and the limited time and capacity of managers make environmental scanning challenging in the complex high-tech environment (Elenkov, 1997). The need to engage in broad scanning *across industries* presents an even greater challenge to firms. The limited exposure to information outside of their immediate sector boundaries may lead managers to pay less attention to unfamiliar sectors (Hambrick, 1982), even though significant opportunities could come from generating associations across diverse sectors.

Prior research shows that when strategic uncertainty is high, managers increasingly depend on personal sources of information (Daft *et al.*, 1988). As stakeholders with significant vested interest in the firm and its success, corporate and family investors can play a potentially important role in facilitating managers' environmental scanning by serving as rich and reliable sources of personal and external information about other industries and organizations. For example, Choi et al. (2012) found that foreign investors provide insights into advanced foreign technology and sophisticated managerial know-how to help firms gain access to a foreign market.

Learning from the Experience of Corporate Institutional Investors

We believe that corporate investors play an important role in facilitating environmental scanning. Many corporate investors gain minority stakes in other firms for strategic reasons, seeking either new or expanded markets, to increase efficiency, or to secure tangible resources (such as supply of raw materials or valuable technologies) or intangible resources (such as human

capital, knowledge base, and reputation) (Bogert, 1996; Buckley *et al.*, 2009). Having invested for such strategic reasons, a corporate investor is likely to have an interest in helping the firm improve its performance.

Corporate investors gain experience and knowledge about the industries and firms they invest in, especially because they tend to invest in sectors that are related to their core business (Douma *et al.*, 2006). Therefore, we expect that those corporate investors who have broad investment experience in a number of industries will be the most capable of helping the firms they invest in. Investors' breadth of investment experience increases their knowledge of other firms and industries. Because they are connected to firms that are not otherwise connected to one another, they can bring knowledge about diverse industries and companies. As a result, corporate investors with broad experience are best positioned to help firms with environmental scanning, helping them to overcome their tendencies for narrow and local search, and gain access to information about multiple industries. Hence,

H1a: The breadth of investment experience of corporate investors significantly increases a firm's innovation performance.

H1a serves as a base-line hypothesis for the mediation analysis on the extent to which external cooperations mediate the relationship between corporate investors' breadth of investment experience and firm innovation performance. We define "external cooperations" as the number of voluntary cooperations the focal firm has with other firms involving the exchange, sharing, or codevelopment of products, technologies, or services. We focus on formalized cooperations involving alliances, cooperation agreements, joint development, and even mergers and acquisitions.

We use external cooperations as a mediator to test the theoretical arguments that the breadth of investment experience influence a firm's innovation performance via environmental scanning. The diverse environmental information investors bring cannot influence organizational performance and effectiveness if it is not translated into effective actions (Kohli *et al.*, 1990). As

problems increase in complexity and response time becomes more critical due to fast-paced changes in the market and technologies, organizations increasingly need to leverage complementary assets from partners to capture specific innovation opportunities (Velu *et al.*, 2013).

Corporate investors' broad knowledge about related, unrelated, and competitor industries and firms allows them to see the potential for unique combinations of existing resources and solutions (Hargadon *et al.*, 1997). Investors who have diverse knowledge about firms in different sectors can create greater awareness of partnership and innovation opportunities. This is consistent with the idea that wider search by organizations often results in more external cooperations (Cassiman *et al.*, 2002). In summary, as corporate investors bring with them information about other companies and industries, such information influences a firm's innovation outcomes by affecting its external cooperation and partnerships with other firms. Hence:

H1b: The greater the breadth of investment experience of corporate investors, the greater the extent of the firm's external cooperation.

Effects of Family Investors' Breadth of Experience

We also examine family investors, as family ownership is the most common ownership and governance structure in the world (Aghion *et al.*, 2013; La Porta *et al.*, 1999). In contrast to corporate investors, we expect that breadth of investment experience of family investors may not necessarily increase innovation performance for family firms, due to their unique characteristics. The emphasis on control and internal cohesion in family firms results in a decreased focus on external knowledge acquisition (less environmental scanning) when family investors have broad investment experience. For corporate investors, broad investment experience helps firms with environmental scanning, identifying a larger set of potential partners that firms can work with and acquiring more external knowledge. On the other hand, the emphasis on control and internal cohesion in family firms suggests that they will be much more focused on integrating existing ties and any new knowledge generated from family investors' broad investment experience, thus

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resulting in less focus on external knowledge acquisition and environmental scanning.

Family firms combine two systems: the family and the business. Family investors are often more motivated to preserve the family's socioemotional wealth than to maximize financial gains (Gómez-Mejía *et al.*, 2011). Gómez-Mejía *et al.* (2007) originated the term "socioemotional wealth" to refer to "affective endowments" of family investors (Berrone *et al.*, 2012). Socioemotional wealth includes two key components: (1) the sense of family identity and pride derived from building a legacy that can be preserved for future generations; and (2) the strong emotional and affective ties among family members (Gómez-Mejía *et al.*, 2007).

Emphasis on Control. Family investors' emphasis on control (e.g., Berrone *et al.*, 2012; Carney, 2005) arises from the focus on family reputation, the aspiration to leave a legacy for the next generation, and the desire to prevent expropriation of benefits by outsiders (Burkart *et al.*, 2003). Furthermore, they tend to stake a large proportion of their personal wealth within the family firm (Fernández *et al.*, 2006). As a result, they are usually reluctant to invest when they do not hold a large enough stake to exert influence over the invested firm (Renneboog, 2000). Hence, family investors often invest to obtain a controlling stake, directly or indirectly, over the invested firm (Anderson *et al.*, 2012; DeAngelo *et al.*, 1985). Due to this emphasis on control, family firms that already have a broad investor base are less likely to capitalize on their investors' broad experience to acquire more external knowledge and partners. Rather, they are expected to concentrate on reconciling and integrating the knowledge of their existing diverse investments.

Strong Ties. Family firms are characterized by strong emotional and affective ties among family members. The common life-history and private language family members use to foster communication result in strong emotional and social bonds between family members (Barros *et al.*, 2016). Higher cohesion cultivates greater tacit understandings and shared strategic consensus and values (Ensley *et al.*, 2005). However, family investors' broad investment experiences are likely to bring about dissenting views and suggestions or alternative approaches (Zahra, 2012). Indeed, prior

research shows that knowledge heterogeneity among decision makers in family firms causes significant challenges for them (Tsai *et al.*, 2017). Such challenges can lead to a focus on reconciling the knowledge from family investors' broad investment experience, rather than on capitalizing on the broad experience to acquire more external knowledge and partners.

The emphasis on control, coupled with the emphasis on knowledge integration within family firms, implies that family firms tend to reduce their focus on acquiring new external knowledge and environmental scanning, when family investors have broad investment experience. Hence:

H2a: The breadth of investment experience of family investors significantly decreases a firm's innovation performance.

H2a serves as a base-line hypothesis for the mediation analysis on the extent to which external cooperations mediate the relationship between family investors' breadth of investment experience and their firms' innovation performance. Similar to H1b, we use external cooperations as a mediator to test the theoretical arguments that the breadth of investment experience of family investors negatively influences a firm's innovation performance due to the decreased emphasis on external knowledge acquisition. Accordingly, we expect that family firms will be less likely to engage in external cooperations when family investors have broad investment experience.

Prior research has established that family firms engage in fewer collaborations and are more reluctant to enter new alliances with untested partners and outsiders (Cesinger *et al.*, 2016). External cooperation necessarily means including outsiders and may require changes in the way the family firm is organized, thus disrupting social cohesion within the firm (Gómez-Mejía *et al.*, 2011). External partnerships can also mean a loss of control, as partners must be consulted, limiting the family firm's autonomy in decision making, and the family's name and reputation could become inextricably tied to the actions and decisions of their partners (Gómez-Mejía *et al.*, 2007).

Family firms protect their socioemotional wealth by prioritizing and participating only in closed, trusted networks or by building social networks only with trusted contacts sharing common

goals, interests, and values (Bennedsen *et al.*, 2015; Cesinger *et al.*, 2016). Given their inherent disinclination for external cooperations, as family firms make more connections through the investment activities of their family investors, they are likely to see decreased rather than increased need to access external knowledge and complementary resources through additional cooperations and alliances. The broader the existing investment experience of family investors, the more likely they are to have built a set of close ties through their investment linkages. When family firms do develop partnerships, they tend to rely on a small group of parties that are part of their closely knit network characterized by strong ties (Bennedsen *et al.*, 2015).

As family investors gain access to diverse knowledge and resources through close, trusted networks enabled by their investments if family investors had invested widely, they would require additional effort to reconcile these diverse views. As a result, family firms are even less likely to build *new* external cooperations. As family investors gain broader investment experience, family firms will need to work on developing greater trust and mutual norms, and creating greater interdependence within this group (Arregle *et al.*, 2007), rather than building new, external partnerships. Hence, we expect that firms with broadly diversified family investors will be even less likely to acquire external knowledge by taking on more external partnerships.

H2b: The broader the investment experience of family investors, the lower the extent of the firm's external cooperation.

External Cooperation and Innovation

With growing complexity and competition, organizations find it increasingly important to collaborate with other firms to generate new ideas, products, and services for several reasons. First, partnerships allow organizations to specialize in specific domains and contribute their specialized expertise, resulting in faster development of innovations (Chesbrough *et al.*, 2007). Second, partnerships encourage more experimentation by allowing for risk sharing and lowering the perceived risk of engaging in innovations (Barringer *et al.*, 1999). Third, individual firms may not

possess all the resources required for innovation and create partnerships to gain access to resources they need. Strategic alliances and partnerships help organizations to access complementary resources and knowledge from partner organizations (e.g., Hagedoorn *et al.*, 2002). The exchange of knowledge with partners leads to better innovation performance for the firm (Inkpen *et al.*, 1998). Further, partners may possess and specialize in knowledge elements that were not previously combined, thus increasing the likelihood of making new unique knowledge combinations (De Luca *et al.*, 2007). Prior research has provided evidence of the benefits of cooperation with other firms on the sales of innovative products (e.g., Zeng *et al.*, 2010) and the number of patents by a firm (e.g., Miotti *et al.*, 2003). Hence, organizations that are able to join partners in seizing new opportunities will become more innovative and adaptive (Velu *et al.*, 2013).

H3: The greater the extent of external cooperation, the greater the amount of firm innovation.

Hypotheses for Mediating Effects

In summary, our proposed research model states that the breadth of investment experience of corporate and family investors, respectively, affects firms' environmental scanning in starkly different ways, and thus have different influences on firm innovation via external cooperation.

In the case of corporate investors, their broad investment experience increases environmental scanning, allowing firms to access diverse information and networks. This brings about greater awareness of partnership opportunities, which will, in turn, positively influence firm innovation performance. To test the theoretical mechanism that corporate investors' broad investment experience affects a firm's innovation performance *through the role of environmental scanning*, we hypothesize that a firm's external cooperation mediates the influence of corporate investors' breadth of experience on a firm's innovation outcomes. To summarize H1a, H1b, and H3:

H4a: The relationship between the breadth of corporate investors' experience and a firm's innovation performance will be mediated through the extent of external cooperation.

Compared with corporate investors, family investors' breadth of investment experience provides more challenges. Because corporate investors invest in strategic areas related to their business, they often have the necessary expertise and knowledge to provide advice to investee firms. This expert advice helps to overcome the costs of broad search (Grant, 1996). However, in family firms, their need for cohesiveness and control increases the focus on integrating and reconciling wide scopes of knowledge and diverse networks. Learning to rely on these diverse networks and ties created through the diverse investments leads to a decreased emphasis on acquiring additional external knowledge or creating new external partnerships, which then lowers their innovation performance. Summarizing H2a, H2b, and H3:

H4b: The relationship between the breadth of investment experience of family investors and the firm's innovation performance will be negatively mediated through the extent of external cooperation.

The overall research model and hypotheses are summarized in Figure 1 and Table 1.

Insert Figure 1 and Table 1 about Here

RESEARCH METHODS

Sample and Data Collection

To test our research model, we assembled a unique data set combining firm financial and shareholder data from the Taiwan Economic Journal (TEJ) database[1], with measures of a firm's external cooperation coded from news articles, and measures of firm innovation performance obtained from patent databases. We studied 314 publicly-traded Taiwanese electronics firms for the period 2001-2008. The number of firm-year observations is 2,312. For each firm, we identified the ten largest investors as the major investors. Taiwanese government regulations mandate that publicly-traded companies disclose the ten largest investors in the firm and their

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[1] Taiwan Economic Journal (TEJ) is recognized as the most authoritative and reliable source of data in Taiwan and provides ownership and financial information on nine major countries in emerging Asia.

changes in shareholdings, as they can influence the firm's share prices. Based on prior research reporting that shareholdings of 0.5 percent are sufficient to influence firm outcome (Johnson *et al.*, 2010), we included only investors who own at least 0.5 percent of the firm's shares.

Investor Types. Corporate investors include legal entities of corporations (except financial institutions and family firms). To identify family investors, we first determined whether the company was a family firm. [2] The term "family investors" refers to associated family members in family firms who are major shareholders (through direct and indirect shareholdings).

Patent Data. Patent data for the same period was collected from the U.S. Patent and Trademark Office (USPTO) database. We focus on patents filed with the USPTO for two reasons (Chin *et al.*, 2009). First, prior research has shown that patent filing in a firm's non-home country, especially in the U.S., is a significant indicator of the firm's innovation ability (Hall *et al.*, 2001b), because the complicated and costly patent filing process in the U.S. implies that only the most important innovations would be patented there. Second, most Taiwanese electronics firms operate on a global basis; hence, it is important for them to protect their intellectual property in key markets of their export and operations, which typically includes the U.S.

Cooperations. We collected data on our sample firms' external partnerships by searching and coding for related news in major Taiwanese newspapers and business magazines. The following keywords were used to search for cooperation data: cooperation, alliance, agreement, joint development, and merger and acquisition. Research assistants followed the procedures described in Appendix A to search and code for news of cooperation by the firms in our sample.

Variable Measurement

Innovation Performance. To measure innovation performance, we use the firm's

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[2] The TEJ database uses the following definition to code for family firms: (1) both the board chairman and the CEO are family members; or (2) family members occupy over 50% of the board seats and outside directors occupy less than 33% of the board seats; or (3) family members occupy over 33% of the board seats and at least three family members are board directors, supervisors, or managers; or (4) controlling ownership exceeds the critical control level.

patenting performance, differentiating between innovation quantity and innovation quality. (1) *Innovation quantity* (INN_QUAN) is measured by the number of patents granted in the US (Chin *et al.*, 2009; Francis *et al.*, 1995). To alleviate the truncation bias related to patent counts data, we follow the approach of Hall *et al.* (2001a), dividing the patent counts with the number of patents applied for in the same technology class, in the same year. (2) *Innovation quality* (INN_QUAL): The number of patents granted to a firm represents only one aspect of a firm's innovation performance, as some innovations are more impactful than others (Chin *et al.*, 2009). Therefore, we use forward citations of patents to indicate the technological significance and impact of an invention (e.g., Nerkar *et al.*, 2005), as another indicator of a firm's innovation performance (Jaffe *et al.*, 2000). Similarly, to correct for the truncation bias related to citation counts data, we followed Hall *et al.* (2001a), adjusting the citation counts by the average citation counts of all patents applied for in the same year and technology class.

Investment Breadth (BREADTH). To test our hypotheses, we measured the breadth of investment experience of corporate investors and family investors as the unique number of sub-industries invested in by all major shareholders of the same investor type from the focal company (Boh *et al.*, 2014; Fleming *et al.*, 2007). We use the unique number, rather than the average number of industries that all major investors of a focal firm invest in, as this takes into consideration overlaps between investments in the same industry and considers the breadth of investment experience across unique industries to which a firm has access, across all its major investors. Using this approach, we calculated two variables: CORP_BREADTH and FAM_BREADTH, representing the breadth of investment experience for corporate investors and family investors respectively. We consider only investments where the investors are among the top 10 shareholders with at least 0.5 percent of the firm's shares, because investors are likely to pay attention to the invested industry and firm if they have substantial shareholdings. To avoid potential simultaneity problems, we use the major investors' investment breadth in year t-1 to

predict the external cooperation and innovation performance of a firm in year t.

External Cooperation (COOP). We use the number of cooperative projects formed by a firm in each year divided by the average number of cooperative projects in the same sub-industry[3] so as to measure the intensity of external cooperation relative to the sub-industry (Stuart, 2000).

Control Variables. Since we tested for the influence of investment breadth, we included depth of investment experience as a control variable. Investment depth is measured as the percentage of major shareholders' holdings in the top sub-industry for each company (Boh *et al.*, 2014). This variable is calculated for both corporate and family investors, thus resulting in two variables: CORP_DEPTH and FAM_DEPTH for the depth of investment experience for corporate investors and family investors respectively.[4] As certain types of investors may be attracted to firms that exhibit better innovation performance, we control for the ownership percentage of each type of investor, including financial institutional and individual investors. We use the percentage of equity owned by each type of major investor, resulting in the following four variables: CORP_%, FAM_%, FIN_%, and IND_% for the shares owned by corporate, family, financial institutional, and individual investors respectively. For family firms, family investor ownership is calculated as the sum of equity holdings by the family firm and all family investors. For non-family firms, family ownership is calculated as the sum of equity holdings by family firms and their controlling members. We use the ownership in year t-1 to predict the innovation performance of a firm in year t.

We also controlled for R&D investments as a percentage of total sales (RD), which is a proxy for the extent of R&D investment by a firm (e.g., Hall *et al.*, 2002; Hoskisson *et al.*, 2002). Current ratio (CR) (current assets divided by current liabilities) is used to measure liquidity and has been found to affect the amount of resources available for R&D (e.g., Baysinger *et al.*, 1989).

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[3] Taiwan's electronics industries include the following sub-industries: semiconductor, optoelectronics, telecommunications, computer component, computer and peripheral equipment, and others.
[4] Our results remain the same if the investment depth control variables are excluded from the analysis.

Firm performance has been shown to influence innovation performance and a firm's ability to cooperate with external partners (Hoskisson *et al.*, 2002). We use return on assets (ROA) to measure accounting performance. We also controlled for firm size (SIZE), measured as the firm's annual sales (Chin *et al.*, 2009; Francis *et al.*, 1995), as size can influence the amount of resources available to the firm and the benefits from economies of scale. We also include firm free cash flow (FCF) in the model, to proxy the availability of slack resources to a firm (Harford *et al.*, 2008). Capital structure reflects the firm's operation risk and is deemed to be an important decisive factor of performance. Therefore, we use the ratio of total liabilities to total assets to proxy capital structure (DEBT). Prior research has also shown that the concentration of ownership may influence the firms' performance, independent of the ownership structure (Cho, 1998). Thus, we include the percentage of shares owned by the largest shareholder (LARGEST) as a control variable.

As corporate investors and family investors affect organizational scanning by providing inputs to firm managers and board of directors, we also control for the experience attributes of firm managers and boards of directors. Prior research has shown that the experience of managers and executives affect firms' innovation performance (e.g., Baysinger *et al.*, 1991; Love *et al.*, 2014). We thus include the breadth and depth of investment experience of both the CEO and the members of the board of directors (CEO_BREADTH, CEO_DEPTH, DIR_BREADTH, DIR_DEPTH), to control for the experience impacts of these groups on external cooperation and innovation performance. This would allow us to show that the breadth of investment experience of corporate and family investors affects firm innovation and external cooperation over and above the experience attributes of managers and board of directors.

Appendix B provides a summary of all the variables used in the study.

Empirical Models

We test the hypotheses using the following functional form:

$$Y_{it} = \alpha + X_{it}\beta + u_i + \varepsilon_{it} \tag{1}$$

where *Y* represents the dependent variable, *i* denotes the firm, and *t* denotes the year. *X* is the vector of variables including key independent variables and control variables. u_i represents the firm level stochasticity, ε_{it} represents stochasticity across firm and time and *β* represents estimated parameters. We performed random effects generalized least squares (GLS) regression estimations predicting innovation quantity and quality. We used random effects instead of fixed effects to estimate our model because Hausman tests suggest that random effects estimators are consistent and efficient.

To investigate the mediating effects of external cooperation on the relationship between investment breadth and innovation performance, we adopted the approach popularized by Baron and Kenny (1986) to test for mediation. We first tested the relationship between investment breadth of corporate and family investors and innovation performance (equation (2)). Then, we established that investment breadth is associated with the mediating variable (COOP) (equation (3)). Finally, to show that COOP mediates the relationship between investment breadth (CORP_ BREADTH or FAM_BREADTH) and the dependent variables (INN_QUAN and INN_QUAL), we repeated the analysis for equation (2) by including the additional independent variable COOP (equation (3)).

$$INN\_QUAN_{it} \text{ or } INN\_QUAL_{it} = \alpha + (CORP\_BREADTH_{it-1} \text{ or } FAM\_BREADTH_{it-1})\beta_1 +$$
$$X_{it}\beta + u_i + \varepsilon_{it} \tag{2}$$

$$COOP_{it} = \alpha + (CORP\_BREADTH_{it-1} \text{ or } FAM\_BREADTH_{it-1})\beta_1 + X_{it}\beta + u_i + \varepsilon_{it} \tag{3}$$

$$INN_{QUAN_{it}} \text{ or } INN_{QUAL_{it}} = \alpha + COOP_{it}\beta_1 + (CORP_{BREADTH_{it-1}} \text{ or } FAM_{BREADTH_{it-1}})\beta_2$$
$$+X_{it}\beta + u_i + \varepsilon_{it} \tag{4}$$

Endogeneity. Endogeneity may be an issue in our analysis as innovation performance could be associated with the extent of external cooperation, such that those firms that have achieved greater innovation performance may find it much easier to attract partners for external

cooperation. We thus correct for endogeneity in external cooperation by using instrumental variable correction when estimating external cooperation via two-stage least squares (2SLS). We include instrumental variables that are associated with external cooperation and are not related to innovation. This allows us to control for potential endogeneity between external cooperation and firm innovation performance. Following Katz (1986), Lai *et al.* (2010), and Sullivan *et al.* (2013), we use interlocking directorate and market competition as instrumental variables for external cooperation. We measured board interlocks as the total number of each company's board members serving on the boards of other companies. Market competition is measured with the concentration of market share across all firms in the industry using Herfindahl Index (Kim *et al.*, 2014; Li, 2013). Details of the instrumental variables estimation are provided in Appendix C. We tested the hypotheses with both GLS and 2SLS, as recommended by Larcker *et al.* (2007), and found that they provide similar results. In this paper, we report the 2SLS results.

Endogeneity may also be an issue for the breadth of investment experience for corporate investors, because firms that are more innovative and have more external cooperations with other firms may be able to attract corporate investors with broader investment experiences. While the lagging of the breadth of investment experience for corporate investors will alleviate this concern to some extent, it will not completely eliminate the bias if the effect of the innovation performance and experience variables are both persistent over time. Accordingly, we control for possible endogeneity by including instrumental variables for the investment experience of the corporate investors via two-stage least squares (2SLS). We include instrumental variables that might affect investment experience of corporate investors but are not correlated with cooperation and innovation by a firm. Following Bushee (2001), Ryan *et al.* (2002), Dikolli *et al.* (2009), and Scheela *et al.* (2015), we use the following variables as instruments: Taiwan Corporate Credit Risk Index – which measures the credit risk of the firm, the time listed on the Taiwan Stock Exchange, firm's market-model beta, the transparency of the firm, and lagged book value per

share. Details of the instrumental variables estimation are provided in Appendix C.[5]

RESULTS

Table 2 presents descriptive statistics and correlations for the key variables used (Appendix B provides the full correlation matrix). Among major investors, on average, corporate investors held 11.07% of the common stock of Taiwanese public electronics firms; family investors held 15.99%; financial institutional investors held 2.11%; and individual investors held 8.52%. Interestingly, these percentages show that corporate investors and family investors dominate the major shareholders. These figures demonstrate that, in the Taiwan market, financial institutional investors tend to diversify broadly into multiple companies, rather than become major investors in a few companies. All correlation coefficients between independent variables are well under 0.7 [6], and the highest VIF value is 4.20, indicating that there is no serious multicollinearity (Judge *et al.*, 1988). We also conducted an analysis to examine the percentage of ownership by major corporate and family investors in family and non-family firms. The results show that family investors tend to become major shareholders of family firms, rather than non-family firms, as the percentage of major family investors ownership is 27.67% for family firms and only 0.13% for non-family firms. Further analysis shows that family investors mainly invest in firms that have become/are part of their family conglomerate (99.9%), rather than invest in family firms that are part of other family conglomerates. This analysis further verifies that family investors tend to invest to acquire influence over the target firms and thus invest in firms that become or are part of the family firm conglomerate.

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[5] We do not conduct an instrumental variable analysis for the breadth of family investors' investment experience, as both the literature and our empirical findings suggest that family firms often invest for non-economic reasons. Family firms tend to factor in the social capital or social connections of the target firms when making investment decisions (Birtch et al. 2018). Hence, endogeneity is less of an issue between the breadth of family investors' investment experience and innovation. Wu-Hausman specification tests conducted also show that endogeneity is not present between breadth of family investors' experience and innovation (x^2= 8.08, p= 0.9207 for INN_QUAN; x^2= 20.51, p= 0.1150 for INN_QUAL).

[6] The only exception is the correlation between family investors' investment experience depth and family ownership, which has a correlation of 0.7. As both variables are control variables and removing either one of the variables does not influence the results, we do not see this as a key concern.

Table 3 provides the results for H1 to H4. Models 1 and 2 examine the direct effects of the investment experience breadth of corporate investors and family investors on innovation performance. The coefficients of CORP_BREADTH are positive and significant when predicting both innovation quantity (Model 1, β=0.097, p=0.072, 90% CI=[0.008 0.187]) and innovation quality (Model 2, β=2.863, p=0.004, 90% CI=[1.239 4.488]), supporting H1a. *Ceteris paribus,* these results mean that if corporate investors invest in one additional industry, firms with average innovation quantity and quality levels will see a 2.78% and 82.0% increase in innovation quantity and quality respectively. Models 1 and 2 also show that the coefficients for FAM_BREADTH are significant and negative when predicting both innovation quantity (Model 1, β=-0.054, p=0.028, 90% CI=[-0.095 -0.014]) and innovation quality (Model 2, β=-0.741, p=0.050, 90% CI=[-1.363 -0.119]). *Ceteris paribus,* this indicates that if family investors invest in one additional industry, firms with average innovation quantity and quality levels will see a 6.5% and 89.3% decrease in innovation quantity and quality respectively. This provides support for H2a.

Model 3 tests the direct effects of the investment experience breadth of corporate investors and family investors on external cooperation. The results indicate that firms with corporate investors who have broad investment experience tend to engage in more external cooperation (Model 3, β=1.048, p=0.018, 90% CI=[0.319 1.777]). *Ceteris paribus,* if corporate investors invest in one additional industry, firms with average external cooperation levels will see a 30.1% increase in external cooperations relative to other firms in the sub-industry. In addition, family investors with broader investment experience have a negative and significant association with external cooperation (Model 3, β=-0.382, p=0.040, 90% CI=[-0.689 -0.076]). That is, c*eteris paribus,* if family investors invest in one additional industry, firms with an average level of external cooperations will see a 46.0% decrease in external cooperations relative to other firms in the sub-industry. Therefore, H1b and H2b are both supported.

Models 4 and 5 test the mediation effects. In Models 4 and 5, the coefficients of COOP are positive and significant (Model 4, β=0.224, p=0.010, 90% CI=[0.080 0.367]; Model 5, β=4.925, p=0.025, 90% CI=[1.306 8.544]), indicating that greater external cooperation enhances firms' innovation performance. That is, for firms with average levels of innovation quantity and quality, increasing the ratio of the firm's external cooperation relative to other firms in the same sub-industry by one increases innovation quantity by 22.0% and innovation quality by 460.0%, c*eteris paribus*. H3 is thus supported. When controlling for external cooperation, the effect of corporate investors' breadth of investment experience on innovation performance becomes insignificant for both innovation quantity (Model 4, β=-0.007, p=0.243, 90% CI=[-0.016 0.003]) and innovation quality (Model 5, β=-0.189, p=0.119, 90% CI=[-0.388 0.010]). The results support H4a, in that external cooperation fully mediates the breadth of the corporate investor investment experience – innovation performance relationship.

After controlling for external cooperation, the coefficient of FAM_BREADTH also becomes insignificant in influencing both innovation quantity (Model 4, β=-0.020, p=0.288, 90% CI=[-0.051 0.154]) and innovation quality (Model 5, β=-0.183, p=0.580, 90% CI=[-0.726 0.360). Taken together, these results show that external cooperation fully and negatively mediates the relationship between the family investors' investment experience breadth and innovation performance. In other words, those family investors with greater breadth of investment experience appear to be associated with worse firm innovation performance, due to the lesser extent of external cooperation with other firms. The results provide support for H4b.

Insert Table 3 about Here

Mediating Effects: Structural Equation Modeling (SEM) and Sobel Test

Preacher *et al.* (2008) and Hayes (2009) argue that the approach proposed by Baron and Kenny (1986) does not quantify the mediating effect, but only infers the existence of a mediating effect by logical inference from a set of hypotheses tests. We thus repeated the analysis by using

structural equation modeling (SEM) with Sobel tests and SEM with bootstrapping to supplement our results. SEM allows us to test multiple pathways simultaneously and allows for the implementation of bootstrapping such that we are able to conduct tests of the indirect effects. The fit indices of the SEM model indicated that the model fit the data well (RMSEA = 0.000, SRMR = 0.000, CFI = 1.000, GFI = 1.000). The results of the SEM path analysis are summarized in Figure 2. [7] Overall, the results are consistent with the main analysis results.

Insert Figure 2 about Here

We then conducted the Sobel test, also known as the product of coefficients approach, which has been proposed as a supplement to the Baron *et al.* (1986) approach (Hayes, 2009; Sobel, 1982, 1986). The Sobel test provides a standard error for path coefficients making up the indirect effect, thus allowing us to generate a statistic that tests whether the indirect effect is significant. We provide the results of the Sobel test for the direct and indirect effects in Table 4. The results show that the indirect effects of CORP_BREADTH on INN_QUAN (Coefficient=0.146, p=0.000, 90% CI=[0.109 0.184]) and INN_QUAL (Coefficient=0.847, p=0.000, 90% CI=[0.627 1.066]) are significant and positive. The proportions of total effect of CORP_BREADTH mediated by external cooperation are 56.81% and 25.07%, for INN_QUAN and INN_QUAL respectively. This provides further support for hypothesis 4a. The indirect effects of FAM_BREADTH on INN_QUAN (Coefficient=-0.022, p=0.014, 90% CI=[-0.037 -0.007]) and INN_QUAL (Coefficient=-0.128, p=0.014, 90% CI=[-0.213 -0.043]) are significant and negative. The proportions of total effect of FAM_BREADTH mediated by external cooperation are 28.95% and 15.35%, for INN_QUAN and INN_QUAL respectively, providing support for Hypothesis 4b.

Insert Table 4 about Here

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[7] We continue to include the instrumental variables analysis by replacing the CORP_BREADTH and COOP variables with predicted values of these variables using the instrumental variables analysis.

Hayes (2009), however, noted that the Sobel test requires the normality assumption for the sampling distribution of the indirect effect. Therefore, we use bootstrapping for SEM as an alternative and efficient method of testing for mediational effects that does not require such normality assumptions. Through multiple iterations of resampling procedures, the bootstrapping process generates 1,000 estimates of the indirect effects, which are used to generate inferences about the confidence interval size of the indirect effects. This generates bias-corrected and accelerated (BCa) confidence intervals for each parameter estimated in the mediated model. Table 5 provides the results of this analysis. The results of bootstrapping show that the indirect effects of CORP_BREADTH on INN_QUAN (Coefficient=0.181, p=0.021, 90% CI=[0.052 0.310]) and INN_QUAL (Coefficient=1.052, p=0.001, 90% CI=[0.543 1.561]) are significant and positive, supporting H4a. Further, the indirect effects of FAM_BREADTH on INN_QUAN (Coefficient=-0.033, p=0.082, 90% CI=[-0.064 -0.002]) and INN_QUAL (Coefficient=-0.191, p=0.029 90% CI=[-0.335 -0.047]) are significant and negative, also supporting H4b.

Insert Table 5 about Here

ROBUSTNESS AND ADDITIONAL ANALYSIS

Robustness Tests

We conducted several tests to examine the robustness of our main results, using the Baron and Kenny approach for testing mediation. Appendix D provides details of the analysis.

Individual Mediational Tests. We conducted separate mediational tests for corporate and family investors' breadth of investment experience by including each variable separately into the regression analysis (Tables D1 and D2 – Appendix D). The results remain unchanged.

Lagging External Cooperation when Predicting Innovation Performance. We took a one year lag for external cooperation to further address concerns about endogeneity between external cooperation and innovation performance (Table D3 – Appendix D). Results remain unchanged.

Using a three-year window period for investment breadth. We further measured the breadth

of investor experience with all investments held by the investors in a previous three-year window period, rather than consider only current investments (Table D4 – Appendix D). Major shareholders would have gained knowledge and experience from investing in firms within a recent time frame, even if they had sold the shares of some firms. The results remain the same.

Two-Year Lagged Effects. As breadth of investors' experience may take a longer period of time to influence firm innovation performance, we ran a robustness analysis by lagging investors' experience by two-year periods (Table D5 – Appendix D). The results for corporate investors indicate that external cooperation mediates the positive influence of CORP_BREADTH$_{t-2}$ on firm's innovation quality performance, and the effects last for at least two years. On the other hand, the results for FAM_BREADTH$_{t-2}$ differ in that it is not significantly associated with firm external cooperation in year t. These results show that the negative effects of FAM_BREADTH on external cooperation last up to one year.

Understanding the Role of Financial Institutional Investors. We conducted robustness analysis by adding investment experience breadth of financial institutional investors, to determine whether financial institutional investors play any role in helping firms with environmental scanning (Table D6 – Appendix D). This analysis shows that the breadth of investment experience for financial institutional investors is associated with neither firm innovation nor external cooperations, providing evidence that breadth of financial institutional investors' experience does not facilitate firm environmental scanning.

Diversity measures of investment experience of corporate investors and family investors. We use the inverse of the Herfindahl-Hirschman index (HHI) as an alternative approach to measure the breadth of investment experience of corporate investors and family investors (CORP_HHI and FAM_HHI) (Table D7 – Appendix D). For each company, we calculated the HHI as follows:

HHI=$\sum_{i=1}^{S} p_i^2$, where p_i is the ratio of the number of investors invested in industry i to the

total number of investors of focal firm, and S is the number of industries. The greater the HHI, the greater the concentration of investor experience within one industry, and the lesser the extent to which the investment experience of investors is equally distributed across multiple industries. Hence, investment experience breadth is measured as [1-HHI]. [8] Using this measure of investment experience breadth, our results show that external cooperation mediates the relationship between corporate investors' breadth of investment experience and innovation performance. However, the effects of the family investors' breadth of investment experience on external cooperation and innovation performance become insignificant using the HHI measure for breadth of investment experience. We do not use this measure of investment experience breadth in our main analysis, as prior research has indicated that the HHI measure effectively treats breadth and depth as two ends of a single dimension and thus is a measure of both the breadth and depth of investors' experience (Boh *et al.*, 2014). Indeed, further analysis shows that 1-HHI is correlated highly with the depth of investment experience for corporate investors (correlation = -0.67) and family investors (correlation = -0.98). As our hypotheses focus on the breadth of investment experience of corporate and family investors, which is expected to help firms with organizational scanning, we use our original measure as a more direct measure of investment experience breadth.

Additional Analysis

Impact of Corporate Investors on Family Firms. Not all firms have the same ability to leverage their corporate investors' investment experience. In particular, we compare family firms with non-family firms. We expect that family firms will benefit less from environmental scanning brought about by corporate investors with broad experience, as their emphasis on internal cohesion and trust (Zahra, 2012) creates a tendency to exclude outsiders, potentially limiting

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[8] We conducted additional analysis by replacing p_i with the percentage of shareholdings by corporate investors and family investors in each industry. The results of the analysis is similar to that described in Table D7 of Appendix D.

their knowledge of important changes in the environment. Hence, even if corporate shareholders with broad investment experience could provide important views and advice, it would be difficult for such views to be valued within the family firm. We conducted additional analysis to investigate whether this premise holds in our data and analysis (Table D8 in Appendix D).

Our results show that the coefficients of CORP_BREADTH*FAM are negative and significant for both innovation quantity (Model 1, β=-0.241, p=0.011, 90% CI=[-0.386 -0.095]) and innovation quality (Model 2, β=-4.198, p=0.000, 90% CI=[-6.177 -2.220]). In addition, CORP_BREADTH*FAM has a negative relationship with COOP (Model 3, β=-1.747, p=0.002, 90% CI=[-2.683 -0.811]). Therefore, family firms are less likely than non-family firms to leverage the breadth of investment experience of corporate investors in influencing innovation performance and external cooperation. This analysis further confirms the basic premise in our hypotheses that family firms are burdened by their desire to preserve socioemotional wealth.

DISCUSSION

Prior research tends to focus on financial institutional investors using agency theory. We add to the understanding of the ownership-innovation relationship by examining two other types of major investors: corporate investors and family investors, who are major investment groups in many non-US markets. In fact, our results show that in Taiwan, the major investors in public high-tech firms tend to be corporate and family investors, rather than financial institutional investors, who appear to take on more diversified portfolios rather than major stakes in firms. Examining corporate and family investors require us to move beyond agency theory, because the dominant investment interests of corporate and family investors may be less on ensuring monitoring to achieve financial returns and more on creating strategic synergies or on preserving socioemotional wealth. We thus turn to an environmental scanning perspective from the organizational learning literature to hypothesize that corporate and family investors can influence the ability of firms to innovate, based on the capabilities of investors reflected by their breadth

of investment experience.

Our results show that corporate investors influence a firm's ability to innovate by contributing to its ability to acquire more information about the external environment. We found that corporate investors with broad investment experience contribute to firm environmental scanning, in turn influencing firm innovation performance, by increasing the number of external cooperations the firm engages in. The mediation analysis shows that corporate investors with broad investment experience bring with them knowledge of potential partners that fosters opportunities for cooperation with others in and outside the industry, thus enabling firms to leverage resources available from the environment for innovation (Daft *et al.*, 1988).

In the case of family investors, we hypothesized and found that the breadth of family investors' investment experience has a negative influence on innovation performance. This relationship is mediated by reduced tendencies to engage in external cooperation, confirming that the unique characteristics of family firms decrease their ability to benefit from environmental scanning that could result from broad investment experience by family investors. Our additional analysis shows that they are similarly unable to benefit from the environmental scanning benefits brought about by corporate investors with broad investment experience.

To solidify our arguments, we investigated further by conducting a small interview study. We interviewed different types of institutional investors and investee firms to determine whether and in what ways the former may have some form of influence over the latter's strategies and actions. We conducted 14 interviews with seven corporate, family, and financial investors, and the senior management of seven investee firms. Semi-structured interviews, each lasting thirty to forty minutes, were conducted in Chinese by a member of the research team. Our interviews revealed several key findings. First, we found that if corporate investors are invested heavily in a firm, they take a long term view of the relationship with that firm, focusing on helping it to succeed. Second, the interviews provided further evidence that corporate investors do play a role

in helping the firm with environmental scanning, as they share their opinions and knowledge of other industries and firms with the managers of the investee firms. Third, we found that family investors typically invest to expand their business. They invest to take large controlling stakes, so that the investee firm becomes part of their trusted network. Hence, they do not easily enter into partnerships where they are unable to gain a controlling stake. On the part of managers, interviews revealed that managers were mindful of major shareholders' views and their potential reactions to any major news, strategy, or undertaking of the firm. (See details of the interview study in Appendix E.)

Research and Practice Implications

Prior literature has established a relationship between ownership structure and innovation. Our study extends this literature in several ways. First, we propose that the focus of prior research on financial institutional investors and agency theory should be broadened. While financial institutional investors are an important group, our research reveals that they may not be the dominant group of investors when we examine major investors in non-US markets. In our research, we consider two other major investor groups: corporate investors and family investors. By adopting the environmental scanning perspective from organizational learning theory, we examine how the capabilities of key investors – in terms of their breadth of investment experience – influence firms' abilities to generate innovations and engage in external cooperations. This approach generates a more comprehensive understanding of the ownership-innovation relationship.

Our findings revealed that corporate investors with broad investment experience contribute to firm environmental scanning and increase innovation performance. However, family investors' preoccupation with preserving the socioemotional wealth of the family firm resulted in negative effects arising from family investors' broad investment experience. These findings suggest that the types of investors and their investment interests are significant factors

in how investor capabilities may influence firm innovation. The same capability – in terms of the breadth of investment experience – can be an asset or liability for firm innovation, depending on the types of investor and their investment interests. These results suggest a need to consider investor types and their investment interests as we examine the role investors play in influencing firm innovation.

More importantly, our findings suggest that the environmental scanning perspective from organizational learning theory usefully supplements the well-established agency theory when considering the ownership-innovation relationship. It demonstrates that, in addition to their monitoring role, which influences managers' motivation to invest in innovation, investors also affect firms' abilities to innovate, once we factor in investor types and capabilities. The environmental scanning perspective is useful because it demonstrates that corporate and family investors influence how firms bridge their innovation strategies with their external environments.

While prior research has identified how a number of internal roles serve as boundary spanners facilitating environmental scanning (e.g., Tushman *et al.*, 1980), we are the first to introduce corporate and family investors as sources of information for firm environmental scanning. By examining how the breadth of corporate and family investors' investment experience influence firm innovation through external cooperations, we are able to provide a direct test of the extent to which such investors help in environmental scanning and in identifying potential resources and partners in the ecosystem that contribute to firm innovation. Further, in showing that the breadth of family investors' experience negatively influences firm innovation, we highlight that not all firms benefit equally from environmental scanning by the investors.

Overall, we provide a significant contribution to the literature by demonstrating the broader role that different investor types play in reality, showing that our traditional conceptualizations of investors may be too limited, especially if we confine ourselves to using only agency theory to understand the ownership-innovation relationship.

Our study also has implications for practice. Practitioners have questioned whether the traditional model of a corporation, where managers deal with largely anonymous owners mostly represented by fund managers who buy and sell shares, is giving way to other organizational forms (Economist, 2015). There is thus a need to better understand the roles that different investors may play in influencing a firm's management. This study makes a contribution toward gaining that understanding by focusing on corporate and family investors and also generates a greater understanding of types of shareholders beyond financial institutional investors.

Limitations

Some limitations to this study suggest avenues for future research. First, while we contribute to the literature by examining the quality and quantity of innovation output in terms of the patents produced by a firm, patents do not necessarily and always translate into actual innovations and products. Future research may benefit from other measures of innovation performance, such as new product sales. Second, while the Taiwanese high-tech industry provided a suitable context to test our research hypotheses relating corporate and family investors' experience to firm innovation, it will be useful for future researchers to examine other non-US contexts where the equity market may have dominant players other than financial institutional investors. Despite the limitations, we provide initial answers to the question of how the experience of corporate and family investors influence firms' innovation performance, thus extending and expanding this research stream into new conceptual configurations that are relevant to our increasingly high-tech and global marketplace.

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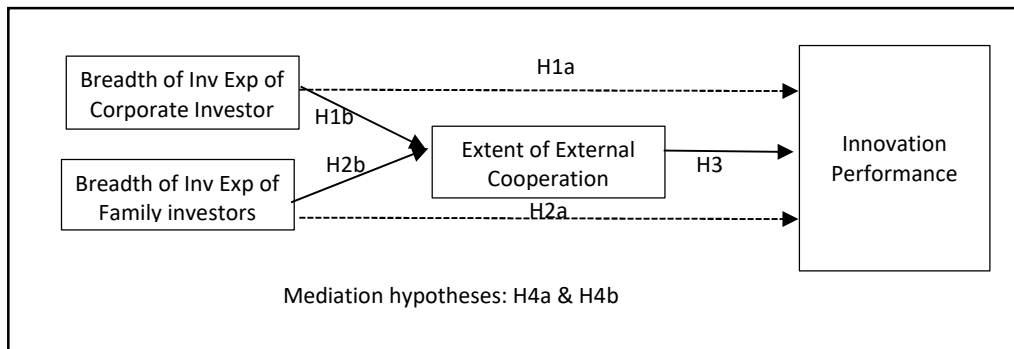
Figure 1: Summary of proposed model

Table 1. Hypotheses summary

Hypothesis	Mediation Notation	Hypothesis	Mediation Notation
H1a	X → Y	H3	M → Y
	for Corporate Investors		
H1b	X → M	H4a	X → M → Y
	for Corporate Investors		for Corporate Investors
H2a	X → Y	H4b	X → M → Y
	for Family Investors		for Family Investors
H2b	X → M		
	for Family Investors		

Note: X, M, and Y represent the following notations: X – independent variable; M – mediating variable; Y – dependent variable.

Table 2: Correlation matrix for Key Variables

	Variable[9]	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1.	INN_QUAN	0.04	0.71										
2.	INN_QUAL	2.88	19.39	**0.60**									
3.	COOP	1.02	2.27	**0.11**	**0.28**								
4.	CORP_BREADTH	3.49	4.43	-0.00	**0.04**	**0.15**							
5.	FAM_BREADTH	0.83	1.02	0.01	0.01	0.02	**-0.07**						
6.	CORP_DEPTH	0.50	0.38	-0.03	**-0.04**	-0.02	**-0.13**	**-0.15**					
7.	FAM_DEPTH	0.51	0.47	0.02	-0.02	**-0.09**	**-0.20**	**0.51**	**-0.20**				
8.	CORP _%	11.07	14.49	-0.02	-0.00	0.02	**0.28**	**-0.33**	**0.31**	**-0.48**			
9.	FAM_%	15.99	18.71	0.01	-0.02	**-0.08**	**-0.22**	**0.61**	**-0.26**	**0.70**	**-0.40**		
10.	FIN_%	2.11	3.54	-0.00	-0.00	**0.09**	**0.13**	0.02	-0.00	-0.03	-0.02	**-0.09**	
11.	DIV_%	8.52	10.23	-0.03	-0.08	**-0.10**	**-0.14**	**-0.39**	**0.09**	**-0.41**	**-0.09**	**-0.37**	**-0.13**

Notes:
- Number of observations = 2,312
- Please see Appendix B for a listing of all variable names and full correlation table including all control variables
- Bold values indicate statistical significance at the 0.01 level

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[9] For those variables whose standard deviation is greater than the mean, such as INN_QUAN, INN_QUAL, COOP, CORP_BREADTH, FAM_BREADTH, we transform these variables by taking the natural logarithm. We add 1 to the variables before taking the natural logarithm to avoid generating values with missing data after transformation Luong H, Moshirian F, Nguyen L, Tian X, Zhang B. 2017. How Do Foreign Institutional Investors Enhance Firm Innovation? *Journal of Financial & Quantitative Analysis* **52**(4): 1449-1490..

Table 3: Analyses testing Hypotheses

	(1) INN_QUAN			(2) INN_QUAL			(3) COOP			(4) INN_QUAN			(5) INN_QUAL		
	Coef.	SE	P>z	Coef.	SE	P>z	Coef.	SE	P>z	Coef.	SE	P>z	Coef.	SE	P>z
CONSTANT	-0.020	0.124	0.870	-0.151	2.016	0.940	-0.511	0.891	0.567	0.158	0.185	0.394	3.879	3.676	0.291
COOP										0.224	0.087	0.010	4.925	2.200	0.025
CORP_BREADTH	0.097	0.054	0.072	2.864	0.988	0.004	1.048	0.443	0.018	-0.007	0.006	0.243	-0.189	0.121	0.119
FAM_BREADTH	-0.054	0.025	0.028	-0.741	0.378	0.050	-0.382	0.186	0.040	-0.020	0.019	0.288	-0.183	0.330	0.580
CORP_DEPTH	0.071	0.042	0.087	2.127	0.761	0.005	0.775	0.339	0.022	-0.000	0.011	0.964	-0.020	0.186	0.913
FAM_DEPTH	-0.029	0.021	0.164	-0.453	0.297	0.127	-0.161	0.148	0.275	-0.015	0.024	0.520	-0.197	0.386	0.610
CORP_%	-0.072	0.040	0.073	-2.033	0.696	0.003	-0.772	0.327	0.018	0.004	0.005	0.433	0.092	0.099	0.354
FAM_%	0.010	0.008	0.226	-0.053	0.120	0.661	-0.018	0.058	0.754	0.014	0.009	0.122	0.172	0.157	0.274
FIN_%	-0.008	0.004	0.035	-0.236	0.074	0.001	-0.045	0.030	0.134	-0.006	0.004	0.156	-0.128	0.072	0.076
IND_%	-0.006	0.004	0.107	-0.098	0.056	0.077	0.013	0.026	0.607	-0.007	0.004	0.117	-0.040	0.073	0.584
RD	0.000	0.008	0.970	-0.061	0.106	0.563	-0.032	0.055	0.562	-0.002	0.007	0.764	0.043	0.112	0.703
CR	0.000	0.000	0.960	0.000	0.000	0.541	0.000	0.000	0.839	0.000	0.000	0.913	0.000	0.000	0.959
ROA	0.021	0.017	0.225	0.706	0.295	0.017	0.205	0.128	0.109	-0.005	0.023	0.841	0.117	0.404	0.773
SIZE	-0.000	0.000	0.603	-0.000	0.000	0.379	0.000	0.000	0.620	-0.000	0.000	0.089	-0.000	0.000	0.081
FCF	-0.003	0.006	0.570	-0.178	0.101	0.078	-0.011	0.045	0.804	-0.010	0.009	0.263	-0.304	0.181	0.093
DEBT	-0.000	0.000	0.497	0.005	0.003	0.140	0.002	0.002	0.209	-0.000	0.000	0.215	-0.003	0.006	0.650
LARGEST	0.002	0.001	0.046	0.047	0.018	0.008	0.019	0.008	0.018	-0.000	0.000	0.348	-0.008	0.007	0.240
CEO_BREADTH	0.024	0.005	0.000	0.045	0.075	0.553	0.021	0.035	0.539	0.012	0.007	0.066	-0.120	0.137	0.380
CEO_DEPTH	0.373	0.121	0.002	4.043	1.916	0.035	-0.680	0.861	0.429	0.516	0.156	0.001	3.822	2.747	0.164
DIR_BREADTH	-0.001	0.001	0.367	-0.017	0.015	0.256	-0.003	0.006	0.634	-0.002	0.001	0.131	-0.051	0.029	0.083
DIR_DEPTH	-0.083	0.097	0.391	-2.586	1.563	0.098	-1.161	0.728	0.111	0.042	0.107	0.695	1.188	1.994	0.551
N	2,312			2,312			2,312			2,312			2,312		
chi2	55.421			33.619			28.325			51.573			32.638		
P>chi2	0.000			0.020			0.077			0.000			0.037		

Notes:
- Please refer to Appendix B for the definitions of variables.

- SE=standard error.
- It is notable that CEO's *depth* of investment experience is significantly associated with innovation quality and quantity. This result supports the observation that the management's depth of experience is important for firm innovation, because it aids the firm in its local search. However, our study shows that to broaden the firm's search to other industries and domains, corporate investors' breadth of experience plays the critical role.
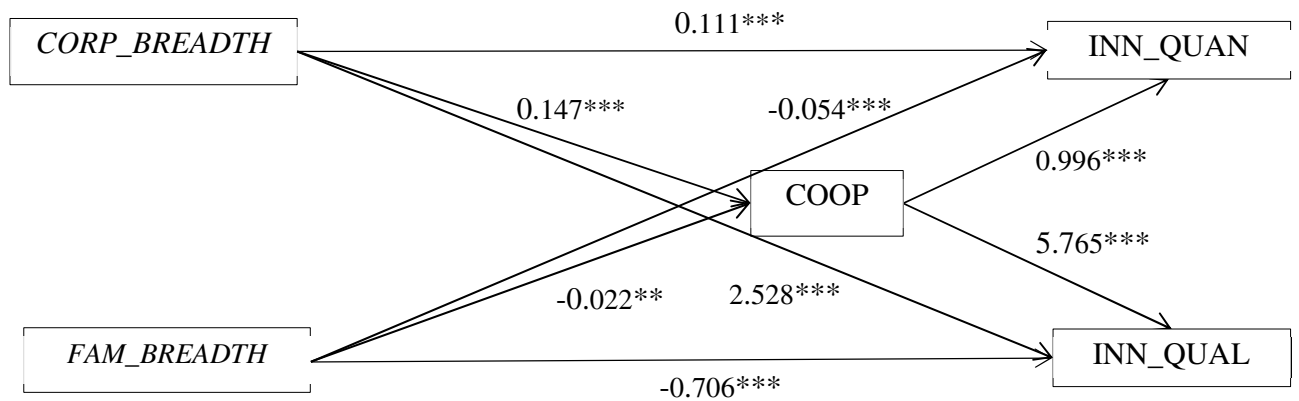
Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2: Path analysis

Table 4: Indirect effects of external cooperation_Sobel test

Independent variable		Depended variable	Direct effect		Indirect effect		Total effect		The ratio of indirect effect to total effect
			Coeff.	P value	Coeff.	P value	Coeff.	P value	
CORP_BREADTH	→	INN_QUAN	0.111	0.000	0.146	0.000	0.257	0.000	56.81%
CORP_BREADTH	→	INN_QUAL	2.528	0.000	0.846	0.000	3.374	0.000	25.07%
FAM_BREADTH	→	INN_QUAN	-0.054	0.009	-0.022	0.014	-0.076	0.000	28.95%
FAM_BREADTH	→	INN_QUAL	-0.706	0.000	-0.128	0.014	-0.834	0.000	15.35%

Table 5: Indirect effects of external cooperation with bootstrapping

Independent variable		Depended variable	Coeff.	z value	P value	Confidence Interval	
CORP_BREADTH	→	INN_QUAN	0.181	2.31	0.021	0.052	0.310
CORP_BREADTH	→	INN_QUAL	1.052	3.40	0.001	0.543	1.561
FAM_BREADTH	→	INN_QUAN	-0.033	-1.74	0.082	-0.064	-0.002
FAM_BREADTH	→	INN_QUAL	-0.191	-2.18	0.029	-0.335	-0.047

Note: Bias-corrected and accelerated (BCa) confidence intervals are used for estimating specific indirect effects.