Hierarchical Complexity and Corporate Opaqueness

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This thesis examines the impact of hierarchical complexity on corporate opaqueness and how this relationship varies under the moderating effect of corporate diversification, quality of the home country institutional environment and the host country institutional environment. I hypothesize that increases in firms' hierarchical complexity are related to greater corporate opaqueness between the firm and outside investors on the capital market. Using a sample of US firms spanning 5 years from 2012 to 2016, I find a statistically and economically significant, positive relationship between hierarchical complexity and corporate opaqueness. The results of the thesis further imply that the impact of hierarchical complexity on opaqueness is alleviated when there is related corporate diversification and an increasing quality of the host country institutional environment.

DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Chapter 1 Introduction

Does a firm's hierarchical complexity, i.e. its complex hierarchical structures derived from both the number of subsidiaries and the multiple management levels, affect its level of corporate opaqueness? Hierarchical complexity entails both the number of subsidiary companies and the number of hierarchical and management layers of firms. In this case, firms can become hierarchically complex by adding an increasing number of subsidiary companies and potentially attaching a greater number of hierarchical layers. Firms are complex organizations. With a number of subsidiary companies operating at the firms' multiple management and hierarchical layers, the subsidiary companies and the multiple management levels can result in complex hierarchical structures of the firms and firms can be associated with a higher degree of hierarchical complexity by adding subsidiaries to their ownership linkage (Glenn & Malott, 2004). This is because as the functional units and systems of the firms, the differentiations and the interactions of the subsidiary companies and the multiple management levels can make the firms hierarchically complex, since an organization that consists of differentiations and varieties in its functional units and systems is considered to be more complex than an organization that consists of less differentiations and varieties (Daft, Murphy, & Willmott, 2010, Jablin & Putnam, 2000, Lawrence & Lorsch, 1967, Thompson, 1967).

Hierarchical complexity can influence the levels of corporate opaqueness. Opaqueness is related to the accuracy and usefulness of firm-specific information released from the firm to outside investors and reflects the ease with which firm specific information is accessible to outside investors. Hierarchical complexity can affect opaqueness by increasing the information friction between firms and outside investors because greater hierarchical complexity can lead to greater information asymmetry increasing investors' information processing challenges.

Thus, hierarchical complexity can prevent outside investors from comprehensively understanding firms' activities and performance. As a result, hierarchically complex firms are perceived to be less transparent. In addition, some of the subsidiary companies of hierarchically complex firms are located in a number of different countries and geographical regions. Thus, firms' complex hierarchical structures which can involve subsidiaries spanning vast distances and the exposure to different economic, political and cultural circumstances can add to the complexity and aggravate firm transparency (Aabo, Pantzalis, & Park, 2015, Duru & Reeb, 2002). Therefore, as one important type of organizational complexity, hierarchical complexity can be related to the corporate opaqueness of firms. For example, the Enron Corporation, which used to be "America's Most Innovative Company" for almost a decade, suffered from increasing opaqueness and finally collapsed. Enron was a complex enterprise that had significant complexity. Enron was comprised of a number of subsidiary companies involved in a variety of industries such as energy supplies and commodity trading and some subsidiary companies operated business overseas due to Enron's significant international expansion. Thus, the complex hierarchical structures which involved an increasing number of subsidiary companies, operating in a variety of industry segments and geographical areas, made Enron complex. As a result, Enron's growing hierarchical complexity increased its opaqueness. The firm impaired the information environment of outside investors by hiding losses and masked performance through a series of accounting information manipulations and fraudulent behaviours. Despite the share price that climbed to the all-time high of 90.56 U.S. dollars, the relatively large number of analysts following the firm and the high share turnover, the capital market analysts and investors were misled by fraudulent financial reports and deceptive information. Consequently, in 2001, a serious case of fraud was found to have been committed in its financial records which finally caused the business giant to end up collapsing.

This thesis casts two main research questions. First, I examine whether hierarchical complexity is positively related to the degree of corporate opaqueness. Second, I investigate whether the relationship between hierarchical complexity and opaqueness could be moderated by firm level and country level characteristics. More specifically, I find a positive relationship between hierarchical complexity and opaqueness. Next, I show that this positive relationship holds for alternative measures of opaqueness. I then investigate whether the relationship between hierarchical complexity and opaqueness could be affected by firms' business characteristics and external regulation environment. In particular, I examine the moderating impact of firms' corporate diversification, quality of home country institutional environment and host country institutional environment on the linkage between hierarchical complexity and opaqueness. Last but not least, I control for potential endogeneity biases and show that opaqueness is likely to be positively related to hierarchical complexity.

In this thesis, I examine the impact of hierarchical complexity on corporate opaqueness based on the following motivations. First of all, the relationship between hierarchical complexity and corporate opaqueness is not clear. In most cases, outsiders, including analysts and investors, rely on the firm's annual report and financial statement as the main information source to obtain firm information and make investment decisions. In this case, if the management of the firm has insufficient information on the firm and has difficulty in analysing and processing the information, the quality and quantity of the firm's financial disclosures and reports may be reduced. This adversely affects the information environment of outsiders and subsequently makes the firm more opaque. Therefore, the information available to top management about the firm and their information processing and analysing capabilities can affect the firm's level of opaqueness.

Although there is no study that explicitly examines the impact of hierarchical complexity on corporate opaqueness, there is related research that investigates the effect of firms' hierarchical

structures on management's information accessibility and cognition capabilities which can influence the level of firm opaqueness. However, evidence on whether complexity stemming from hierarchical structures enhances or weakens management's information availability and information processing capability is mixed. One strand of literature argues that the hierarchical structures of the firms can ameliorate management's information availability and information validity. Mihm, Loch, Wilkinson and Huberman (2010) show that the hierarchical structures of firms can indirectly improve top management's information environment in that hierarchical structures enable managers from each multiple organizational layer of the hierarchy to contribute their own sub-piece of information and respective minds to increase the firm's overall managerial quality. Thus, hierarchical structures can improve top management's information analysis quality by enhancing communication efficiency within the organization (Mihm, Loch, Wilkinson, & Huberman, 2010, Siggelkow & Rivkin, 2005). Chandler (1990) argues that hierarchical structures allow management to obtain adequate and objective information on the operational divisions and subsidiary companies which enables management to make unbiased analysis and evaluations of the firm's operations and performance. This is because hierarchical structures can provide allocations of duties between the parent company management and subsidiary managers. Specifically, parent company management makes strategies, coordinates business responsibilities among managers of operational divisions and subsidiaries and monitors their activities while managers of operational divisions and subsidiary companies are assigned specific and detailed business operating authorities. Such allocations of duties enabled by hierarchical structures permit the subsidiary managers to make more valid and practical business decisions based on the actual situations and conditions of each product or geographical lines (Chandler, 1990, Zey & Camp, 1996). As a result, by assuming that there are effective monitoring mechanisms that monitor the activities of subsidiary managers, the firms' hierarchical structures can provide parent company

management with information advantages by increasing the parent company management's information availability and information reliability (Chandler, 1990, Hoskisson, Harrison, & Dubofsky, 1991, Mahajan, 1986, Simon, 2013, Wang & von Tunzelmann, 2000).

However, another strand of literature argues that firms' hierarchical structures can reduce the parent company management's information availability and hamper management's information processing capabilities. Glenn and Malott (2004) argue that hierarchical complexity that originates from firms' increasing number of operational divisions and subsidiaries and multiple hierarchical layers can make these operational divisions and subsidiary companies be more autonomous and independent. This leads to unrelatedness between the parent company and subsidiary companies. Such unrelatedness decreases top management's information availability by aggravating the information disconnections between the top management and subsidiary managers. Thus, increasing hierarchical complexity which stems from hierarchical structures makes top management become less aware of the activities and contingency of subsidiary companies. Prahalad and Doz (1981) posit that the hierarchical structures of firms prevent parent company management from comprehensively accessing information of the firms' operational divisions and subsidiaries. Due to the local business environment involvement of subsidiary companies, the parent firm is likely to delegate management authority to subsidiaries to some extent. When top management delegates some authority and responsibility to managers of subsidiaries, such delegation of authority increases the unrelatedness between the parent company and subsidiaries and reduces the subsidiaries' dependence on the parent company. Thus, hierarchical structures can impair top management's control over the activities and behaviours of subsidiary managers which provides subsidiary managers with opportunities to hide or even distort information that should be reported to the parent company management (Bartlett & Ghoshal, 2002, Campbell, Datar, & Sandino, 2009, Dikolli & Vaysman, 2006, Mittal, Kamakura, & Govind, 2004, Prahalad & Doz, 1981).

Therefore, it can be seen from this strand of literature that although the parent firm may not delegate full authority on the decision-making process and managerial discretion to the subsidiaries, the firm's organizational structure can become more hierarchically complex by including more subsidiaries, which can decrease the parent firm's information availability and hamper the top management's cognition capabilities.

In summary, prior literature provides mixed results in terms of the influence of firms' hierarchical structures on management's information availability and cognition abilities. From the theoretical perspective, there are no prior studies that directly examine the relationship between hierarchical complexity and corporate opaqueness. From an empirical perspective, the question of whether hierarchical complexity can be associated with corporate opaqueness is not obvious.

Secondly, corporate opaqueness is of great concern because it can affect firms' cost of capital and investment policies (Durnev & Mangen, 2009, Easley & O'hara, 2004, Myers & Majluf, 1984). In spite of the importance of corporate opaqueness, however, its linkage to firms' hierarchical complexity has never been directly and thoroughly addressed in business studies literature. Thus, the link as to whether and how hierarchical complexity can affect the level of corporate opaqueness remains unclear. There are many past studies that investigate the impact of complex organizational features such as corporate and geographical diversification on firm characteristics, such as CEO market and corporate governance systems (Berry, Bizjak, Lemmon, & Naveen, 2006, Boyacigiller, 1990, Bushman, Chen, Engel, & Smith, 2004, Jennings, Seo, & Tanlu, 2014, Naveen, 2006), but none has drawn from a comprehensive study that explicitly addresses the relationship between hierarchical complexity and opaqueness.

Thirdly, inspired by Enron's case indicating the importance of hierarchical complexity and corporate opaqueness, a proper and comprehensive analysis of the relationship between

complex organizational forms and corporate opaqueness needs to examine all three types of organizational complexity: hierarchical complexity, corporate diversification and geographical diversification. Previous studies find that corporate diversification and geographical diversification can increase the level of information asymmetry between the firm and outside investors, since increasing both types of diversification can provide top management with opportunities to undertake entrenchment behaviours and make it more difficult for outsiders to fully access firm information and be aware of firm activities (Aabo, Pantzalis, & Park, 2015, Bushman, Chen, Engel, & Smith, 2004, Duru & Reeb, 2002, Jennings, Seo, & Tanlu, 2014). However, investigations of corporate and geographical diversification are not sufficient to draw conclusions on the impact of complex organizational forms on opaqueness. This is because corporate diversification and geographical diversification mostly concentrate on the firms' sales diversity across different industry segments and geographical areas which cannot comprehensively reflect the type of complexity that is derived from the firms' complex organizational forms and structures. Thus, in this thesis, I examine the relationship between hierarchical complexity and corporate opaqueness.

Finally, studying the relationship between hierarchical complexity and opaqueness is practically important. It can be seen from the example of Enron that an increase in hierarchical complexity can be associated with a higher level of corporate opaqueness. Increases in hierarchical complexity can lead to information asymmetry between the firms and outside investors which adds to the outside investors' information frictions and makes firms become more opaque and less transparent. Increases in corporate opaqueness could significantly affect firms' cost of capital and investment policies. Insufficient access to useful firm specific information and a subsequent decreased quality of the investors' information environment are found to increase firms' financing costs and reduce firms' efficiency of investment on capital markets (Botosan, Plumlee, & Xie, 2004, Myers & Majluf, 1984, Shroff, Verdi, & Yu, 2013).

Moreover, through influencing the behaviours of capital market intermediaries, such as reducing the forecasting accuracy of financial analysts, increasing opaqueness can also affect capital market functioning and market efficiency (Duru & Reeb, 2002, Healy, Hutton, & Palepu, 1999, Healy & Palepu, 2001, Lang & Lundholm, 1996, Rajan & Zingales, 1995).

Using a sample of U.S. firms spanning 5 years between 2012 and 2016 and employing several proxies for corporate opaqueness from the market's and investors' perspective, the empirical results of the thesis provide support for the positive relationship between hierarchical complexity and corporate opaqueness, implying that the degree of hierarchical complexity is associated with higher firm opaqueness and lower information transparency. Moreover, I also demonstrate that a higher degree of firms' related corporate diversification and an increasing quality of the host country institutional environment mitigate the relationship between hierarchical complexity and opaqueness.

This thesis makes several contributions to the literature. First, this thesis extends the recent conceptual and empirical developments that have focused on investigating the impact of organizational complexity on firms. In this thesis, I directly address hierarchical complexity by integrating the firms' number of subsidiary companies and the number of hierarchical levels which directly construct hierarchical complexity and explicitly investigate the impact of hierarchical complexity on firm opaqueness. Thus, as one important type of organizational complexity, the direct construct and examination of hierarchical complexity extends previous studies that examine how organizational complexity affects the firms both conceptually and empirically. Specifically, previous literature investigates organizational complexity through the lens of corporate diversification and geographical diversification which argues that corporate and geographical diversification reflect firms' organizational complexity by revealing important business and operational information about the firms (Bushman, Chen, Engel, & Smith, 2004, Jennings, Seo, & Tanlu, 2014, Naveen, 2006). While corporate

diversification and geographical diversification can reveal significant operational information about the firms, the degree to which these two types of diversification can reflect organizational complexity is limited. This is because such diversification mostly indicates the firms' sales diversity and proportions of sales by different industry or geographical segments; it cannot directly reflect the dimensions of organizational complexity. In contrast, hierarchical complexity more comprehensively reflects organizational complexity by capturing the complexity of the firms' subsidiary companies and hierarchical structures as well as their interactions in business operations and activities. This is in alignment with the definition of organizational complexity indicating that organizational complexity stands for the differentiations of the units and systems constituting the organization and their dynamic interactions (Anderson, 1999, Dooley, 2002, Glenn & Malott, 2004, Stacey, 2003). Thus, this thesis represents an important extension of the construct and examination of organizational complexity.

Second, this thesis is the first study to examine the impact of complexity stemming from firms' complex hierarchical structures on the information asymmetry between the firm and outside investors, contributing to the literature that investigates how firms' complex business and operational characteristics affect firm transparency. Extant literature finds firms' increasing geographical diversification, international dispersions and multinationality indicated by the proportion of foreign sales can deteriorate the information environment of outside investors and thus increase information asymmetry between the firm and outside investors (Aabo, Pantzalis, & Park, 2015, Ashbaugh & Pincus, 2001, Duru & Reeb, 2002, Hope, Kang, Thomas, & Vasvari, 2009). These studies have implicitly relied on the assumption that firms' concomitant complex business and operational structures resulted from internationalization and that business operational divisions that span across vast distances can be positively

associated with opaqueness. By providing evidence that firms' hierarchical complexity can be positively related to opaqueness, this study fills a gap in current research.

Third, this thesis provides some support to the mixed results in prior literature in terms of the linkage between firms' hierarchical structures and the management's information availability. Prior studies show that the adoption of hierarchical structures can increase top management's information availability and enable top management to have information advantages (Chandler, 1990, Mihm, Loch, Wilkinson, & Huberman, 2010, Wang & von Tunzelmann, 2000, Williamson, 1979), while other studies show that hierarchcial structure can impair top management's information analyzing capabilities and prevent top management from comprehensively understanding the firm's business operations and activities (Gilson, Healy, Noe, & Palepu, 2001, Glenn & Malott, 2004, Habib, Johnsen, & Naik, 1997, Prahalad & Doz, 1981). In this thesis, although I do not directly examine the impact of hierarchical structures on management's information availability and cognition capabilities, the findings of the thesis show that hierarchical complexity is positively related to corporate opaqueness and a reduced quality of outside investors' information environment. Thus, these findings indirectly imply that firms' complex hierarchical structures can reduce top management's information availability and hamper its cognition abilities. Therefore, the findings of the thesis provide some indirect support to the line of literature which argues that firms' hierarchical structures make it difficult for top management to fully and sufficiently get access to firm information.

The thesis is organized as follows. The next chapter includes the literature review and introduces the previous related research. Chapter 3 introduces the theoretical background and hypotheses. Chapter 4 describes the methods of the study that detail the exact construct of variables. Chapter 5 performs the empirical analysis on the relationship between hierarchical complexity and corporate opaqueness and shows the results. The final chapter concludes.

Chapter 2 Literature Review

2.1 Introduction

In this chapter, I present an overview of the literature and related research which are in alignment with my research objectives to demonstrate the line of research on organizational complexity and hierarchical complexity and the literature on corporate opaqueness. I first introduce complexity theory and its applications in nature science, organization science and management studies. I then present the studies of organizational complexity by organization and business studies. Lastly, I introduce the previous research on corporate opaqueness.

As early as the 1960s, organization researchers used the term organizational complexity to depict the complex internal structures and functional departments of organizations. However, research at this stage mostly regarded organizational complexity as the linear and static term that reflected the objective complexity of the organization. With the emergence of complexity theory and its successful application in nature science in the 1990s, researchers in organization science and management studies employed the models and insights from complexity theory as well as its metaphorical implications to transform organization design and improve managerial quality. Following this, research advanced the modern studies of organizational complexity by regarding organizational complexity as the non-linear and dynamic term that considers the dynamic interactions of the organizations' constitute units, systems and departments. Meanwhile, researchers from business studies employ the term organizational complexity to reflect the complexity and diversity of the firms' business activities and examine the impact of organizational complexity on various firm level characteristics. The research in business studies differs from other lines of research into organizational complexity, since business studies use organizational complexity to capture the diversity and reflect business and operational information of firms by directly measuring organizational complexity. Other lines

of research mainly depend on the metaphorical implications of complexity theory and organizational complexity to qualitatively characterise the features of organizations.

This chapter provides the foundations for the study in this thesis. First, as one important dimension of organizational complexity, I conceptually consider hierarchical complexity based on the classic and modern definitions of organizational complexity. The literature reviews on complexity theory and organizational complexity allow me to consider the conceptual and empirical construct of hierarchical complexity. Second, the literature reviews on organization complexity and corporate opaqueness identify the gap in that there is no previous research which studies the impact of hierarchical complexity on corporate opaqueness. I thus fill this void in my study.

2.2 Literature review on organizational complexity

2.2.1 Complexity theory and its applications

Hierarchical complexity is one important type of organizational complexity. Organizational complexity is the term which is used by organization researchers to depict and characterize the inter-relationships among functional units and operations of the organization. Organizational complexity is advanced by complexity theory which originated from nature science. Thus, in this section, in order to provide a finer-grained picture and comprehensive understanding of hierarchical complexity and organizational complexity, I introduce the studies on complexity theory and its applications in nature science and organization science by presenting the literature and related research.

The entities in the natural world are comprised of a number of constituent components which are dynamic and constantly changing, such as the weather systems. The constituent components subsequently consist of a variety of sub-level functional units and elements. In

terms of the constituent components, some of them are related and interconnected through similar sub-level functional units. For example, meteorological factors such as air movements which belong to the same zones are interrelated. Thus, the related constituent components could form a number of sub-systems and these sub-systems constantly interact with each other and generate physical or chemical changes. Such interactions and changes do not follow any regular order and it is difficult to predict them in the future. Thus, the sub-systems and their relationships are non-linear and dynamic and cannot be modelled or predicted by linear and static techniques (Costanza, Wainger, Folke, & Mäler, 1993). Therefore, the constantly changing constituent components and the sub-systems as well as their relationships constitute the complex systems of the natural world.

Thus, in order to explain the operations of complex systems and predict the trend of changes, nature scientists employ complexity theory to study complex systems. Complex systems exist in a range of fields, including chaotic mathematics, biology, psychology, ecology, etc. Manson (2001) states that complexity theory is used to explain non-linear and dynamic relationships which exist in constantly changing entities, rather than equilibrium and static relationships (Manson, 2001).

Nature science researchers use complexity theory to study the internal interactions among complex systems' functional elements and predict the changes which result from internal interactions and relationships within complex systems. Following this, Sambrook and Whiten (1997) characterise the complexity of the systems by measuring the degree of system complexity. In their study, Sambrook and Whiten (1997) describe the system as composed of systematic patterns which can be broken down to the minimum units and levels: such minimum units and levels that are partitioned from the system are referred to as minimum programs which are used to describe the system. The patterns of the system are then organized as organizations. In the system, the information amount of the minimal program is the summation

of pattern information and organizational information. Based on this, they argue that the system's complexity is equal to the number of levels of the minimal program.

In addition to the application of complexity theory in nature science, some efforts have been made to apply the models and concepts of complexity theory to organization studies. Organization scholars analyse operations and emergent behaviours of the organization by using the models and insights originated from complexity theory. The operations and emergent behaviours result from the interaction of the organization's functional units and elements. In this line of studies, the study of Dooley and Van de Ven (1999) is based on chaos theory and deterministic complexity (Dooley & Van de Ven, 1999). Chaos theory is applied in the work of Lorenz (1996), in which he investigates the changes of the weather system (Lorenz, 1996). Chaotic dynamics and deterministic complexity indicate that the outcome of complex systems is unpredictable and chaotic due to the interactions of involved factors. Based on this insight, Dooley and Van de Ven (1999) establish the model which can be used to explain the four dynamic patterns of the event time series of the organizational process. The four dynamic patterns of the event time series are the periodic, chaotic, white noise and pink noise. Dooley and Van de Ven (1999) argue that periodic and chaotic dynamic patterns are essentially governed and determined by precise laws, although chaotic patterns can seem to be irregular and appear to be random. In contrast, pink noise and white noise are essentially random. In the event time series analysis, the path and pattern are unpredictable in the case of randomness. Following this, Dooley and Van de Ven (1999) show that systems with independent factors generate periodic and white noise patterns, whereas systems with interrelated dependent factors result in pink noise and chaotic patterns. Thus, following the implications of the study, researchers can choose and adopt the most appropriate causal process theory to explain the dynamic patterns and outcomes of the organizational processes.

Apart from the study of Dooley and Van de Ven (1999), based on the models of complexity theory, MacIntosh and MacLean (2001) and Stacey and Griffin (2007) argue that one important implication of complexity theory is that the emergence of order and the patterns of behaviours of complex systems are manifested through the process of self-organization which is governed by a set of order-generating rules. The rules enable the systems to operate and function on the edge of chaos, or the equilibrium between randomness and stasis (MacIntosh & MacLean, 2001, Stacey & Griffin, 2007). Under the pressure of changes of the system's internal and external environment, old order-generating rules can be replaced by a new set of order-generating rules so that the system can evolve and adapt to the constantly changing environment (Bechtold, 1997). Therefore, based on the intimations above, Morel and Ramanujam (1999) argue that models which depict the impact of pressure from both the external and internal environment on the organization's changes should be adapted in organizational research (Morel & Ramanujam, 1999). By using the model which is illustrated through a tree paradigm, Morel and Ramanujam (1999) demonstrate that changes in the organization's worst performing units can affect the units and routines which are connected to it. Following this, they argue that the organization's rule of evolution and self-organization is different from that of ecology.

Another representative study is the work by Boisot and Child (Boisot & Child, 1999). Boisot and Child (1999) analyse the potential strategies and alternatives which western firms could take to handle China's complex environment when they have subsidiary companies in China. According to the complex adaptive system theory, the evolution pattern and emergence development of the complex system are determined by the interactions of its local agents and such self-organizing ability enables the system to develop and evolve to adapt to the external environment so as to survive (Holland, 1992, Stacey & Griffin, 2007). Thus, based on the insights of complex adaptive system theory, Boisot and Child (1999) argue that firms could utilize complexity reduction and complexity absorption strategies in order to avoid

uncertainties and the complexity of the external business environment. Specifically, complexity reduction strategy refers to directly understanding and addressing geographical complexity. Complexity absorption strategy refers to circumventing geographical complexity through forming alliances and taking risk-hedging strategies. Boisot and Child (1999) further show that the primary strategy which Chinese domestic firms take to deal with environment complexity is complexity absorption. This is different to the complexity reduction strategy which is preferred by western firms to deal with environment complexity. Therefore, Boisot and Child (1999) point out that in order to reduce the negative impact of environment complexity, western firms could choose between complexity absorption and complexity reduction strategies, the choice of which depends on the consideration of various factors when they operate in China.

Apart from its applications in organization science, another line of research from management studies focuses on using complexity theory to promote organizational change, thus improving managerial quality and optimising organization performance. There is a consensus that organizations should be able to manage change so as to survive and develop in today's ever-changing business environment and the manager's capability to manage change is regarded as one of the organization's core competencies (Benn, Edwards, & Williams, 2014, Brown & Eisenhardt, 1997, Dawson, 2003, Johnson, Scholes, & Whittington, 2002). Thus, with the emergence of complexity theory and its metaphorical implications, management researchers try to take advantage of the ideas of complexity theory to explain why and how organizations should be able to manage change. These researchers argue that like metrology systems, organizations and firms are non-linear systems and complex organizations. By using the implications of complexity theory, particularly aggregate complexity from chaotic mathematics, management researchers argue that organizations should not be stable but rather they should be changing: organizations should be neither too stable nor too chaotic, such

changes should be governed by a set of order generating rules (Lewis, 1994, Lorenz, 1996, MacIntosh & MacLean, 1999, Stacey, 2002). In order to be dynamic rather than stable, researchers show that managers should reject top-down and command-control styles of management and instead, should encourage diversified views and delegate more powers to individuals because individuals are able to shape their present and future through self-generating rules (Bechtold, 1997, Fitzgerald, 2002, MacIntosh & MacLean, 2001, Stacey, 2003, Tetenbaum, 1998). In addition, organizations can only survive through continually innovating and improvising and they should take change as an everyday practice so as to gain competency (Brown & Eisenhardt, 1997).

The studies above show that complexity theory is decomposed into three divisions: algorithmic complexity, deterministic complexity and aggregate complexity. Algorithmic complexity is defined to be the number of bits or pieces of information which is required to generate such complexity (Chaitin, 1990). The measure of algorithmic complexity is to calculate the efforts which are required to solve a mathematical problem and the number of factors needed to predict the given amount of the system's variance, such as finding a shortest path through a network (Manson, 2001, Sambrook & Whiten, 1997).

Deterministic complexity emphasized the resulting outcome brought by the changes of initial conditions. By using deterministic mathematics, the notion of feedback and the degree of sensitivity to initial conditions, deterministic complexity is applied to investigate the unpredictable large and non-linear outcome due to external causes and changes to initial conditions (Fitzgerald, 2002, Stacey, 2003). One application of deterministic complexity is that it could be used to investigate the general trend and boundaries of chaos systems, such as the changes of weather and the butterfly effect.

Aggregate complexity concentrates on the relationships among the entity's or system'sdynamic constituent parts brought along by their interactions. Within a given system, components which are connected tightly form the system's sub-systems although homogeneous components can still display diversity due to the re-structure of their relationships. Such relationships among components and sub-systems constitute the system's internal structure. Based on this, the dynamic interactions of these components and subsequently formed sub-systems push the system to change and adapt to the complex, external environment and thus the entire system grows and evolves through learning and interactions (Holland, 1992).

In conclusion, among these three types of complexity, aggregate complexity provides insights and valuable information into the study of this thesis. In organization and management studies, firms and enterprises with complex business operations and organizational structures are characterised as complex organizations and thus complexity theory and aggregate complexity could be applied to depict organizational operations (Alexander, 1993, Brown & Eisenhardt, 1997, Lewis, 1994, Tetenbaum, 1998). Firms and enterprises which have business operations across different product markets and vast distances have subsidiaries allocated in different product markets and geographical areas. Subsidiary companies which serve homogeneous product markets or the same geographical areas could be regarded as the firms' sub-systems as they are connected to one another through homogeneous ties and relationships. Thus, interconnected sub-systems can be seen as the company's internal structures and the internal structures and their interactions constitute the organizational complexity of the firms. Therefore, aggregate complexity provides metaphorical insights into the study of the organizational complexity of firms.

Moreover, deterministic complexity also provides insights into the study of the thesis by allowing me to consider interactions between the organization and external environment. When firms have subsidiary companies located in geographical regions other than the parent company,

deterministic complexity shows that changes in the initial conditions of the outside environment may influence the firms and cause some kinds of consequences to the firms' characteristics. Therefore, I also include the impact of the external environment into considerations.

2.2.2 Organizational complexity

In this section, I present an overview of the literature on organizational complexity and its applications in business studies. Researchers from business studies employ the term organizational complexity to portray firms' structures and activities. Research at the early stage investigates organizational complexity through differentiations within the organization such as organizational size and divisions of labour. Then, with the exuberance of complexity theory and its application in the field of nature science and organization studies, the development of complexity theory advances the understanding of organizational complexity by including the interactions among the organization's functional parts into consideration. Organizational complexity can affect firms in various dimensions, from management to performance and researchers therefore study organizational complexity so as to capture the important influence of organizational complexity on firms and on transforming firms' performance. The research on organizational complexity can be divided into two strands. The first strand of literature tries to capture the determinants of organizational complexity by investigating various functional features of the organization. The second strand of literature empirically investigates the impact of organizational complexity on various firm level characteristics. I start with the first strand of literature.

2.2.2.1 Determinants of organizational complexity

Prior to the exuberance of complexity theory and its applications in organization science, organization researchers explored organizational complexity from the 1960s. In this strand of

literature, organization researchers capture the determinants and predictor of organizational complexity by examining organization level characteristics and proposing possible measures. Hage (1965) suggests that organizational complexity could be captured by the organization's internal specializations which could be measured by a number of specialized occupations and the length of required training. Pugh, Hickson, Hinings, Macdonald, Turner and Lupton (1963) argue that the size of the organization could be the measure of organizational complexity. Based on prior research, Hall, Johnson and Haas (1967) use the division of labour and the mean hierarchical levels within organization departments to measure organizational complexity. Their study shows that the relationship between size and organizational complexity is not strong (Hall, Johnson, & Haas, 1967). However, under the context of US state employment agencies, Blau's deductive theory of differentiation points out that the size of the organization is the key internal determinant of organizational complexity (Blau, 1970, Blau & Schoenherr, 1971). Based on prior research, Beyer and Trice (1979) study the relationship between the US federal organizations' size and various components of organizational complexity. In their study, they use the number of employees to measure the organization's size and four separate components to represent organizational complexity, namely: vertical differentiation, horizontal differentiation, and division of labour and personal specialization. Vertical differentiation and horizontal differentiation are measured by the number of levels in the tallest part of the hierarchy and the number of supervisors or administrative units who report to the director of the installation, respectively. The division of labour is measured by the number of different job titles, while personal specialization is measured by the salary and educational requirements. The study shows that using federal data, division of labour is an important determinant of organizational complexity, while at the same time, organization size is an important determinant of organizational complexity in the context of state employment agencies (Beyer & Trice, 1979).

Following prior studies and their implications, Boyacigiller (1990) indicates organizational complexity by the job levels of professional employees within the organization. Organizational complexity is argued to affect the management characteristics of the firms. Boyacigiller (1990) examines how organizational complexity could affect the allocation of the proportion of managers between U.S. nationals and domestic nationals in managerial staff. The allocation of management staff with domestic nationality is one important characteristic of the organization's management structure. The reduction of management staff with domestic nationality would result in the parent company's increased difficulty in exercising control through personnel and coordination in multinational companies which jeopardizes the firms' overall information processing capabilities and increases uncertainties among independent and interdependent subsidiaries (Kobrin, 1982). Boyacigiller (1990) argues that the proportion of U.S. nationals in firms' branch management is positively associated with the increasing organizational complexity of the firms due to their technical and managerial competency.

In summary, the literature shows that organizational complexity can be defined to be the amount of diversity or differentiation which exists in the organization and thus organizational complexity could be reflected by the number of its constituent parts and their diversity (Daft, Murphy, & Willmott, 2010, Jablin & Putnam, 2000, Lawrence & Lorsch, 1967, Thompson, 2017). These findings provide some insight for the analysis in this thesis. As one type of organizational complexity, based on the definition of organizational complexity, hierarchically complex firms consist of different subsidiary companies which operate in diverse business operations of the firms. Hierarchical complexity can therefore be reflected by a number of different subsidiary companies operating at various management levels of the firm.

2.2.2.2 Empirical examinations of the impact of organizational complexity on firm level characteristics

In addition to the research of organizational complexity which has been advanced by the success of complexity theory, the second strand of literature studies organizational complexity in the field of business studies. Specifically, this literature focuses on investigating the impact of organizational complexity on various firm characteristics.

The literature finds that organizational complexity can affect many aspects of the firm. In particular, scholars have investigated the impact of organizational complexity on management, the CEO market, firms' corporate governance systems and management forecasting behaviours (Berry, Bizjak, Lemmon, & Naveen, 2006, Boyacigiller, 1990, Bushman, Chen, Engel, & Smith, 2004, Fung & Su, 2006, Jennings, Seo, & Tanlu, 2014, Lee & Yeo, 2016, Naveen, 2006). Organizational complexity is decomposed into business complexity and geographical complexity. Business complexity refers to firms' diversification of sales across different industry segments. Geographical complexity is determined by the firms' diversity of sales in different geographical areas. Business complexity and geographical complexity are argued to reflect organizational complexity by providing important information on the distribution of sales across industries and geographical areas which could reveal operational and informational complexity of the firms (Bushman, Chen, Engel, & Smith, 2004).

In regard to the impact of organizational complexity on the CEO market, Finkelstein and Hambrick (1989) and Rose and Shepard (1994) find that firms with a higher level of organizational complexity tend to hire CEOs with higher capabilities and the replacing of a CEO is more costly, since managing a more complex firm requires more advanced managerial skills (Finkelstein & Hambrick, 1989, Rose & Shepard, 1994). Following this, Berry, Bizjak, Lemmon and Naveen (2006) examine the relationship between organizational complexity and

the CEO labour markets. Specifically, this study examines whether organizational complexity is associated with CEO turnover and succession patterns. The study uses two methods which include dummy variables and a firm's degree of industry concentrations to measure organizational complexity. The study shows that in firms with a high degree of organizational complexity, CEO turnover is insensitive to the firm's financial performance and more complex firms experience less forced CEO turnover than less complex firms. In addition, when the former CEO vacates the position, the newly hired CEO in more complex firms is more experienced, older and paid more (Berry, Bizjak, Lemmon, & Naveen, 2006). They argue that CEO replacement costs are higher in more complex firms than in focused firms due to more complex firms requiring CEOs with greater capability and that CEO turnover in firms with greater organizational complexity is completely insensitive to firms' financial performance. The research findings above are supported by Naveen (2006). Naveen (2006) shows that organizational complexity has significant impact on the benefits and costs associated with the succession of CEOs. Firms of higher levels of organization complexity tend to have greater costs of succession due to the high costs to transfer firm-specific knowledge in such firms. By using firms' industry concentrations to proxy organizational complexity, measured by the Herfindahl-Hirschman index, this study further argues that larger and more complex firms are more likely to replace CEOs through fostering inner candidates, rather than forced replacement (Naveen, 2006).

Another strand of literature studies the impact of organizational complexity on corporate governance systems (Bushman, Chen, Engel and Smith 2004). This study measures organizational complexity using the Herfindahl-Hirschman index which indicates firms' industry concentrations and geographic concentrations. The results show that firms' ownership concentration and directors' equity-based incentives increase with organizational complexity (Bushman, Chen, Engel, & Smith, 2004). Since organizational complexity can provide

management with more opportunities to pursue entrenchment activities, firms require strengthened corporate governance systems to reduce agency costs of equity.

Moreover, Jennings, Seo and Tanlu (2014) examine whether organizational complexity influences manager's earning forecasting behaviours. Following Bushman, Chen, Engel and Smith (2004), organizational complexity is indicated by the firm's industry concentrations and geographic concentrations through the Herfindahl-Hirschman index. The study finds that increasing organizational complexity can result in decreased quality of communications between the firm management and outside investors. Specifically, greater industry and geographical diversifications are negatively associated with the management's forecasting accuracy (Jennings, Seo, & Tanlu, 2014). This is because increases in industry and geographical diversifications can make it more difficult for the management to gain and analyse adequate amounts of business and operational information of the firms which decreases the quality and accuracy of management forecast behaviours.

In conclusion, extant literature mainly focuses on examining whether business complexity and geographical complexity affect firm characteristics. No prior research has been devoted to understanding the impact of hierarchical complexity on firm opaqueness and transparency which is essential to the information environment of outside investors. In this study, I fill the gap by examining how firm opaqueness varies with the level of hierarchical complexity.

2.2.2.3 Hierarchical complexity

In the previous literature of organizational complexity, Glenn and Malott (2004) provide the concept of hierarchical complexity. The study shows that an organization's hierarchical complexity reflects the complex hierarchical and authority structures of an organization which is related to the number of diversifying management layers and authority structures. Moreover, hierarchical complexity can be positively associated with the organization's size, the depth of

its business components and departments and its manufacturing technological development levels. The number of the organization's constituent components, elements and professional labour specializations increases with the organization's business scope and technological development which subsequently require multiple hierarchical and authority structures as well as more management layers (Glenn & Malott, 2004, Thompson, 1967).

Empirically, in addition to the empirical investigations which examine the impact of business complexity and geographical complexity on firms, Altomonte and Rungi (2013) investigate the relationship between business groups' vertical integration, hierarchical complexity and productivity. In their study, Altomonte and Rungi (2013) use hierarchical complexity to indicate the degree of complexity of business groups' hierarchical structures. They analyse business groups as the hierarchical structures which consist of headquarter and subsidiary companies and the hierarchical complexity of the hierarchical structure is indicated by node entropy which considers the number of levels and the number of companies at each level. Their study shows that hierarchical complexity is positively related to the productivity of the business groups. Specifically, they argue that hierarchical structures can internalise the business participants such as subsidiary companies within the business group, enabling more effective transmission mechanisms, reducing fixed transaction costs and effectively improving the transmission efficiency of knowledge and other tangible physical assets.

In conclusion, hierarchical complexity literature provides an important and valuable insight for the study area of the thesis. Conceptually, hierarchical complexity reflects the features of complex hierarchical structures which consist of a number of subsidiary companies operating at various management levels. Moreover, the literature also shows that hierarchy structures may be adapted by firms so as to improve organization efficiency and performance. Empirically, following previous literature, hierarchical complexity is reflected by the number of subsidiary companies and the multiple management layers which are required for

management purposes. Therefore, I include these two essential elements into consideration when constructing hierarchical complexity both conceptually and empirically.

2.3 Literature review on corporate opaqueness

Corporate opaqueness refers to outside investors' inaccessibility to firm-specific information. Corporate opaqueness is the opposite of transparency which impacts on firms' capital structure and financial performance. Corporate transparency is defined to be the availability of firm specific information (Bushman, Piotroski, & Smith, 2004). Transparency is argued to have significant impact on capital market functioning and efficiency (Healy & Palepu, 2001, Rajan & Zingales, 1995), the firm's equity capital costs (Easley & O'hara, 2004, Francis, Nanda, & Olsson, 2008) and capital market intermediaries such as the accuracy of financial analysts (Healy, Hutton, & Palepu, 1999, Lang & Lundholm, 1996). In the literature of business studies, corporate opaqueness could be divided into two streams. One stream of literature examines corporate opaqueness through the lens of transparency, focusing on using firms' annual and financial report disclosures to indicate transparency and corporate opaqueness. The second stream of literature studies corporate opaqueness from the market's perspectives, employing firms' market behaviours and investors' information environment as predictors of corporate opaqueness.

This first stream of research focuses on firm-specific information availability through corporate disclosure reports. Disclosure reports are based on the firm's annual and financial reports which are viewed as the particular important documents which uncover the firms' financial situations, business operations and performance (Botosan & Plumlee, 2002). Thus, transparency is regarded to be the financial disclosure intensity which refers to the degree of availability of the firm's accounting or auditing information and governance disclosure intensity. In this line of research, transparency is widely measured by scoring the firm-specific information availability.

Specifically, researchers construct the score based on firms' published annual reports by selecting the contents of interest from their particular research topic or scheme (Alford, Jones, Leftwich, & Zmijewski, 1993, Botosan, 1997, Bushman, Piotroski, & Smith, 2004, Healy, Kuppuswamy, & Serafeim, 2011, Masry, 2015, Meek, Roberts, & Gray, 1995, Miller, 2002). Alternatively, transparency is also indicated by employing the scoring and ranking reports which are elaborated and released by third parties who are leading financial ranking and evaluating companies, such as the transparency and disclosure score by Standard & Poor's (Botosan & Plumlee, 2002, Lang & Lundholm, 1993, Lang & Lundholm, 1996, Patel, Balic, & Bwakira, 2002, Sengupta, 1998, Welker, 1995).

For example, Miller (2002) indicates corporate transparency by identifying the disclosed information items, having them coded and calculating the number of information items based on their disclosure times which is argued to be able to reflect the voluntary disclosure level of firms. Miller (2002) shows that firms' voluntary disclosure is positively associated with earnings. Botosan (1997) investigates the relationship between firms' voluntary disclosure level and the costs of equity and finds that increased information disclosure helps firms reduce their costs of equity capital. Botosan (1997) divides the annual reports' disclosed information into five categories, namely: the firm's background information, summary of historical results, key non-financial statistics, projected information and management discussion and analysis. By observing whether the required items are disclosed, points are given to the firm if certain items are made known to the public through the annual reports. The disclosure score is calculated by the summation of points given to the firm which is used to indicate the firm's level of voluntary disclosure and transparency. Similar measures are used by Meek, Roberts and Gary (1995) and Alford, Jones, Leftwich and Serafeim (1993). Alternatively, apart from self-constructed disclosure scores, researchers also use disclosure ratings elaborated by third parties to study firms' transparency levels and disclosures. Botosan and Plumlee (2002)

conduct research on transparency by employing the disclosure scores available from the reports of the Association for Investment Management and Research. Botosan and Plumlee (2002) show that although firms' cost of equity capital decreases with the level of disclosure, it increases with firms' timely disclosures which is an obligation that companies have to release prompt information to the public, regardless of whether the information is favourable or unfavourable. In addition, the disclosure scores and ratings reports from the Financial Analysts Federation Corporate Information Committee and Standard & Poor's are also widely used by researchers to study the level of transparency of firms (Lang & Lundholm, 1996, Patel, Balic, & Bwakira, 2002).

The second stream of literature address corporate opaqueness through market perspectives and the information environment quality of outside investors. Following the definition of transparency (Bushman, Piotroski, & Smith, 2004), opaqueness is defined to be the firm-specific information unavailability to the capital market participants. Unlike the previous line of research which investigates opaqueness through transparency and information disclosure, this stream of literature examines corporate opaqueness by focusing on the quality of the information environment of capital market participants, including outside investors and financial analysts (Aabo, Pantzalis, & Park, 2015, Anderson, Duru, & Reeb, 2009, Arping & Sautner, 2013, Duru, Wang, & Zhao, 2013, Ma, Ma, & Tian, 2017, Ravi & Hong, 2014, Upadhyay & Sriram, 2011, Upadhyay & Zeng, 2014).

In this stream of literature, one line of research investigates firm opaqueness from the information environment of analysts. Previous research finds that the quality of the information environment of financial analysts and their forecasting accuracy reflect the level of corporate transparency and market expectations (Brown, 1996, Fried & Givoly, 1982, O'brien, 1988). Based on this, increasing analyst following which is indicated by increases in the number of financial analysts following the firm is argued to be able to increase the corporate transparency

of firms (Brennan & Subrahmanyam, 1995, Coller & Yohn, 1997, Dempsey, 1989, Hong, Lim, & Stein, 2000). Thus, based on the findings of previous studies, Arping and Sautner (2013) study corporate opaqueness by focusing on the information environment quality of analysts. By employing the quality of the information environment of analysts, the study finds that the corporate disclosures and governance reforms which are brought by the Sarbanes-Oxley Act section 404 significantly decrease the level of corporate opaqueness of firms. Following this, Pattnaik, Chang and Shin (2013) find that firms which are affiliated to business groups are more opaque compared to unaffiliated firms, since affiliated firms' reliance on internal financing make them to be less likely to disclose information (Pattnaik, Chang, & Shin, 2013). Moreover, Ravi and Hong (2014) show that marginal increases in the corporate transparency of opaque firms lead to more severe inter-investor information friction among outside investors.

Apart from the research which studies firm opaqueness and transparency through the lens of analysts, another line of research examines opaqueness through the market perspective. Anderson, Duru and Reeb (2009) examine the relationship between corporate founders and their ownership and firm opacity. In the study, firm opacity is studied through the dimensions of market information of firms. This study focuses on: 1) the founder and heir's entrenchment effect which expropriate corporate wealth and 2) founder and heir's monitoring effect which increases corporate performance. On the one hand, previous studies show that controlling and persistent shareholders such as the founder and the heir could extract firm resources and accrue their wealth by reducing information disclosure and increasing firm opacity which is the entrenchment effect (Lang, Lins, & Miller, 2004, Leuz, Nanda, & Wysocki, 2003). On the other hand, opacity could also help the founder and heir to continue their ownership and stay to address the agency problems through the monitoring effect because large and controlling shareholders have compelling incentives to monitor and regulate the behaviours of managers and thus promote firm value and performance (Demsetz & Lehn, 1985, Shleifer & Vishny,

1986). The study shows that compared to more diffuse shareholder firms, founder and heir firms are associated with a larger degree of opacity. Moreover, by examining whether the founder/heir ownership and the associated corporate opacity affect the firm performance, the study further shows that there is a positive relationship between founder/heir ownership and company performance within the more transparent firms in the SP 500 and Fortune 500, suggesting that the monitoring effect plays a dominant role in the more transparent firms. In contrast, there is a negative relationship between founder/heir ownership and company performance in terms of less transparent firms, indicating that the entrenchment effect plays a dominant role in less transparent firms. Following this study, through employing similar ways to examine firm opacity, Upadhyay and Sriram (2011) find that board size is negatively related to the degree of firm opacity which indicates that investors perceive a larger board as able to provide more firm specific information which increases firm transparency. In another study, Upadhyay and Zeng (2014) show that board diversity which is indicated by gender and ethnicities is negatively associated with opacity, suggesting that increasing board diversity could improve the transparency of firms.

Apart from this, Aabo, Pantzalis and Park (2015) investigate the relationship between firms' multinationality and opaqueness. In this study, they define opaqueness as the quality of outside investors' information environment. Specifically, three dimensions of opaqueness are studied, namely: stock price informativeness, analyst forecast accuracy and idiosyncratic risk. Aabo, Pantzalis and Park (2015) argue that increases in multinationality add to the degree of opaqueness of firms, due to the complex business operations and organizational structures which span across vast distances. Through using a similar approach to examine firm opaqueness, Durnev, Errunza and Molchanov (2009) examine how the degree of firm opaqueness affects firm growth and investment efficiency, with respect to countries with secured protection of property rights and countries with less secured protection of property

rights. This study finds that more transparent firms in countries with insecure protection of property rights are associated with worse investment efficiency and grow more slowly, due to the risks of government expropriation.

In conclusion, so far in business literature, researchers examine opaqueness through the lens of transparency and disclosure and through the information environment of the capital market. In this study, I examine the issue of how firm opaqueness varies with degrees of hierarchical complexity which focuses on the information availability and information environment quality of outside investors. In this thesis, corporate opaqueness focuses the firm specific information accessibility to outside capital market participants. Therefore, based on previous literature, I study corporate opaqueness through market and outside investors' information environment perspectives.

Chapter 3 Theoretical Background and Hypotheses

3.1 Introduction

In this chapter, I firstly introduce the concept of organizational complexity so as to provide background knowledge on hierarchical complexity. Following this, I present the definition of hierarchical complexity and corporate opaqueness and introduce the firm level and country level moderators. Specifically, I include corporate diversification, quality of the home country institutional environment and host country institutional environment as moderators.

In this section, I present the concepts of the three moderators. I also discuss the theoretical background as to why I use these three moderators. The corporate diversification of firms, quality of the home country institutional environment where firms are geographically located and quality of the host country institutional environment where the subsidiary companies operate businesses can influence the release and quality of firm specific information that is accessible to outside investors. This can affect the information environment quality of outside investors and firm opaqueness. I therefore include these three moderators in the study.

Next, I present the hypotheses development of the thesis. In this section, I discuss the mechanisms of hierarchical complexity which lead to corporate opaqueness. Following this, in addition to the hypotheses development which focuses on whether and how hierarchical complexity is related to corporate opaqueness, I further examine the theoretical impact of firm level and country level moderators on the relationship between hierarchical complexity and corporate opaqueness.

3.2 Theoretical background

3.2.1 Hierarchical complexity and corporate opaqueness

In the study, I examine the relationship between hierarchical complexity and corporate opaqueness. Hierarchical complexity is one important dimension of organizational complexity. Organizational complexity is defined as the amount of diversities and differentiations that exist within different organizational functional units that constitute the organization (Dooley, 2002, Jablin, Putnam, Roberts, & Porter, 1987, Lawrence & Lorsch, 1967, Luhmann, 1995). The difficulties in coordinating these functional units increase organizational complexity (Daft, 2006, Scott & Meyer, 1994). In particular, an organization is complex if it has diversified functioning units and systems that operate in different categories. For example, the diversities of the different functional departments within the organization, the various roles and specializations of labour and the subsidiary companies could constitute organizational complexity.

Hierarchical complexity is one important dimension of organizational complexity. In organization studies literature, given that complex organizations are comprised of functional systems and subsequent sub-level systems, Glenn and Malott (2004) define hierarchical complexity of the organization as the number of hierarchical and management levels which connect the organization's functional systems and sub-level systems. In this definition, the functional systems refer to the various functional departments and operational labour specialisations of the organization whereas hierarchical levels are equivalent to the management levels of the organization.

Based on the study of Glenn and Malott (2004) which considers hierarchical complexity through the lens of the number of hierarchical levels, in this thesis, I define hierarchical complexity of firms through the perspective of firms' subsidiary companies, the number of

hierarchical levels and the associated subsequent complex hierarchical structures. Thus, in this study, hierarchical complexity of firms is determined by the number of subsidiary companies and the subsequent multiple hierarchical levels at which the subsidiary companies are located.

The origins of the hierarchical complexity of firms are comprised of two issues. The first issue refers to the increasing number of subsidiary companies which can add to hierarchical complexity. Firms could have a number of subsidiaries which serve different business operational purposes primarily due to three categories of motivations: improving firm specific organizational efficiency, gaining international competitive advantages and increasing profitability (Cantwell, 1995, Cantwell & Mudambi, 2005, Chandler, 1990, Danneels, 2002, Dunning, 2000, Zey & Camp, 1996). For example, firms can allocate resources more efficiently and diversify risks by having subsidiary companies. Moreover, due to strategic development goals, firms can also have more subsidiary companies through undertaking mergers and acquisitions. Therefore, as the firm grows and expands its business, the firm can become hierarchically complex as it can add an increasing number of subsidiary companies which play critical roles in the firm's business functions and operations.

The second issue is that firms can organize the subsidiary companies in hierarchical ways and structures so as to transform firm competence and performance. Within the hierarchical structures, a different number of subsidiary companies are located at various hierarchical and management levels based on ownership relationships. Top management strategically plans and arranges product or service processing and manufacturing and organizes industry segments and geographical regions into different subsidiaries. Managers of subsidiary companies have their own control and decision-making rights. Subsidiaries are organized in hierarchical structures so as to address internal and external complexity thus improving firm specific efficiency (Anderson, 1999, Chandler, 1962, Van de Ven & Poole, 1995). As the firms grow and develop, firms can encounter a larger degree of complexity which arises from inside and outside the

firms, including complexity of product associated R&D and manufacturing technologies, complexity of administration and management and complexity of the sophisticated external environment conditions (Hobday, 1998, Mintzberg, 1979, Rosenberg, 1994, Sharp & Galimberti, 1993). As a result, in order to address the internal and external complexity, the firms develop hierarchy so as to cope with increasing complexity which arises both internally and externally and transforms performance. Specifically, hierarchical structures enable the firm to better allocate authority and communications. Managers of subsidiary companies can improve efficiency in coordinating product flows from production to distribution based on actual conditions of the local environment, while top management can strategically allocate resources and responsibilities among managers of subsidiary companies who are in charge of diverse business activities (Chandler, 1990, Zey & Camp, 1996).

However, hierarchical complexity is then derived from the complex structures of the firms, and the degree of hierarchical complexity can get larger as the number of hierarchical levels of the firm increases. One important implication of hierarchical complexity is that high level management becomes increasingly unrelated to the contingencies of the lower levels as hierarchical complexity increases which disconnects the top management from subsidiaries (Glenn & Malott, 2004). Due to the increasing number of subsidiary companies, firms would require more management levels to take management responsibilities and such management levels also enable the subsidiaries to be connected at different hierarchical levels. In this case, increases in the number of subsidiary companies and the associated hierarchical levels add to hierarchical complexity. The concomitant hierarchical complexity thus increases disconnects between top management and subsidiary companies and results in inconsistency between tiers of the firm which adds significant difficulty for top management to control and coordinate the subsidiary companies and makes top management increasingly unrelated to the subsidiaries.

Therefore, hierarchical complexity can jeopardize the management efficiency and quality and threaten the organization's success (Glenn & Malott, 2004, Scott & Meyer, 1994).

Corporate opaqueness is defined to be the situation in which outside investors are not able to get effective access to the firm's underlying economic situation in understandable ways through disclosure and reports (Barth & Schipper, 2008). Opaqueness happens when there is an insufficient amount of firm-specific information that is useful to outside investors for making investment decisions. This is the opposite side of corporate transparency (Bushman, Piotroski, & Smith, 2004). Corporate opaqueness is related to the ease with which information flows from the firm to outside investors in a timely manner. If the firms become more opaque, it is more difficult for outside investors to analyse and predict the firms' performance and values. Opaqueness is important to the firms because it could affect the firms' cost of capital, capital structures and investment policies (Barron, Sheng, & Thevenot, 2012, Durnev & Mangen, 2009, Francis, Nanda, & Olsson, 2008).

3.2.2 Moderators: Corporate diversification and quality of the institutional environment

In addition to the investigation of the relationship between hierarchical complexity and opaqueness, I also examine whether and how this relationship could be affected by firms' corporate diversifications, quality of the home country institutional environment and host country institutional environment.

First, as one important business characteristic of firms, corporate diversification has been empirically studied by scholars. Business researchers describe corporate diversification as the term that characterises the diversification of the firms' industry and business segments (Palepu, 1985). Corporate diversification refers to the situation where firms' business scope expands to multiple industry segments and which reveals important business and operational information

of the firms by providing details on the distribution of sales across a number of various industry segments. Prior literature has shown that the relationship between corporate diversification and firm transparency is controversial. In particular, the literature on corporate diversification provides conflicting predictions on how corporate diversification affects the level of information asymmetry between the firm and the outside investors on the capital market. One strand of literature offers some evidence for a positive relationship between corporate diversification and information asymmetry which documents that an increase in corporate diversification is related to a reduction of firms' transparency. Specifically, from the outside investors' information friction perspective, Nanda and Narayana (1999) show that corporate diversification can lead to information asymmetry between the firm and outsiders on the capital market (Nanda & Narayanan, 1999). They argue that the disaggregated information such as the unobservable information on firms' cash flows of different industry segments and operational divisions cannot be accessible to outside investors due to corporate diversification since the outside investors only receive consolidated information, selectively reported by the management, which may be less related to firms' business operations and activities (Ataullah, Davidson, Le, & Wood, 2014, Krishnaswami & Subramaniam, 1999, Thomas, 2002). Duru and Reeb (2002) show that increasing corporate diversification is positively related to the use of incentive-based CEO compensation and greater reliance on market-based firm performance measures, instead of accounting-based measures. This is because increases in corporate diversification can lead to more severe information asymmetry between management and shareholders and thus more effective management incentive and monitoring mechanisms are required by the shareholders. Additionally, following similar arguments that increases in corporate diversification can be associated with a larger degree of information asymmetry between managers and shareholders, Bushman, Chen, Engel and Smith (2004) find that ownership concentration and directors' equity-based incentives of the firms' corporate

governance systems increase with the growth of corporate diversification. This implies that corporate diversification is associated with moral hazard problems and the reduction of firm transparency. From the analyst forecasting perspective, Dunn and Nathan (1998) find that analyst forecasting accuracy is negatively associated with corporate diversification since the information complexity of diversified firms can add difficulty for the analysts in processing and analysing the information of firms (Dunn & Nathan, 1998).

However, another line of literature shows that the relationship between corporate diversification and firm transparency is not significant. In other words, corporate diversification might not necessarily lead to information asymmetry between the firms and outside investors. Thomas (2002) provides evidence that a larger degree of corporate diversification is not associated with increases in information asymmetry between the firm and outsiders which indicates that corporate diversification is not significantly related to firm transparency (Thomas, 2002). In another study, Clarke, Fee and Thomas (2004) show that on average, industry diversified firms are associated with less severe information asymmetry between the firm and outside investors. and thus this study argues that corporate diversification is not on average related to an increase in information asymmetry and a reduction in firm transparency (Clarke, Fee, & Thomas, 2004). According to the studies above, it is argued that diversification in industry and business segments can reduce the occurrence of forecasting errors of outsiders and provide more information sources to outsiders. Specifically, these authors argue that the outsiders' errors in forecasting cash flows of each industry segment of diversified firms are imperfectly correlated and thus the portfolio theory indicates that the absolute value of the percentage of errors in forecasting the firms' cash flows may be smaller for diversified firms than for focused firms (Hadlock, Ryngaert, & Thomas, 2001). In this case, corporate diversification can help to reduce the analyst forecasting errors of the firms which can effectively alleviate the information asymmetry between the firms and outside investors.

Therefore, when firms are hierarchically complex, hierarchical complexity may hamper the quantity and quality of information obtained by outside investors. In such cases where firms become opaque to outside investors, the presence of corporate diversification of firms may influence the information environment quality of outside investors. This is because corporate diversification can affect the information availability and information processing difficulty of the firm management as well as the forecasting accuracy of the analysts which in turn influences the level of information accessibility of the outsiders. Thus, the level of firm opaqueness may vary with the interaction between hierarchical complexity and corporate diversification. Moreover, the investigation into the moderating effect of corporate diversification can also help to solve the existing controversies in the literature by indirectly examining the impact of corporate diversification on information asymmetry between the firms and outsiders.

Second, the principle-agent problem can exist between the firms and the outsiders. The outside investors invest their money in the firm and they hope to gain investment returns but the outsiders do not directly participate in the firms' management and business activities. Thus, the strategy and development goals of firms are not always in alignment with those of outside investors. The strategies of firms can deviate from or even conflict with the benefit of outside investors. In this case, firms have incentives to retain and expropriate the outsiders' money and investment returns to gain development opportunities by sacrificing outside investors' interest (Anderson, Duru, & Reeb, 2009, Jensen & Meckling, 1976, Lang, Lins, & Miller, 2004). Therefore, principle-agent problems can exist between the firms and outside investors due to the lack of goal convergence and a different division of labour (Lang & Lundholm, 2000). In hierarchically complex firms, hierarchical complexity can aggravate agency problems between the two parties by providing firms with more opportunities to act on self-interest seeking behaviours at the expense of outside investors' benefit, especially the benefit of minority

investors and shareholders. This is because due to the corporations' complex operations and organizational structures, it could be difficult for outside investors to gain an adequate and sufficient amount of firm-specific information. This masks firm activities and aggravates agency conflicts between the firms and outsiders (Callen, Hope, & Segal, 2005, Doukas & Pantzalis, 2003, Duru & Reeb, 2002, Hope & Thomas, 2008, Huang, 2012). Therefore, institutional rules and institutional environment regulations may influence agency conflicts and the degree of firm opaqueness between the firm and outside investors. Strong policies, legal enforcement and effective regulations from the external institutional environment can rule and discipline the behaviours of the firms and the subsidiary companies by increasing the costs and difficulty involved for the firms to undertake expropriation behaviours (La Porta, Lopez‐de‐Silanes, Shleifer, & Vishny, 2000). Thus, improving the quality of the institutional environment can counteract the impact of hierarchical complexity on corporate opaqueness and function as a moderator on the relationship between firms' hierarchical complexity and corporate opaqueness.

Therefore, in this thesis, inspired by previous studies which examine the impact of corporate diversification on information asymmetry and firm transparency, while I do not directly examine the impact of corporate diversification on firm transparency, I include firms' corporate diversification as the moderating factor and examine the moderating effects of corporate diversification on the relationship between hierarchical complexity and firm opaqueness. Following this, I investigate the moderating impact of the home country institutional environment quality and the host country institutional environment quality on the relationship between hierarchical complexity and corporate opaqueness.

3.3 Hypotheses development

Hierarchical complexity and corporate opaqueness

The channels through which hierarchical complexity leads to opaqueness have two components, with the first component consisting of two issues. The first issue stands for the disconnections and unrelatedness which are derived from hierarchical complexity between top management and subsidiary companies, while the second issue refers to the reduced quantity and quality of communications between the firms and outsiders. The second component indicates the information friction between the firm and outside investors which is derived from the affiliated companies (i.e. subsidiaries of subsidiary companies) of the firms.

In regard to the first component, hierarchical complexity could cause disconnections and unrelatedness between top management and the subsidiary companies. In particular, disconnections refer to the situation where the top management of the parent company is not effectively connected to the business operations of the subsidiary companies which hampers the information flows between the parent company and subsidiary companies. Unrelatedness indicates the situation when the information flows between the parent company and subsidiary companies can be incomplete or even distorted. The hierarchical complexity and the resulting disconnections subsequently increase the difficulty and costs for the top management of the parent company to obtain sufficient information on firm operation and performance which consequently reduce the quality and quantity of the communications between the firm and the outside market. Thus, corporate opaqueness is derived from the outside investors' inaccessibility to firm information and their lack of clarity regarding firms' activities and performance.

Specifically, the first issue is that hierarchical complexity could prevent top management from being properly informed on the operations and contingencies of the firm and its subsidiaries.

The increases in the hierarchical levels add to management distance between headquarters and subsidiary companies and thus a larger degree of hierarchical complexity can make management at the parent company be increasingly unrelated to management at the subsidiary companies. As a result, such disconnections weaken the linkage between top management and subsidiary companies which makes it difficult for top management to obtain sufficient and comprehensive information on the firm's operations. Hierarchical complexity and the subsequent disconnections make the reporting and provision of information to top management become costly, since the efficiency and accuracy of information reporting can be less as a result of the firms' complex hierarchical and management structures (Christie, Joye, & Watts, 2003, Dikolli & Vaysman, 2006). Thus, hierarchical complexity jeopardizes the information flows between the subsidiary companies and the parent company. Consequently, it could become difficult for top management to be well informed about the firm's operations. Moreover, through years of experience, some subsidiary companies may have gained relative independence and autonomy due to their resources and competitive advantages (Bartlett & Ghoshal, 2002, Ghoshal & Bartlett, 1990, Gupta & Govindarajan, 1991, Hedlund, 1994). Consequently, the relative independence of the subsidiary companies enables them to be able to restrict the quantity and quality of information that is reported to the top management of the parent company, since the management of subsidiaries may distort information so as to pursue self-interests or mask business performance (Dikolli & Vaysman, 2006). Therefore, a higher degree of hierarchical complexity could increase the difficulty and cost for the top management to obtain sufficient information on the firms that are connected to the parent company through a chain of ownership linkages.

The second issue is that top management's insufficient information availability which is due to hierarchical complexity can decrease communications between the firm and outside investors which can, in turn, reduce the investors' firm-specific information accessibility and lead to

opaqueness. First, the management's insufficient information availability hampers the top management's capability to comprehensively analyse the firm and its operations, since top managers must gather and process adequate information and data so as to understand, analyse and control the firm. Second, although managers may intentionally and selectively release fractions of firm information in the annual report under the allowance of current accounting standards (Bushman, Chen, Engel, & Smith, 2004, Gordon, Loeb, Lucyshyn, & Sohail, 2006, Jennings, Seo, & Tanlu, 2014), the reduced quantity of information obtained and analysed by the management due to increases in hierarchical complexity can cause managers to disclose an even less amount of useful firm-specific information to the external market participants because managers themselves do not have much information (e.g., about the firms' and the subsidiary companies') to disclose (Jennings, Seo, & Tanlu, 2014). Consequently, top management's insufficient information availability reduces the quality of the firms' financial statements and accuracy of management forecasting behaviours which decreases the values of annual reports and firm disclosures (Dye, 1985, Jennings, Seo, & Tanlu, 2014, Jung & Kwon, 1988). Thus, hierarchical complexity finally diminishes the quality and effectiveness of managers' communication with external market participants. As a result, the decreased communications between management and outside investors reduce the amount and informativeness of firm-specific information that is released to the outside market participants which makes it more difficult for outside investors to get access to firm information and understand firm performance and operations. Although some analysts might have their own private ways to obtain firm information, the annual reports and financial statements released by the firms are the primary sources for outside investors and analysts to gain firm specific information but despite that it is not possible for investors to access the complete and total amount of information. In this case, increasing hierarchical complexity could make it difficult

for outside investors to obtain a sufficient amount of information about the firms. Thus, opaqueness increases as firms become more hierarchically complex.

Apart from this, hierarchical complexity can also make firms become opaque because of the regulatory barriers which are derived from the firms' affiliated companies. Under the requirements and regulatory standards of the U.S. Securities and Exchange Commission (SEC), firms should disclose firm-specific information in the consolidated financial statements which combine financial information of both the parent company and its subsidiary companies. In particular, firms are required by the SEC to disclose information on subsidiaries under Item 601 of Regulation S-K. However, the SEC does not require firms to disclose information of affiliated companies in which the firms do not have a majority stake. In this case, the financial statements and annual reports of the firms do not include or reflect information on the activities and performance of the affiliated companies. As a result, it can be difficult for outside analysts and investors to access comprehensive firm-specific information due to the regulatory barriers, as well as the information friction of affiliated companies which are located at longer distances in the chain of ownership linkages. Consequently, the firms can become more opaque and less transparent.

Hypothesis 1: There is a positive relationship between firms' hierarchical complexity and corporate opaqueness.

Firms' corporate diversification

Corporate diversification refers to the situation where the firm operates in more than one industry sector. Firms' corporate diversification includes related corporate diversification and unrelated corporate diversification. Related corporate diversification stands for the situation where the firms' diversified industry segments share similar resources such as similar assets, skills and product manufacturing process and technologies with each other. In contrast,

unrelated corporate diversification indicates the condition when the firms' diversified industry segments' resources such as product manufacturing and categories are different to each other. Both related and unrelated corporate diversification can influence the relationship between hierarchical complexity and opaqueness.

First, the related corporate diversification of firms can improve top management's information disclosure capability by reducing management's difficulty in processing and analysing information on firm activities and operations. Firms with related corporate diversifications can have divisions and subsidiary companies operate in industry segments that share similarities. When firms have divisions and subsidiary companies operating in related industry segments, the firms' scope of products and the market situations of the subsidiary companies share relevant characteristics, since the firms can allocate similar technologies and managerial capabilities to the related industry segments (Nayyar, 1993). Thus, the information which is required to understand and analyse the operations of the firm and subsidiary companies is homogeneous.

In particular, information on the divisions and subsidiary companies which operate in one industry segment could span over more than one industry because operating and business information on the scope of products and resources, as well as the associated business and market conditions of the related industry segments, can have a high degree of commonality (Breschi, Lissoni, & Malerba, 2003, Teece, 1982). Moreover, managers of firms which have a related corporate diversification process and analyse information from a lower number of sources with less varieties simplify the procedures to process information and data and improve efficiency (Jennings, Seo, & Tanlu, 2014). As a result, firms' related corporate diversification and the associated lack of variety of the industry segments where subsidiary companies operate could reduce the cost and difficulty for top management to process and analyse information.

Therefore, related corporate diversification effectively improves top management's capability to know and understand the firm operations which enhances the accuracy of management forecasting behaviours and improves information disclosure quality. In this case, the benefits of information synergies brought by related corporate diversification partly offset the information insufficiency resulting from hierarchical complexity. Thus, related corporate diversification can mitigate the relationship between hierarchical complexity and the opaqueness of firms.

Second, unrelated corporate diversification could strengthen the relationship between hierarchical complexity and opaqueness by aggravating management's difficulty in processing information and analysing the operations of the firm. In contrast to management's reduced difficulty in processing and analysing firm information due to related corporate diversification, unrelated corporate diversification exacerbates such difficulty. In firms that have corporate diversification, the success of the firms relies on the top management's capability to manage a wide range of opportunities and risk brought by corporate diversifications. When firms operate businesses in a number of different and unrelated industry segments, the different and unrelated industry segments can increase the difficulty for top management to process and analyse information. This is because the varieties and differentiations of the firms' business scopes can add a number of different information sources to management which can hamper the information processing capabilities of managers from the parent company (March & Simon, 1958). In firms that operate business in unrelated industry segments, the industry segments of the firms are different and may share less synergies with each other. Thus, the differentiations among unrelated industry segments require that top management has specialised information on each industry division so as to analyse firm operations in various industries. Hence, the specialised information from various sources adds cognitive challenges such as information loadings to management when processing and analysing information (Scott, 2015).

Moreover, the processing and analysis of information on the operations of subsidiary companies from particular industries requires understanding of local business conditions and environments. Such information needs to be gained through years of experience and cannot be easily transferred with technological methods (Christie, Joye, & Watts, 2003). As a result, top management of hierarchically complex firms which are engaged in unrelated corporate diversification faces greater challenges and costs to collect, aggregate and process information and data which reflect business activities and performance of the companies from various unrelated industry segments (Bushman, Chen, Engel, & Smith, 2004, Jennings, Seo, & Tanlu, 2014, Scott, 2015). Therefore, the firms' complex business operations which stretch over a number of different unrelated industry segments add to the impact of hierarchical complexity on opaqueness and are perceived to be less transparent.

Third, related corporate diversification and unrelated corporate diversification can affect the forecasting accuracy and predicting capabilities of financial analysts differently which in turn, affects the relationship between hierarchical complexity and opaqueness differently. Specifically, when the firm has corporate diversifications in related industry segments, analysts following the firm can apply a significant proportion of information and expert knowledge of one industry segment to another and thus analysts can collect, process and analyse information in terms of the firm's industry segments simultaneously (Bhushan, 1989, Dunn & Nathan, 2005). Therefore, related corporate diversification can reduce the difficulties for analysts to analyse firm activities and forecast firm performance. However, analysts can face greater difficulty and complications in terms of firms which diversify in unrelated industry segments. Firms with unrelated corporate diversification have business and industry segments from a number of different and unrelated industries while individual analysts often specialise within one particular industry. Thus following the firm with unrelated corporate diversifications can

exceed the analysts' areas of expertise at least along some dimensions (Clarke, Fee, & Thomas, 2004, Thomas, 2002).

Moreover, when following firms with unrelated corporate diversification, analysts have to become familiar with the information and data from multiple industry segments separately which adds greater difficulty and complications for analysts. (Dunn & Nathan, 2005). Therefore, related corporate diversifications can reduce the difficulty faced by analysts and increase forecasting accuracy which provides a relatively larger amount of useful information to outside investors and alleviates the level of firm opaqueness. In contrast, unrelated corporate diversifications can reduce the forecasting accuracy and weaken the predicting capabilities of analysts which increases the level of firm opaqueness.

Hypothesis 2a: Increases in related corporate diversification weaken the relationship between firms' hierarchical complexity and corporate opaqueness.

Hypothesis 2b: Increases in unrelated corporate diversification strengthen the relationship between firms' hierarchical complexity and corporate opaqueness.

Home country institutional environment

Firms develop and operate in states with different institutional environments with some states having stricter institutional policies and better institutional environments. However, due to various factors such as remote geographical locations and different economic development levels, the quality of institutional environments may vary across states. The federal state's institutional environment could influence the linkage between hierarchical complexity and opaqueness by affecting agency conflicts between the firm and outside investors.

The moderating effect of the quality of institutional environment on the relationship between hierarchical complexity and opaqueness has two key components. The first component is that regulating authorities set obligatory laws and regulation rules so as to increase firm

transparency and protect the outside investors' rights and benefits, for example, state governments establish obligatory regulation policies and laws which promote corporate transparency, including advancing auditor independence and actively encouraging firms to improve information disclosures.

The second component is that improved quality of the state institutional environment could affect the degree of opaqueness by alleviating agency conflict between the firm and outside investors. A higher quality of the institutional environment where firms are located can reduce the degree of opaqueness by influencing firms to consider more fully the mutual benefit which exists between firms and outside investors. During the growth periods and development process of firms, the institutional environment stipulates social, political and legal rules that regulate the behaviours of the firms. In other words, firms operate on the ground and basis set by the institutional environment (Davis, North, & Smorodin, 1971). This institutional environment is comprised of both formal and informal regulations. Formal regulations refer to the constraints from political and legal rules, while informal regulations consist of codes of conduct, moral standard of behaviours and traditional outlooks on value that are included in the culture and ideology of the society (North, 1990). Both the formal and informal regulations set obligatory rules for firms and firms operate and develop by adhering to these rules and interacting with them (Hillman & Keim, 1995). In the states that have relatively more strict institutional rules and policies, firms are assumed to be more or less influenced to follow the obligatory rules set by the institutional environment. Similar to the growth from childhood of human beings, the influence from the institutional environment lasts for the entire time span and development process of the firms' growth from establishment. As a result, firms which are located in states with an improved institutional environment quality are more likely to have the potential to increase the quality and quantity of firm-specific information disclosures and adjust the degree of corporate opaqueness. Moreover, these firms are more likely to take investors' benefit into

account when making business decisions and strategic choices. In addition, such a mutual relationship would also benefit the firms by reducing their costs of capital and optimising their equity structures. As a result, the level of outside investors' information inaccessibility and agency conflict between the firm and outside investors could be alleviated due to the imperceptible regulations and influence imposed by a better quality of the institutional environment. Therefore, increasing the quality of the institutional environment where firms are located could negatively moderate the relationship between hierarchical complexity and opaqueness.

Hypothesis 3: Increases in the quality of the home country institutional environment mitigate the relationship between firms' hierarchical complexity and corporate opaqueness.

Host country institutional environment

With corporate growth and business expansions, some hierarchically complex firms have subsidiary companies operating in different countries. Firms expand business overseas so as to utilize location advantages and gain competitive advantages, such as accessing strategic assets, exploiting local resources, reducing manufacturing costs and expanding their markets (Coase, 1937, Dunning, 2000, Dunning, 1988, Geringer, Tallman, & Olsen, 2000, Rugman, 1981, Rugman & Verbeke, 2001, Williamson, 1979). In order to gain such advantages and strengthen competency, firms can establish subsidiary companies overseas. The subsidiary companies conduct business in different countries with diversified economic development levels and cultures and thus the quality of the institutional environment of the host countries where subsidiaries operate varies. For firms which have subsidiary companies operating in host countries with strict regulation policies and law enforcement, a high-quality host country institutional environment could mitigate the relationship between hierarchical complexity and corporate opaqueness in several ways.

First, strict institutional regulations and rules of the host country are necessary to regulate and discipline the degree of opaqueness of firms derived from hierarchical complexity. When firms have subsidiaries located in a number of countries, firms can have more complex hierarchical structures. As a result, firms can use the complex hierarchical structures of subsidiaries to undertake related party transactions between the parent company and foreign subsidiaries as well as among subsidiaries.

Related party transactions mean the business deals and arrangements which are made between two related parties. Some of the related party transactions are developed in accordance with the firms' development strategies, while there are also some related party transactions which are performed to expropriate the wealth of investors. Although accounting standards and monitoring mechanisms exist to discipline related party transactions, these mechanisms do not eliminate related party transactions, since related party transactions can be part of contracting between the firm and subsidiary companies and firms may enter into but do not disclose the related party transactions (Kohlbeck & Mayhew, 2010, Kohlbeck & Mayhew, 2004). In this case, hierarchically complex firms could maliciously transfer wealth and hide and distort financial information by performing related party transactions at the expense of investors' benefits (Johnson, La Porta, Lopez-de-Silanes, & Shleifer, 2000, La Porta, Lopez-de-Silanes, & Shleifer, 2006, Nekhili & Cherif, 2011). The most direct consequence of fraudulent related party transactions is that executives can enrich themselves and generate misleading financial statements. This can jeopardize firms' transparency and make firms become more opaque. For example, the parent company and subsidiaries could fraudulently transfer funds to each other so as to distort and mask financial information and performance. The distorted and false financial and accounting information can be misleading to outside investors when they analyse the firm value and make investment decisions.

Among related party transactions, foreign subsidiary companies play important roles in enabling the firms to undertake such frauds. Hierarchically complex firms with subsidiary companies allocated at various geographical regions and the associated information asymmetry provide subsidiaries with capabilities and opportunities to undertake such fraudulent behaviours. This is due to investors' information inaccessibility to foreign subsidiary companies and home country regulating authorities' lack of monitoring of behaviours of foreign subsidiary companies which result from the firms' complex hierarchical structures. Therefore, strict institutional regulation rules and policies of the host countries are required to discipline the behaviours of firms and the foreign subsidiary companies.

Second, increasing the quality of the host country institutional environment can affect the level of opaqueness by regulating the behaviours of local subsidiary companies. The development of the host country institutional quality, particularly the regulating authorities and legal systems, plays a critical role in ruling the behaviours of local subsidiaries and reducing the occurrence of fraudulent related party transactions. By applying strict and comprehensive accounting and auditing standards, strict regulatory policies and powerful legal enforcement systems of the host countries help to increase the subsidiary companies' accounting information reliability and financial transparency. The local subsidiaries are required to report reliable and true financial statements and information on business operations. Thus, for those subsidiary companies which are involved in fraudulent related party transactions, more strict regulatory standards effectively reduce the opportunities for them to participate in such related party transactions (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998). Moreover, improvement and adoption of regulations and reinforced law enforcement make the fraudulent behaviours difficult to apply. In such cases, firms and the subsidiary companies would have to go through more distorted and complicated ways to undertake such behaviours. For example, under effective investor protection rules, firms and the subsidiaries have to set up more affiliated

companies so as to use fraudulent related party transactions to enrich the firm, which could take up a remarkable amount of time and capital resources and tend to be efficiency wasteful (Shleifer, Vishny, La Porta, & Lopez-de-Silanes, 2000). As a result, increasing the quality of the host country institutions where strict regulation policy and law enforcement powers apply could effectively regulate the behaviours of the firms and the subsidiary companies and subsequently force the parent firm to provide more reliable financial statements and disclose greater amount of accurate information. Thus, improvement of host country institutions increases corporate transparency and reduces corporate opaqueness which is due to hierarchical complexity.

Hypothesis 4: Increases in the quality of the host country institutional environment weaken the relationship between firms' hierarchical complexity and corporate opaqueness.

Chapter 4 Methods

4.1 Introduction

In this chapter, I present the empirical strategy for testing my hypotheses. First, I describe the databases used for this study. Second, I specify the measurements for the dependent, independent and control variables which are included in the baseline model. Following this, I then introduce the measurements for the moderating variables which include firms' related corporate diversifications, unrelated corporate diversifications, quality of the home country institutional environment and host country institutional environment. I will formally test whether they moderate the relationship between hierarchical complexity and corporate opaqueness in the next chapter. Lastly, I specify the empirical models as well as the empirical strategies to address potential endogeneity bias.

4.2 Data

In this study, I employ data from U.S. companies to test my hypotheses. U.S. companies are especially appropriate for studying the relationship between hierarchical complexity and opaqueness of firms because US companies account for a large share of the world's firms that have complex hierarchical structures and business operations, some of which may spread over several world regions. Thus, they present an ideal context for the study of hierarchical complexity and opaqueness.

The sample includes the universe of firms listed on NYSE, NASDAQ and AMEX, which are the largest stock exchange markets of the United States. The sample period is from 2012 to 2016, inclusive. I require that firms have information on subsidiaries which I use to construct the measure of hierarchical complexity. I draw on the Bureau van Dijk (BvD) database, which contains data and information for the subsidiaries of firms. I use the CRSP and I/B/E/S

databases to obtain the daily stock data of firms and the analyst data which I use to construct the corporate opaqueness variables. I use the Compustat database to obtain firms' financial and accounting data. I refer to the US Census Bureau and US Department of Labour database to collect the data that is used to construct the home country, federal state institutional environment variables. The data on the host country institutional environment is obtained from the World Bank databases. In the sample, the original number of firms from the Compustat fundamentals annual database is 7041 but I drop firms that are from financials, public utilities and firms with unclear industry classifications. Financial firms have different financial structures and public utilities are highly regulated. Moreover, I also drop firms with missing SIC codes, missing BvD database identification numbers and missing Central Index Key (CIK) numbers. After processing the duplicates of firms within the databases and merging different databases, the final sample includes 1,667 firms with 8,335 firm-year observations covering the 5 year period from 2012 to 2016.

4.3 Measures

4.3.1 Dependent Variables

Opaqueness index. The dependent variable, opaqueness, refers to the firm-specific information unavailability to outside investors (Bushman, Piotroski, & Smith, 2004). Based on previous studies (Duru, Wang, & Zhao, 2013, Upadhyay & Sriram, 2011, Upadhyay & Zeng, 2014), I measure corporate opaqueness by an index which ranks the opacity or transparency of each firm in the sample. The opaqueness index is comprised of three components which are the share turnover of the firms' stock, the bid-ask spread and the number of analysts following. The share turnover and bid-ask spread belong to the category of the information environment of the capital market. Share turnover is calculated by the mean daily trading volume divided

by the outstanding shares of one fiscal year. The bid-ask spread is measured by the mean daily bid-ask spread of the fiscal year. In addition to the category of the capital market information environment, the opaqueness index is also complemented by the category of capital market intermediaries, the analyst following. The analyst following is obtained through the mean number of analysts following one firm within the fiscal year.

After computing the values of the three components, in order to construct the corporate opaqueness index, following Anderson, Duru and Reeb (2009) and Duru, Wang and Zhao (2013), I rank each of the three components into deciles. In each component, I assign the point value from 1 to 10 to each firm: the value 10 indicates the highest level of opaqueness and the value 1 means the lowest level of opaqueness. Then each firm in the sample is assigned with points of value from all three components. The comprehensive and robust opaqueness index is then computed as the sum of assigned points of value of each firm divided by 30, which is the total possible points from the three components. As a result, the opaqueness index ranges from 0.1 to 1 with the larger value indicating a higher level of opaqueness.

Information transparency. Following Aabo, Pantzalis and Park (2015) and Durnev, Errunza and Molchanov (2009), I also proxy corporate opaqueness using the information transparency of firms so as to provide a more comprehensive examination of the linkage between hierarchical complexity and opaqueness. Information transparency measures the degree of stock price synchronicity (Morck, Yeung, & Yu, 2000). Specifically, if the firms' stock returns move more asynchronously with the market returns, then the stock returns would contain a greater amount of firm-specific information which could be reflected in the stock prices (Durnev, Errunza, & Molchanov, 2009). In this case, the increases of firm-specific information accessibility would make firms be less opaque and more transparent to outside investors. The information transparency is constructed following the market model regressions:

$\gamma_{i,w,t}=\alpha_{i,t}+\beta_{i,t}*\gamma_{m,w,t}+\varepsilon_{i,w,t}$

In the model, I regress stock returns of firms on the returns of the market index. $\gamma_{i,w,t}$ is the excess return for stock *i* in week *w* in year *t*, $\gamma_{m,w,t}$ is the value-weighted excess return of the US stock market index in week *w* in year *t*. I use weekly data instead of monthly data and daily data because the number of monthly observations might be small and in addition, weekly data can also avoid the problem of non-trading observations which are derived from using daily data (Conrad & Kaul, 1988). Following the study of Durnev, Errunza and Molchanov (2009), I use the logarithmic transformation of coefficient of determination which is obtained from the regressions above to measure firms' information transparency:

Information transparency= $\ln[(1-R2)/R2]$,

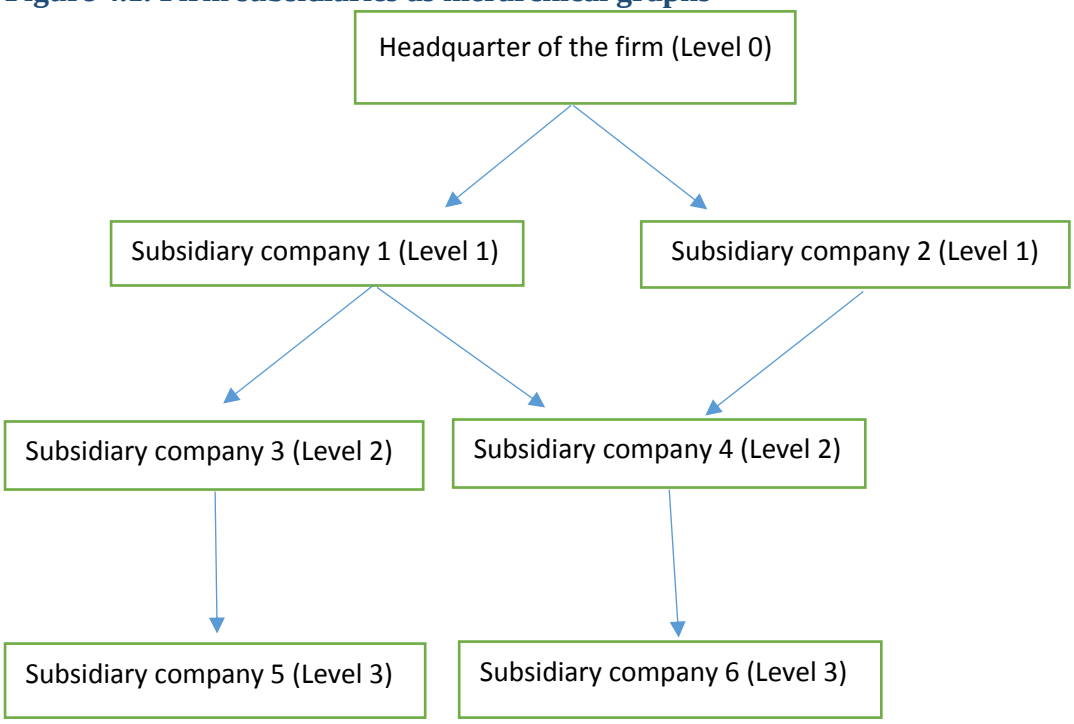
where R^2 means the values of the coefficient of determination which is obtained from the market model regressions. Lower values of information transparency indicate that firms' stock returns move more synchronously with market stock returns and thus firm-specific information is less accessible to outside investors. Therefore, lower values of information transparency are associated with high corporate opaqueness.

Moreover, Aabo, Pantzalis and Park (2015) use the values of idiosyncratic risk of firms which are obtained from the market model regressions to proxy corporate opaqueness and they argue that increases in opaqueness could be indicated by lower values of idiosyncratic risks and higher values of R^2. Thus, in this thesis, I use firms' idiosyncratic risks as another measurement for opaqueness in the robustness test to further examine the linkage between hierarchical complexity and opaqueness. For robustness tests purposes, I obtain the idiosyncratic risk by calculating the log of residuals' variance from the regression model above. Lower value of idiosyncratic risk and higher value of R^2 indicate increases in firm opaqueness.

4.3.2 Independent Variables

Hierarchical complexity. Hierarchical complexity is the independent variable in the model. Hierarchical complexity reflects the degree of complexity of the firm's subsidiary structures. In hierarchically complex companies, the headquarter company owns many subsidiary companies. One or more subsidiary companies may subsequently own a number of subsidiaries. In some cases, one subsidiary may be owned by one or more higher level companies. Here I use a hierarchical complexity graph tree below to better illustrate this.

Figure 4.1. Firm subsidiaries as hierarchical graphs



In the graph above, the parent company of the firm owns two subsidiaries which are located at hierarchical level 1, subsidiary company 1 subsequently owns two subsidiary companies, subsidiary company 3 and subsidiary company 4 which are located at hierarchical level 2, while the second subsidiary is co-owned by subsidiary company 2 at the same time. Following this, subsidiary company 3 and subsidiary company 4 in turn have two subsidiary companies at hierarchical level 3.

The subsidiary companies are located at different hierarchical levels which are determined by different ownership and control relationships. Therefore, it is appropriate for us to assume that the firm can have a total of L levels with a varied number of subsidiaries located at different levels. Specifically, the headquarter company is at level 0 of the hierarchy, with a different number of subsidiary companies located at 1, 2, 3…*l*…L levels. In this case, the hierarchical structure of the firm's subsidiaries is analogous to the hierarchical graph of mathematics.

Based on mathematical graph theory, in the hierarchical graph, each subsidiary company could be represented as the nodes or vertices, the ownership and control relationships between headquarter and subsidiaries. In addition, the control relationships among subsidiary companies could be represented as the edges that connect the nodes.

Among numerous graphs from mathematics, the hierarchical graph is the most suitable to capture the hierarchical structure and complexity of firms. This is because hierarchical graphs allow ultimate nodes and vertices at lower hierarchical levels to be directly or indirectly connected by nodes at higher levels which is equivalent to the case when the subsidiary is owned by one or more companies at higher hierarchical levels. In addition, hierarchical graphs allow the parent node at the highest hierarchical level to be able to connect and control other nodes at lower hierarchical levels which is analogous to the case when the headquarter company controls and coordinates lower level subsidiaries (Altomonte & Rungi, 2013, Brandstadt & Spinrad, 1999, Emmert-Streib & Dehmer, 2007). Thus, the hierarchical structures and complexity of firms can be well represented by the hierarchical graph.

Following Altomonte and Rungi (2013), based on the measures and computations from graph theory (Emmert-Streib & Dehmer, 2007), I calculate the hierarchical complexity of firms by using node entropy as follows :

$$\textit{Hierarchical complexity}=\sum_{l}^{L} l * \frac{nl}{N} * \log(\frac{N}{nl})$$

In the equation above, *l* represents the given hierarchical level, *nl* stands for the number of subsidiary companies at each hierarchical level *l*; *N* and *L* indicate the total number of subsidiary companies and the total number of hierarchical levels of the firms, respectively. In the equation, we multiply the product of *nl/N* and log (*N/nl*) with *l* so as to be able to sum up the hierarchical complexity at each sub-hierarchical level.

Thus, hierarchical complexity is the function of the number of subsidiary companies at each hierarchical level, the hierarchical level and the total number of subsidiary companies of the firms. The measure of hierarchical complexity is continuous and it ranges from zero to infinity, mathematically and theoretically. If the firm has one level of subsidiary companies that are controlled by headquarters, then hierarchical complexity is equal to zero. In addition, it is additive in *L*.

Here I further demonstrate how the degree of hierarchical complexity of firms evolves as the number of subsidiary companies at each hierarchical level and the total number of hierarchical levels increase. It can be seen from the formula above that the value of hierarchical complexity is determined by the summation of the current *L*th level and all previous (*L*-1) levels and thus for illustration purposes, I assume that the firm has a total number of 10 hierarchical levels, with 1 subsidiary company at level 1, 2 subsidiaries at level 2, 3 subsidiaries at level 3… and 10 subsidiaries at level 10. Then I calculate the value of hierarchical complexity at each hierarchical level by assuming that the hierarchical level used in each calculation is the largest *L*th hierarchical level. The table below shows how hierarchical complexity changes.

Table 4.1. Hierarchical complexity changes

Hierarchical level	Hierarchical complexity	Determination elements
1	0.07	(1,1)
2	0.31	(2,2,1)
3	0.78	(3,3,2,1)
4	1.55	(4,4,3,2,1)
5	2.64	(5,5,4,3,2,1)
6	4.09	(6,6,5,4,3,2,1)
7	5.92	(7,7,6,5,4,3,2,1)
8	8.17	(8,8,7,6,5,4,3,2,1)
9	10.83	(9,9,9,8,7,6,5,4,3,2,1)
10	13.93	(10,10, 9,8,7,6,5,4,3,2,1)

In the table above, the left column includes the hierarchical levels of the firm. The middle column displays the values of hierarchical complexity. The right column uses $1\times (L+1)$ dimension matrix to demonstrate elements which determine hierarchical complexity which are the hierarchical levels and the number of subsidiaries at each hierarchical level. Within each matrix, element $a_{1,1}$ is the Lth hierarchical level which is included in the calculation while elements $a_{1,2}$ through $a_{1,11}$ are the number of subsidiaries at each hierarchical level.

4.3.3 Moderators

Related corporate diversification entropy.

Firms' related corporate diversification entropy reflects the scope of the firms' related industry segments. I use the value of firms' net sales from the Compustat database which covers all sample firms to calculate the values of the entropy variable. Larger scores on the related corporate diversification entropy indicate larger degrees to which the firm is engaged in related

corporate diversifications. Based on the studies of Jacquemin and Berry (1979) and Palepu (1985), the related corporate diversification entropy is calculated as the following:

First, assuming that the firm operates in *1, 2…j…N* related industry groups, related corporate diversification entropy of the *j*th industry group is calculated based on the percentage of sales of *i*th segment in the *j*th industry group:

$DR_j=\sum_{i,j} P(i,j) * \ln(\frac{1}{P(i,j)})$, where *P(i,j)* represents the percentage of sales of *i*th segment in the *j*th industry group.

Thus,

$DR=\sum_{j=1}^{N} Pj * DRj$

In the equation, *DR* on the left-hand side represents the firm's related corporate diversification entropy, *Pj* stands for the percentage of sales of the *j*th industry group in the total *N* industry groups, *DRj* on the right-hand side is the related corporate diversifications of the *j*th industry group.

In the calculations above, the industry is defined by the primary Standard Industrial Classification code (SIC). I use the four-digit SIC code to identify similar and different segments that belongs to a particular industry group. I use the two-digit SIC code to identify similar and different industry groups.

Unrelated corporate diversification entropy.

Firms' unrelated corporate diversification entropy reflects firms' business and operation scopes across unrelated industry segments. Unrelated industry segments are defined to be industries with different two-digit SIC codes. When the firm operates across *1, 2…j…M* unrelated industry groups, firms' unrelated corporate diversification entropy is calculated as follows:

$DU=\sum_{j=1}^{M} Pj * \ln(\frac{1}{Pj})$,

where DU is the unrelated corporate diversifications, *Pj* represents sales in the *j*th industry segment.

Home country institutional environment.

The home country institutional environment refers to the US federal state institutional environment where the firms' parent companies are geographically located. The institutional environment is comprised of sets of rules and standards which regulate the behaviours of economic entities. Improved formal and informal regulations can influence and shape the firms' development strategies (Hillman & Keim, 1995) and hence improve firms' disclosure quality and moderate firms' opaqueness. In this context, states with strong accounting and auditing professions, financial examiners and analyst professions and legal enforcement systems would be associated with the development of a more rigorous and stricter institutional environment. Following Ding, Hope, Jeanjean and Stolowy (2007), I use the density of accounting and auditing professionals, finance examiners and financial analyst professionals and legal occupations, which include lawyers and legislators, to proxy the quality of the home country institutional environment (Ding, Hope, Jeanjean, & Stolowy, 2007). Thus, the value of the home country institutional environment is measured by the total number of the state's accounting and auditing professionals, finance examiners and financial analyst professionals and legal professionals, scaled by the total number of firms that are geographically located in that state. This measure avoids the confusion arising from companies of one state being registered in another geographically different state. Higher values of the home country institutional environment variable indicate increasing quality of the home country institutional environment which implies that it is more suitable to affect and regulate the opaqueness of firms.

Host country institutional environment.

Firms can own subsidiary companies in different countries. Stricter investor protection policies, strengthened legal systems and law enforcement mechanisms in the host countries could help to increase and improve the amount and quality of firms' information absorbed by outside investors which helps to protect the rights and benefits of outside investors (La Porta, Lopez-de-Silanes, & Shleifer, 2006, La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998). Thus, the institutional environment of host countries could moderate the level of opaqueness of firms. I measure the quality of the host country institutional environment as follows:

Host country institutional environment $= \sum_{i=1}^{n} SHAREit * COUNTRYit$

In the equations above, $SHAREit$ is the subsidiary's share of the firm's total assets which is measured as the value of the subsidiary's total assets divided by the firm's total assets. The letter "*i"* indicates the value of the *i*th subsidiary, letter "*t*" means the year. *COUNTRYit* means the value of the quality of the host country's institutional environment at year *t* where the *i*th subsidiary operates. Following Lu, Liu, Wright and Filatotchev (2014), among the six dimensions of the World Governance Indicators constructed by Kaufmann, Kraay, and Mastruzzi (2009), I calculate the country governance indicator by computing the mean value of the host country's Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality Estimate, Rule of Law and Control of Corruption. The data is provided by the World Bank database. I use the country governance indicator values to measure the institutional environment quality of the host countries because it captures and reflects the soundness and importance of the host country's policies, regulations and institutional transparency which regulate the behaviours of subsidiary companies (Kaufmann, Kraay, & Mastruzzi, 2009, Lu, Liu, Wright, & Filatotchev, 2014). The values of the country governance indicator range from -2.5 to 2.5, with larger values indicating a stricter

and higher quality of the host country institutional environment. For robustness test purposes, I also use the host country institutional environment variable which is constructed by the subsidiary's share of the firm's number of employees and the quality of the host country institutional environment.

4.3.4 Control variables

In the empirical models, I include several performance and financial characteristics of the firm to control for factors potentially affecting hierarchical complexity and corporate opaqueness.

Firm size. Prior studies show that firm size can affect the firm's organizational complexity because firms of a larger size may tend to have more constituting components both operationally and structurally which may lead to a higher level of organizational complexity (Beyer & Trice, 1979, Blau, 1970, Blau & Schoenherr, 1971, Li, Meng, Wang, & Zhou, 2008). In addition to its effect on organizational complexity, firm size may also affect the firm's level of opaqueness, since larger firms tend to release annual reports and disclosures that are less readable (Dempsey, Harrison, Luchtenberg, & Seiler, 2012, Li & Madarász, 2008). I therefore use firm size as the control variable. Firm size is calculated as the log of a firm's total assets.

Leverage. Previous research finds that a firm's financial characteristics such as financial leverage tend to influence the firm's level of opaqueness because a higher value of leverage implies that the creditors of the firm can get access to other sources of firm information. This indicates that the firms whose leverage value is high usually tend to be more opaque (Duru, Wang, & Zhao, 2013). Leverage is calculated as the sum of long-term debt and current liabilities divided by the sum of the value of long-term debt, current liabilities, common equity and preferred equity.

Profitability. Performance and profitability of the firm can also affect the firm's level of opaqueness since firms with greater profitability are more inclined to restrict the level of

opaqueness and tend to be more transparent as opaqueness could affect the firm's capital costs among other aspects (Duru, Wang, & Zhao, 2013). Therefore, I control for the firm's profitability in the model. Profitability is calculated as the firm's income divided by total annual sales.

Research and development (R&D). I also include the firm's expenditure on research and development (R&D) as the control variable because the R&D level indicates the firm's level of internal specialisation that implies organizational complexity (Dooley, 2002). In the model, I calculate R&D as the firm's book value of R&D expenditure divided by total annual sales.

Capital expenditure. I use the firm's capital expenditure to control for managerial decisions and other operational aspects that may affect the firm's organizational complexity and opaqueness. In the model, the firm's capital expenditure is calculated as the book value of capital expenditure scaled by the total annual sales.

Book-to-market ratio. The book- to- market asset ratio indicates the worth of the firm and is more accurate than the firm's market value in evaluating the value of the firm. The book- to-market asset ratio is calculated as the ratio between the firms' total assets and the sum of total liabilities and the number of outstanding shares multiplied by the closing share price.

Share price. Share price estimates the value of the firm assets based on future expectations which are related to firm opaqueness. Following Armstrong, Core and Guay (2014), I calculate share price as the annual mean value of the daily closing market price per share (Armstrong, Core, & Guay, 2014).

Scaled Amihud's illiquidity. Amihud's illiquidity indicates the price impact which measures investors' demand for a return premium to compensate for transaction costs. Amihud's illiquidity affects the level of opaqueness of firms. Following Aabo, Pantzalis and Park (2015),

I calculate scaled Amihud's illiquidity as the annual average of the daily ratio of stock's return to the trading volume, scaled by the number of outstanding shares.

Firm age. Firm age is calculated as the natural log of the difference between the year of observation and the earliest date when the firm appeared in the CRSP database.

4.4 Models

Panel-data regression models are used to analyse whether hierarchical complexity affects the opaqueness of firms. The models use corporate opaqueness as the dependent variable and the firm-year observations cover time periods of 5 years. In the empirical models, I regress the dependent variable on explanatory variables with firm fixed effects, year fixed effects, industry fixed effects and state fixed effects. Following the formal regression analysis, I also consider the potential bias of the research which I address in the robustness test section. Specifically, potential bias refers to the endogenous nature of the relationship between hierarchical complexity and opaqueness. There are three types of endogeneity that may exist in this research. First, the models may suffer from an omitted variable bias. In the regression models, there could be unobservable characteristics that do not change over time and these unobservable and time-invariant characteristics could be correlated to the independent variable but are not included in the models. Consequently, the inclusion of these characteristics in the error term correlates the independent variables with the error term, making the independent variable endogenous. The correlations between the independent variable and the error term cause the estimate on the coefficient of the independent variable to be inconsistent and biased (Wooldridge, 2010). Employing within-group fixed effects addresses this issue by eliminating the unobserved and time-invariant characteristics from the models. Thus, drawing on interactions of fixed effects could address the omitted variable bias to some extent.

Second, the models may suffer from a simultaneous endogeneity bias. In the thesis analysis, my underlying argument is based on the effect of hierarchical complexity on opaqueness. However, one could argue that the direction of causation between hierarchical complexity and firm opaqueness could be reversed. Since more opaque firms could have tendencies to be involved in more complex firm structures, it is possible that more opaque firms might be involved in a higher degree of hierarchical complexity which is indicated by establishing a number of subsidiary companies that operate at different hierarchical levels. As a result, it could be difficult to identify and determine cause and effect between the two variables. To reduce the impact of potential reverse causality by using lagged explanatory variables in the models, I lag the independent variables, control variables and moderator variables by one year. Moreover, in order to address the reverse causality problem further, I use the changes in dividends as the moderator to perform additional robustness tests.

Third, the models may suffer from dynamic endogeneity bias because it is possible that the values of firm opaqueness in past periods could influence the realizations of firm opaqueness in contemporary periods. Since outside investors could make investment decisions based on previous firm performance and behaviours, firms' previous level of opaqueness could be a reference for investors to make investment decisions and affect the level of opaqueness of the current period. It is therefore likely that the past realizations of the dependent variable could affect the current realizations of the dependent variable. Consequently, the coefficient estimate on the independent variable could be biased.

To address this and the other issues of endogeneity, Blundell and Bond (1998) suggest dynamic panel regressions using the generalized method of moments (difference- GMM of dynamic panel regressions) which correct for all three types of endogeneity, namely the endogenous variable bias, reverse causality endogeneity and dynamic endogeneity (Abdallah, Goergen, & O'Sullivan, 2015, Blundell & Bond, 1998). By differencing the equations with

lagged dependent variables, the models could eliminate unobservable and time-invariant characteristics which are attributed to the error term. Following this, the lagged differences of the dependent variables and the explanatory variables are then used as instruments. In addition, the GMM method does not require the strong spherical disturbance assumption of the error term and the GMM estimators are efficient and consistent (Chen, 2010). Therefore, following Abdallah, Goergen and O'Sullivan (2015), I draw on dynamic panel regressions with difference- GMM to address the endogenous variable bias, reverse causality bias and dynamic endogeneity bias.

Further, I also use sensitivity checks to examine whether the relationship between hierarchical complexity and opaqueness could be affected by the change of indicator variables in the robustness test. Since the change of indicator variables might influence the signs of coefficient and significance of the variables, I use alternative dependent variables to examine the robustness of the linkage between hierarchical complexity and opaqueness.

Chapter 5 Results

5.1 Introduction

In this chapter, I present the results of my empirical investigation into the relationship between hierarchical complexity and corporate opaqueness and the moderating effects of firms' related corporate diversification, unrelated corporate diversification, home country institutional environment quality and host country institutional environment quality. This chapter starts with the univariate analysis of the variables. Next, I present the empirical results of the baseline relationship between hierarchical complexity and opaqueness. I then test the models that include moderator variables so as to examine whether the relationship between hierarchical complexity and opaqueness could be affected by corporate diversifications and institutional environments. Following the main analysis, I then perform the robustness tests in order to address the potential endogeneity bias of the empirical investigations. The last section concludes.

5.2 Descriptive analysis

I take several steps to obtain the results on the relationship between hierarchical complexity and opaqueness. First, I present the mean values of hierarchical complexity by different industry groups and the evolving trend of hierarchical complexity from 2012 to 2016. Following this, I also present the industry distributions of sample firms by dividing the sample into different industry groups according to the industry classification scheme reported by French and Fama (1997) (Fama & French, 1997). I have excluded industries classified as belonging to the miscellaneous categories. Table 1 describes the distribution of mean hierarchical complexity in ascending orders, the changes of hierarchical complexity through the sample years and the industry membership of the sample firms by each year. The values in

Table 1 are obtained based on firms with hierarchical complexity data. In terms of the industry membership of the firms, I include the percentage of firms in the industry in the parenthesis by dividing the actual number of firms by the total number of firms of each year. Based on the 4-digit SIC codes, 42 industries are represented by sample firms, with 25 industries represented by at least ten firms. The number and the percentage of the firms are as follows and the number and the percentage are calculated based on mean values through the sample years. Business services (192 firms, 12.43%), pharmaceutical products (175 firms, 11.32%), petroleum and natural gas (104 firms, 6.75%), electronic equipment (61 firms, 3.97%), transportation (56 firms, 3.61%), machinery (54 firms, 3.48%), wholesale (49 firms, 3.21%), medical equipment (47 firms, 3.04%), healthcare (35 firms, 2.28%), chemicals (35 firms, 2.28%), retail (32 firms, 2.11%), construction materials (30 firms, 1.96%), computers (28 firms, 1.85%), automobiles and trucks (28 firms, 1.85%) and telecommunications (27 firms, 1.76%) are each represented by at least 25 firms.

Following this, I demonstrate how hierarchical complexity behaves according to different industry groups. As expected, it can be seen that hierarchical complexity is at a relatively low level among light industries that manufacture products for consumers and end-users, while most firms which belong to heavy industries with complex processes that manufacture large and heavy equipment and facilities have a relatively higher level of hierarchical complexity. Interestingly, I also note that firms in textiles, food products, shipping containers and tobacco products have relatively high levels of complexity which may be attributed to the firms' complex subsidiary and operational structures. Moreover, the evolving trend of hierarchical complexity through the sample period shows a general increase and this suggests that the firms may become more hierarchically complex as they grow and expand their business.

I then examine how indicators of corporate opaqueness behave at different levels of hierarchical complexity. I first divide the values of hierarchical complexity of sample firms

into 10 groups by quantile categories, with smaller group numbers indicating lower degrees of hierarchical complexity. Then, I assign the mean value of the opaqueness index and the mean value of information transparency to each of the groups. The results are presented in Table 2. It can be seen from the second column in Table 2 that the values of the opaqueness index evolve with a general ascending trend as the level of hierarchical complexity increases, suggesting that hierarchical complexity could be positively associated with the opaqueness index. Moreover, the third column in Table 2 shows that the values of the information transparency variable goes down as hierarchical complexity increases, suggesting that increases in hierarchical complexity could decrease the level of transparency and lead to firm opaqueness.

Table 3 presents the descriptive statistics of the variables: the means, standard errors, minimum and maximum values. From the table, it can be seen that the mean value of hierarchical complexity is 1.523. The mean value of the opaqueness index is 0.459 which is comparable to the value of 0.524 as reported in Duru, Wang and Zhao (2013) who find that staggered boards of the firm could be beneficial to firm value as corporate opaqueness increases. In addition, the mean value of information transparency is 1.748, which is similar to the value of 2.298 as reported in Durnev, Errunza and Molchanov (2009) who find that in countries with weak property rights protection, corporate transparency could decrease the investment efficiency of firms.

In regard to the correlations of the variables, as expected, hierarchical complexity is positively correlated to the opaqueness index and is negatively correlated to the information transparency variable. Thus, the results indicate a positive relationship between hierarchical complexity and the opaqueness index and a negative relationship between hierarchical complexity and information transparency. Moreover, the opaqueness index is negatively correlated to the information transparency variable. It is also noted that hierarchical complexity is negatively associated with the idiosyncratic risk variable and is positively associated with R^2. In addition,

this simple correlation analysis also shows that the opaqueness index is positively correlated to R^2, while information transparency and idiosyncratic risk are negatively correlated to R^2.

Further, I also conduct multicollinearity tests to examine potential multicollinearity among explanatory variables using the variance inflation factor (VIF) values. Table 3 shows that all the VIF values are below 3.29 with the mean VIF value equalling 1.83, indicating that multicollinearity is unlikely to be a concern in this study (Pan & Jackson, 2008). I proceed to the multivariate analysis in the next section.

Table 5.1 Distribution of hierarchical complexity by industry

Distribution of mean hierarchical complexity by different industry groups in ascending orders, the evolving trend of hierarchical complexity and distribution of industry membership of firms by different industry groups from 2012 to 2016.

Industry	Mean hierarchical complexity	Hierarchical complexity 2012	No. of firms in 2012	Hierarchical complexity 2013	No. of firms in 2013	Hierarchical complexity 2014	No. of firms in 2014
Alcoholic beverages	0.326	0.512	3(0.26%)	0.646	3(0.29%)	0.428	4(0.29%)
Pharmaceutical products	0.567	0.453	140(12.32%)	0.525	125(12.19%)	0.537	202(14.90%)
Candy and soda	0.626	0.098	3(0.26%)	0.567	3(0.29%)	0.358	4(0.29%)
Recreational products	0.864	0.744	7(0.61%)	0.490	5(0.48%)	1.045	9(0.66%)
Medical equipment	0.870	0.874	47(4.13%)	0.817	30(2.92%)	0.812	56((4.13%)
Non-metallic mining	0.883	0.823	8(0.70%)	0.659	9(0.87%)	0.757	11(0.81%)
Restaurants, hotel, motel	1.089	1.183	19(1.67%)	1.200	18(1.75%)	1.131	27(1.99%)
Retail	1.100	0.875	30(2.64%)	0.713	30(2.92%)	1.041	34(2.50%)
Coal	1.101	1.000	5(0.44%)	0.947	5(0.48%)	1.326	4(0.29%)
Precious metals	1.178	0.961	4(0.35%)	0.953	4(0.39%)	1.235	4(0.29%)
Petroleum and natural gas	1.212	1.004	96(8.45%)	0.987	99(9.65%)	1.306	111(8.19%)
Apparel	1.278	1.137	9(0.79%)	1.145	7(0.68%)	1.343	9(0.66%)
Transportation	1.306	1.006	51(4.48%)	0.959	52(5.07%)	1.411	55(4.05%)
Healthcare	1.355	1.084	35(3.08%)	1.234	31(3.02%)	1.337	37(2.73%)
Electronic equipment	1.407	1.291	66(5.80%)	1.277	46(4.48%)	1.313	74(5.46%)
Defence	1.461	1.103	6(0.52%)	1.327	5(0.48%)	1.612	6(0.44%)
Business services	1.463	1.278	178(15.66%)	1.334	150(14.63%)	1.259	220(16.23%)
Shipbuilding, railroad equipment	1.531	1.246	7(0.61%)	1.565	7(0.68%)	1.517	7(0.51%)
Entertainment	1.555	1.202	20(1.76%)	0.693	19(1.85%)	1.603	23(1.69%)
Computers	1.653	1.305	31(2.72%)	1.342	22(2.14%)	1.600	36(2.65%)
Electrical equipment	1.786	1.687	13(1.14%)	1.609	14(1.36%)	1.790	16(1.18%)
Wholesale	1.832	1.461	46(4.04%)	1.438	45(4.39%)	1.853	53(3.91%)
Construction materials	1.856	1.691	29(2.55%)	1.585	30(2.92%)	1.712	32(2.36%)
Construction	1.857	1.681	16(1.40%)	1.712	14(1.36%)	1.936	17(1.25%)

Table 5.1. Continued

Industry	Mean hierarchical complexity	Hierarchical complexity 2012	No. of firms in 2012	Hierarchical complexity 2013	No. of firms in 2013	Hierarchical complexity 2014	No. of firms in 2014
Personal services	1.873	1.425	12(1.05%)	1.411	13(1.26%)	1.783	14(1.03%)
Consumer goods	1.953	1.811	14(1.23%)	1.597	14(1.36%)	1.876	17(1.25%)
Steel works, etc.	1.981	2.311	17(1.49%)	2.067	17(1.65%)	1.662	19(1.40%)
Printing and publishing	1.989	1.283	5(0.44%)	1.306	3(0.29%)	1.530	8(0.59%)
Automobiles and trucks	2.069	1.542	27(2.37%)	1.998	26(2.53%)	1.914	31(2.28%)
Telecommunications	2.098	1.819	26(2.28%)	1.966	23(2.24%)	2.107	31(2.28%)
Rubber and plastic products	2.266	2.264	8(0.70%)	2.393	8(0.78%)	2.125	9(0.66%)
Machinery	2.429	2.272	49(4.31%)	2.306	50(4.87%)	2.286	54(3.98%)
Fabricated products	2.449	1.723	3(0.26%)	1.913	3(0.29%)	1.939	3(0.22%)
Chemicals	2.578	2.502	32(2.81%)	2.077	30(2.92%)	2.651	38(2.80%)
Measuring and control equipment	2.602	2.438	24(2.11%)	2.596	18(1.75%)	2.373	27(1.99%)
Business supplies	2.662	2.820	15(1.32%)	2.810	14(1.36%)	2.561	16(1.18%)
Food products	3.213	3.400	13(1.14%)	2.750	14(1.36%)	3.302	15(1.10%)
Aircraft	3.237	3.140	9(0.79%)	3.778	7(0.68%)	2.781	9(0.66%)
Shipping containers	3.515	3.302	6(0.52%)	4.312	6(0.58%)	2.590	6(0.44%)
Textiles	3.568	2.040	4(0.35%)	2.683	4(0.39%)	3.148	4(0.29%)
Tobacco products	6.509	6.232	2(0.17%)	6.074	2(0.19%)	8.010	2(0.14%)
Summary	**Mean:1.856**	**Mean:1.632**	**Total:1136**	**Mean:1.702**	**Total:1025**	**Mean:1.799**	**Total:1355**

Table 5.1. Continued

Industry	Hierarchical complexity 2015	No. of firms in 2015	Hierarchical complexity 2016	No. of firms in 2016
Alcoholic beverages	0.087	4(0.34%)	0.084	4(0.27%)
Pharmaceutical products	0.695	160(13.80%)	0.595	250(16.96%)
Candy and soda	0.613	3(0.25%)	1.179	5(0.33%)
Recreational products	0.621	6(0.51%)	1.146	9(0.61%)
Medical equipment	1.020	40(3.45%)	0.850	63(4.27%)
Non-metallic mining	1.129	11(0.94%)	1.001	10(0.67%)
Restaurants, hotel, motel	1.120	25(2.15%)	0.916	33(2.23%)
Retail	1.276	32(2.76%)	1.485	38(2.57%)
Coal	1.131	6(0.51%)	1.122	7(0.47%)
Precious metals	1.303	3(0.25%)	1.466	4(0.27%)
Petroleum and natural gas	1.366	106(9.14%)	1.354	111(7.53%)
Apparel	1.571	7(0.60%)	1.233	9(0.61%)
Transportation	1.474	60(5.17%)	1.587	62(4.20%)
Healthcare	1.605	36(3.10%)	1.485	38(2.57%)
Electronic equipment	1.663	47(4.05%)	1.521	75(5.08%)
Defence	1.597	5(0.43%)	1.665	6(0.40%)
Business services	1.734	171(14.75%)	1.670	244(16.55%)
Shipbuilding, railroad equipment	1.704	7(0.60%)	1.622	7(0.47%)
Entertainment	1.818	19(1.63%)	2.343	22(1.49%)
Computers	1.801	20(1.72%)	2.128	35(2.37%)
Electrical equipment	1.829	15(1.29%)	1.957	18(1.22%)
Wholesale	2.065	50(4.31%)	2.233	55(3.73%)
Construction materials	1.968	30(2.58%)	2.313	31(2.10%)
Construction	1.963	15(1.29%)	1.946	21(1.42%)
Personal services	2.332	13(1.12%)	2.349	14(0.94%)
Consumer goods	1.897	13(1.12%)	2.484	17(1.15%)

Table 5.1. Continued

Industry	Hierarchical complexity 2015	No. of firms in 2015	Hierarchical complexity 2016	No. of firms in 2016
Steel works, etc.	1.922	19(1.63%)	1.987	20(1.35%)
Printing and publishing	2.642	7(0.60%)	2.507	9(0.61%)
Automobiles and trucks	2.341	27(2.32%)	2.536	29(1.96%)
Telecommunications	2.165	26(2.24%)	2.366	31(2.10%)
Rubber and plastic products	2.435	9(0.77%)	2.126	9(0.61%)
Machinery	2.628	57(4.91%)	2.598	60(4.07%)
Fabricated products	3.610	3(0.25%)	3.063	3(0.20%)
Chemicals	3.142	36(3.10%)	2.441	41(2.78%)
Measuring and control equipment	3.001	19(1.63%)	2.697	28(1.89%)
Business supplies	2.579	16(1.38%)	2.574	17(1.15%)
Food products	3.573	16(1.38%)	3.034	17(1.15%)
Aircraft	3.294	8(0.69%)	3.318	9(0.61%)
Shipping containers	3.564	6(0.51%)	3.807	6(0.40%)
Textiles	5.246	4(0.34%)	4.724	4(0.27%)
Tobacco products	7.689	2(0.17%)	4.539	2(0.13%)
Summary	**Mean:2.127**	**Total:1159**	**Mean:2.032**	**Total:1474**

Table 5.2 Distribution of corporate opaqueness variables

Distribution of mean opaqueness indicators by different hierarchical complexity groups.

Hierarchical complexity group	Mean opaqueness index	Mean information transparency
Group 1	0.460	2.431
Group 2	0.297	2.354
Group 3	0.494	1.253
Group 4	0.511	1.890
Group 5	0.526	1.785
Group 6	0.522	1.684
Group 7	0.541	1.495
Group 8	0.534	1.188
Group 9	0.530	0.920
Group 10	0.533	0.694

Note: The order of hierarchical complexity groups is ranked from small to high complexity: Group 1 contains the smallest value of hierarchical complexity while Group 10 includes the largest value.

Table 5.3 Descriptive statistics and correlations

Summary statistics and correlation analysis

	Mean	Standard Deviation	Minimum	Maximum	1	2	3	4	5	6	VIF
1. Opaqueness index	0.459	0.215	0.000	0.866	1.000						n/a
2.Information transparency	1.748	1.578	-0.649	7.939	-0.153	1.000					
3. Idiosyncratic risk	-6.046	1.12	-8.424	-3.273	-0.334	0.522	1.000				n/a
4. Idiosyncratic risk2	0.221	0.164	0.000	0.656	0.138	-0.842	-0.618	1.000			n/a
5. Hierarchical complexity	1.523	1.838	0.000	9.358	0.111	-0.331	-0.394	0.402	1.000		2.31
6. Firm size	6.196	2.166	1.086	11.148	0.272	-0.556	-0.605	0.604	0.535	1.000	3.12
7. Leverage	0.347	0.413	-0.316	2.445	-0.070	-0.107	-0.018	0.119	0.171	0.221	1.20
8. R&D expenditures/total sales	5.107	27.131	0.000	228.881	-0.078	0.105	0.207	-0.113	-0.122	-0.172	3.27
9. Capital expenditure/total sales	0.266	1.019	0.000	8.518	-0.105	0.056	0.184	-0.072	-0.112	-0.092	3.15
10. Book-to-market ratio	0.684	0.603	0.077	4.479	-0.385	-0.007	0.013	0.029	0.105	-0.003	1.31
11. Profitability	-0.149	0.457	-2.732	0.303	0.356	-0.286	-0.514	0.297	0.225	0.549	1.57
12. Share price	30.343	34.968	0.773	202.713	0.226	-0.341	-0.502	0.383	0.273	0.560	1.89
13. Scaled Amihud illiquidity	0.003	2.832	-15.390	15.317	0.028	-0.021	-0.073	0.022	0.020	0.030	1.01
14. Log(firm age)	2.429	1.122	0.000	4.477	0.055	-0.219	-0.410	0.296	0.268	0.280	1.27
15. Related corporate diversification	0.080	0.226	0.000	1.188	0.092	-0.182	-0.225	0.231	0.263	0.283	1.21
16. Unrelated corporate diversification	0.118	0.265	0.000	1.219	0.149	-0.204	-0.296	0.273	0.261	0.321	1.24
17. Home country institutions	11.429	2.154	0.000	12.865	-0.098	0.051	0.129	-0.076	-0.019	-0.104	1.04
18. Host country institutions	0.342	0.670	0.000	9.123	0.197	-0.272	-0.355	0.339	0.563	0.393	2.06
19. Host country institutions1	0.426	0.635	0.000	7.872	0.234	-0.209	-0.321	0.270	0.496	0.355	1.78

Table 5.3. Continued

	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Opaqueness index													
2.Information transparency													
3. Idiosyncratic risk													
4. Idiosyncratic risk1													
5. Hierarchical complexity													
6. Firm size													
7. Leverage	1.000												
8. R&D expenditures/total sales	-0.056	1.000											
9. Capital expenditure/total sales	-0.003	0.747	1.000										
10. Book-to-market ratio	-0.044	-0.034	0.061	1.000									
11. Profitability	-0.018	-0.288	-0.213	0.058	1.000								
12. Share price	0.039	-0.093	-0.071	-0.196	0.303	1.000							
13. Scaled Amihud illiquidity	-0.023	-0.002	-0.035	-0.019	0.064	0.036	1.000						
14. Log(firm age)	0.018	-0.122	-0.137	0.074	0.228	0.243	0.018	1.000					
15. Related corporate diversification	0.078	-0.066	-0.067	0.000	0.138	0.160	0.013	0.194	1.000				
16. Unrelated corporate diversification	0.082	-0.075	-0.078	0.023	0.172	0.183	0.021	0.271	0.207	1.000			
17. Home country institutions	-0.060	0.011	0.021	-0.014	-0.109	-0.083	-0.016	-0.106	-0.119	-0.102	1.000		

Table 5.3. Continued

	7	8	9	10	11	12	13	14	15	16	17	18	19
18. Host country institutions	0.099	-0.092	-0.090	-0.056	0.167	0.248	0.011	0.250	0.221	0.231	-0.054	1.000	
19. Host country institutions1	0.086	-0.093	-0.096	-0.053	0.197	0.173	0.015	0.245	0.199	0.248	-0.071	0.663	1.000

Note: Idiosyncratic risk1 variable is the values of coefficient of determination R^2 which is drawn from the market model regressions. Host country institutions1 variable is the employee number-based host country institutional environment variable. Correlations with an absolute value equal to or larger than 0.022 are significant at or above 5%.

5.3 Multivariate analysis

In this section, I conduct multivariate analysis to examine the relationship between hierarchical complexity and opaqueness. First, I carry out a set of analyses with the opaqueness index and information transparency as the dependent variables. In this section, I perform the empirical analysis by testing the baseline models with lagged independent variables and lagged control variables so as to reduce the impact of potential causality. Following this, I then perform the analysis by including lagged moderator variables into the models so as to investigate the impact of moderators on the relationship between hierarchical complexity and opaqueness. The independent variables, control variables and moderator variables included in the regressions are lagged for one year period. I use cluster standard robust errors in the regressions. In order to avoid the impact of extreme values, I winsorize the top and bottom 1% values of all continuous variables, including the dependent variables, independent variables, control variables and moderator variables.

5.3.1 *The Opaqueness index as the dependent variable*

In this part, I estimate the models with the opaqueness index as the dependent variable. Panel 1 presents the regression results of the baseline models and models with moderator variables. As is displayed in the results, I include the *p*-value in parentheses. Column (1) in Table 1 of Panel 1 includes only the dependent variable, lagged independent variables and lagged control variables. This permits to test Hypothesis 1. Results from the models show that the opaqueness index is positively and significantly related to hierarchical complexity (α=0.0069, *p*=0.000). The statistical significance indicates that Hypothesis 1 is supported, suggesting that increases in hierarchical complexity could be related to higher level of opaqueness and less transparency.

Next, I investigate models including moderator variables to examine whether the relationship between hierarchical complexity and opaqueness could be affected by firms' related corporate

diversifications, unrelated corporate diversifications, home country institutional environment quality and host country institutional environment quality. The Models in Columns (2) through (5) of Table 1 in Panel 1 include the moderator variables, as proposed in Hypotheses 2a, 2b, 3 and 4. I first investigate the moderating effect of firms' related corporate diversifications and unrelated corporate diversifications. The values of the corporate diversification entropy reflect the degree of corporate diversifications of firms. It can be seen from Column (2) that the coefficient estimate on the moderation term between hierarchical complexity and firms' related corporate diversification entropy variable is significantly negative (α=-0.0180, *p*=0.000). Thus, the results support Hypothesis 2a, suggesting that firms' hierarchical complexity could have less positive impact on the level of opaqueness in the presence of related corporate diversifications.

In terms of the moderating effect of unrelated corporate diversification, it can be seen from Column (3) that the coefficient estimate on the moderation term between hierarchical complexity and firms' unrelated corporate diversification entropy variable is insignificant (α=-0.0005, *p*= 0.917), which suggests that the degree of firms' unrelated corporate diversifications could not effectively moderate the relationship between hierarchical complexity and opaqueness. Therefore, Hypothesis 2b is not supported.

Panel 1: Main results using the opaqueness index as the dependent variable

Table 1 of Panel 1. Main results of regressions using the opaqueness index

Regression of the opaqueness index on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index
L.Hierarchical complexity	0.0069***	0.0113***	0.0074***	-0.0083	0.0084***
	(0.000)	(0.000)	(0.000)	(0.310)	(0.000)
L. Firm size	-0.0158***	-0.0177***	-0.0170***	-0.0158***	-0.0173***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	-0.0197	-0.0208*	-0.0195	-0.0199*	-0.0213*
	(0.052)	(0.049)	(0.067)	(0.048)	(0.036)
L. Profitability	0.1392***	0.1365***	0.1383***	0.1393***	0.1387***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Capital expenditure	-0.0094	-0.0095	-0.0097	-0.0096	-0.0090
	(0.140)	(0.133)	(0.127)	(0.134)	(0.162)
L. Book-to-market ratio	-0.0304*	-0.0298*	-0.0323*	-0.0311*	-0.0322*
	(0.018)	(0.025)	(0.015)	(0.015)	(0.013)

Table 1 of Panel 1. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index
L. Research & Development	0.0001	0.0001	0.0001	0.0001	0.0000
	(0.796)	(0.747)	(0.756)	(0.756)	(0.820)
L. Share price	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Scaled Amihud illiquidity	-0.0000	0.0001	0.0002	0.0000	-0.0000
	(0.993)	(0.922)	(0.868)	(0.999)	(0.982)
L. Firm age	0.0092***	0.0084**	0.0079**	0.0091***	0.0083**
	(0.001)	(0.002)	(0.005)	(0.001)	(0.002)
L. Related diversification entropy		0.0639***			
		(0.001)			
L. Hierarchical complexity* L. Related diversification entropy		-0.0180***			
		(0.000)			

Table 1 of Panel 1. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index
L. Unrelated diversification entropy			0.0277		
			(0.125)		
L. Hierarchical complexity* L. Unrelated diversification entropy			-0.0005		
			(0.917)		
L.Home country institutional environment				0.0768	
				(0.717)	
L. Hierarchical complexity* L.Home country institutional environment				0.0292	
				(0.064)	
L.Host country institutional environment					0.0235**
					(0.002)

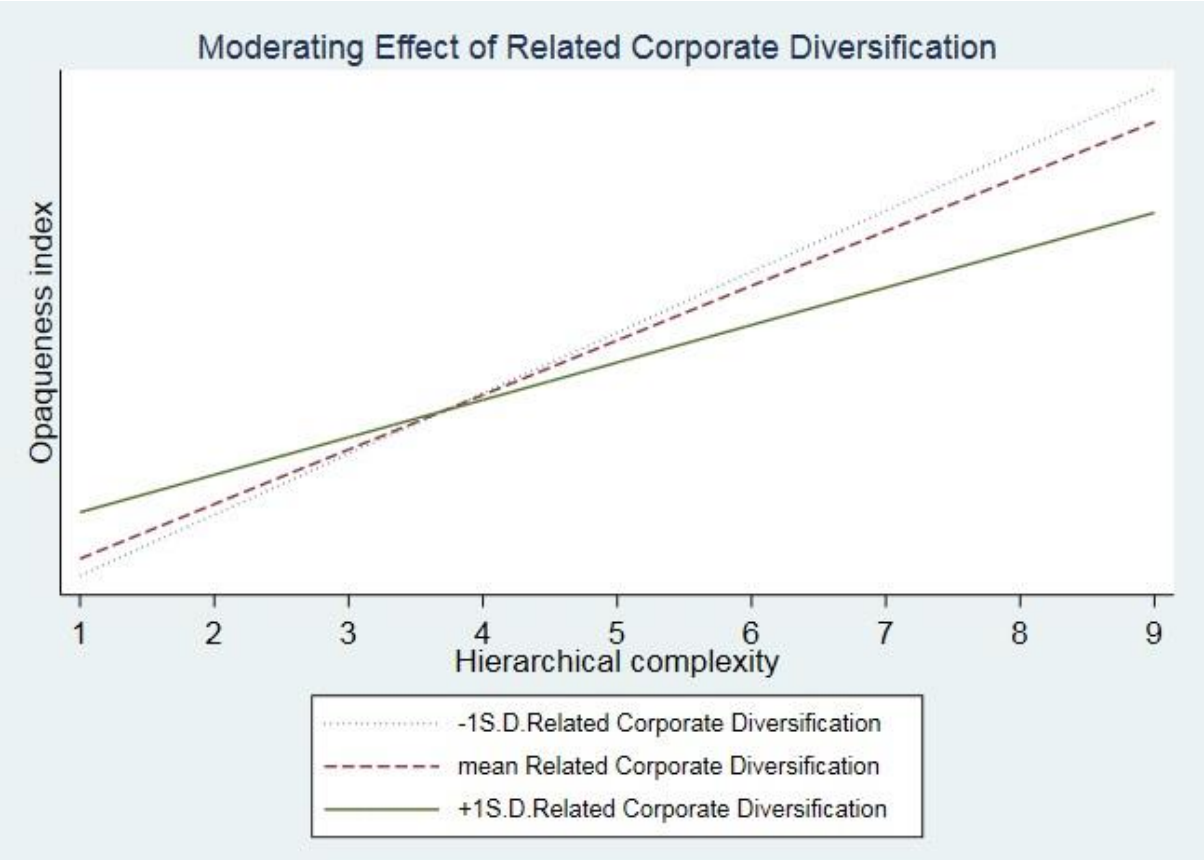
Table 1 of Panel 1. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index
L. Hierarchical complexity* L.Host country institutional environment					-0.0036** (0.008)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
State fixed-effects	Yes	Yes	Yes	Yes	Yes
N	2548	2449	2413	2548	2548
F	30.892	26.828	26.648	26.084	27.135
p	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Following this, I further explain the moderating effect of firms' related corporate diversification using graphs. I show the moderating effect of the related corporate diversification entropy variable on the relationship between hierarchical complexity and opaqueness index, with hierarchical complexity running from 1 to 9 and related corporate diversification values at the mean value, one unit of standard deviation below and above the mean value. The moderating effect graph is displayed in Figure 1.

Figure 5.1. Moderating effect of related corporate diversification on the opaqueness index and hierarchical complexity



It can be seen from the graph above that the increasing values of firms' related corporate diversifications negatively moderate the linkage between hierarchical complexity and the opaqueness index, suggesting that firms' related corporate diversifications could weaken the positive relationship between hierarchical complexity and opaqueness. Moreover, the graph also shows that the mitigating effect is more pronounced for firms with a higher degree of

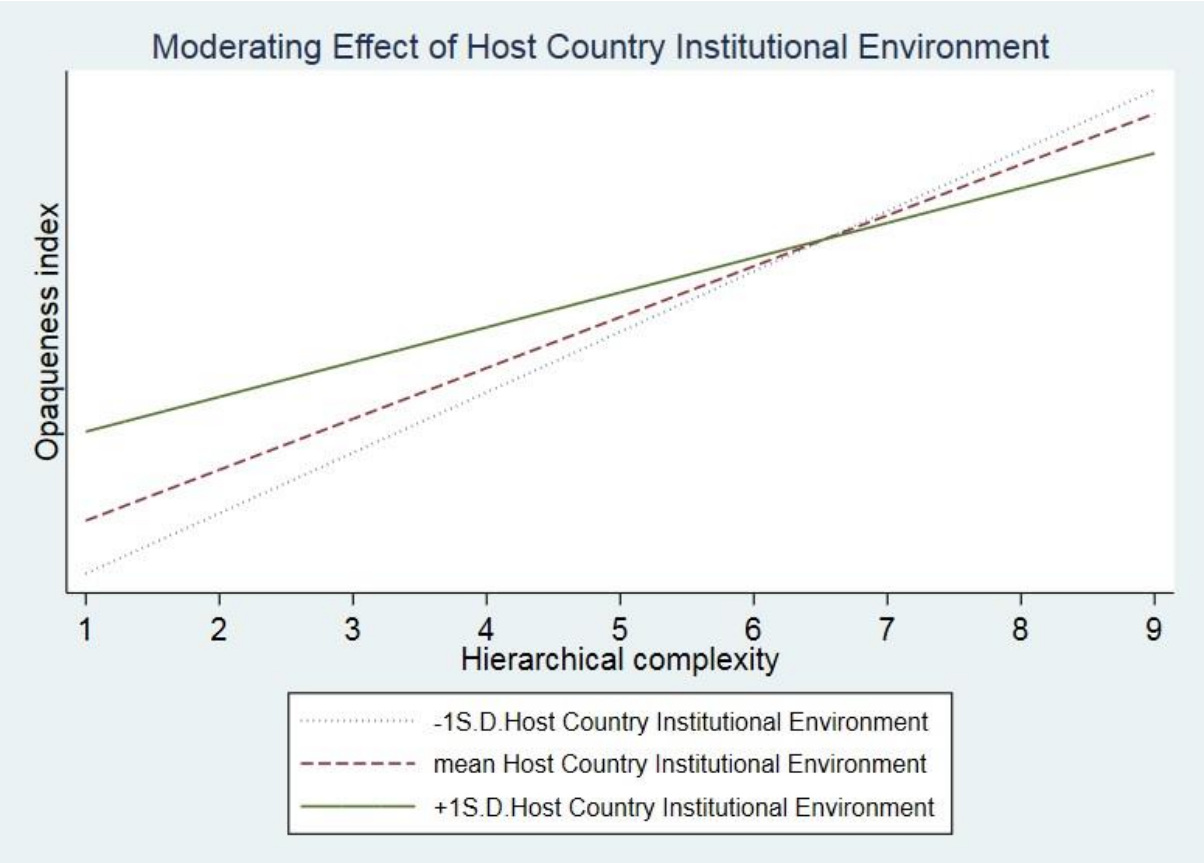
hierarchical complexity. This indicates that related corporate diversifications play more critical roles in more complex firms.

I next investigate the moderating effect of the home country institutional environment quality of each U.S. federal state where the firms are established. For this purpose, Column (4) of Table 1 includes the federal state institutional environment of the home country variable into the model (see Hypotheses 3). The results in Column (4) show that the coefficient estimate on the interaction term (hierarchical complexity x state institutional environment) is insignificant (α=0.0292, p=0.064). The results suggest that an improved home country federal state institutional environment with strict regulations and legal systems does not effectively moderate the relationship between hierarchical complexity and opaqueness. Thus, Hypothesis 3 is not supported.

I then examine the moderating effects of the quality of the host country institutional environment by including the host country institutional environment quality variable into the models. The results in Column (5) show that the coefficient estimate on the interaction term between hierarchical complexity and the host country institutional environment variable is negative and significant (α=-0.0036, p=0.008). The results suggest that stronger regulations in the host countries where subsidiaries are located could produce more strict regulatory policies and legal enforcement on firms' behaviors which makes the relationship between hierarchical complexity and firm opaqueness weaker. Therefore, the results support Hypothesis 4.

Following this, I use graphs to further illustrate the moderating effect of the host country institutional environment. I show the moderating effect by plotting hierarchical complexity between the range of 1 and 9, for strong host country institutions (+ 1 S.D. above the mean), the mean score of host country institutions and weak host country institutions (-1 S.D. below the mean). This interaction plot is displayed in Figure 2.

Figure 5.2. Moderating effect of the host country institutional environment on the opaqueness index and hierarchical complexity



The graph above shows that the host country institutional environment variable negatively moderates the relationship between hierarchical complexity and the opaqueness index. This suggests that an improved quality of host country institutions seems to mitigate the positive effect of hierarchical complexity on opaqueness. In addition, the graph further shows that the moderating effect of an increasing quality of host country institutions is more evident when applied to firms with a low degree of hierarchical complexity. This indicates that the regulating impact of host country institutions is more applicable to less complex firms.

5.3.2 *Information transparency as the dependent variable*

In this section, I use the information transparency of firms as another indicator of corporate opaqueness. Information transparency could indicate the amount of firm-specific information received and absorbed by outside investors and thus it captures the firm-specific information accessibility and information environment quality of outside investors (Aabo, Pantzalis, & Park, 2015, Durnev, Errunza, & Molchanov, 2009, Jin & Myers, 2006). Therefore, I employ information transparency as an alternative proxy for corporate opaqueness.

Table 2 of Panel 1 displays the regression results using information transparency as the dependent variable. In Table 2, the model in Column (1) examines the baseline hypothesis by including only the dependent, independent and control variables. It can be seen from the results that the coefficient estimate on hierarchical complexity is negative and significant (α=-0.0381, p=0.013). Since lower values of information transparency are associated with a reduced amount of firm-specific information obtained by outside investors and a higher level of firm opaqueness, the results suggest that higher hierarchical complexity reduces the quality of outside investors' information environment and thus hierarchical complexity could increase the level of opaqueness of firms. Therefore, Hypothesis 1 is supported.

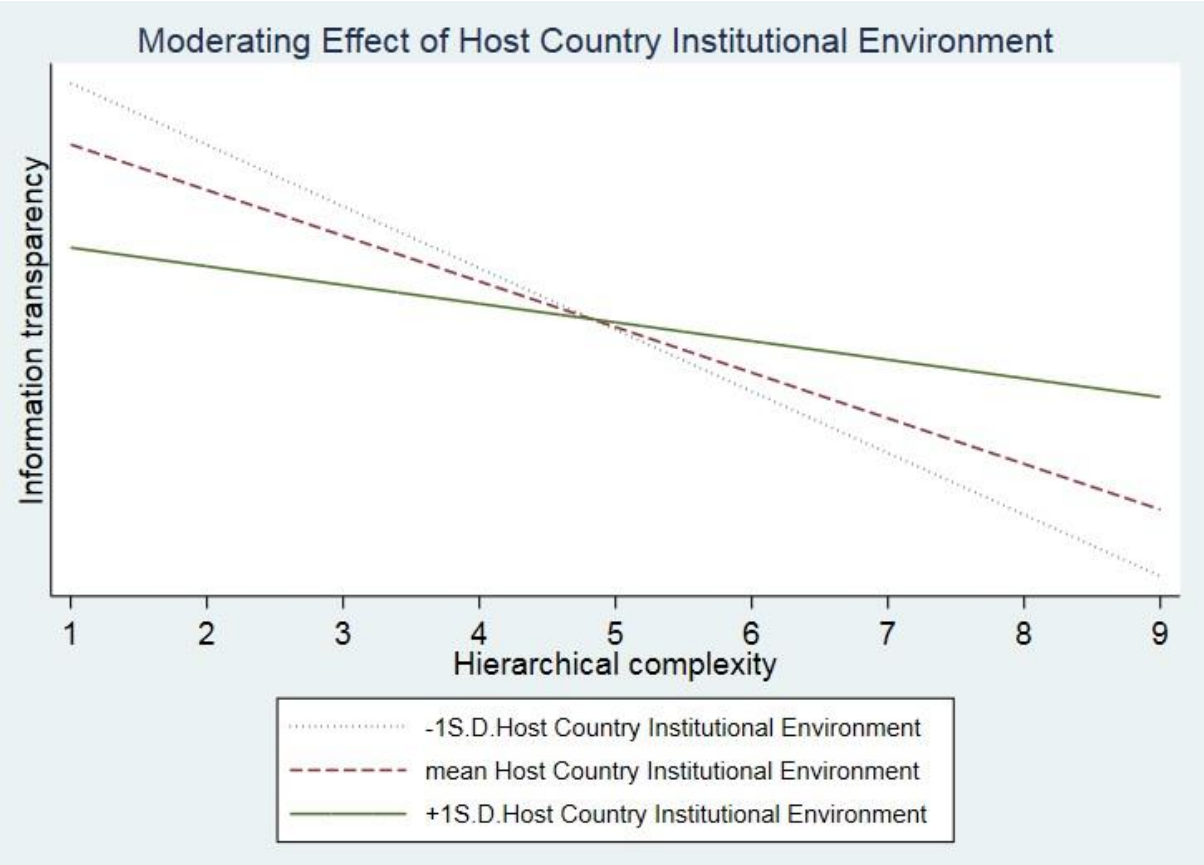
Column (2) through (5) in Table 2 of Panel 1 investigate the moderating effects of firms' related corporate diversification, unrelated corporate diversification, home country institutional environment and host country institutional environment. I start by examining the moderating effect of firms' corporate diversification, including related and unrelated corporate diversification. As is displayed in Column (2) and (3), the coefficient estimates of the interaction terms between hierarchical complexity and the related and unrelated corporate diversification entropy variable are insignificant (α=0.0728, p=0.090; α=0.0664, p=0.128). Thus, Hypothesis 2a and Hypothesis 2b are not supported by the results.

In terms of the moderating effect of the quality of the home country institutional environment, results in Column (4) show that the coefficient estimate on the moderating term between hierarchical complexity and home country institutional environment is insignificant (α=-0.0292, *p*=0.869). This suggests that increasing the quality of the home country institutional environment represented by more strict institutional rules and regulations cannot effectively moderate the relationship between hierarchical complexity and informational transparency of firms. Thus, Hypothesis 3 is not supported.

Column (5) presents the moderating effect of the indicator used to proxy the host country institutional environment quality. It can be seen from Column (5) that the coefficient estimate on the interaction term between hierarchical complexity and the host country institutional environment variable is positive and significant (α=0.0520, *p*=0.002). These results suggest that hierarchical complexity could have less negative impact on information transparency of firms in the presence of increasing quality of host country institutions. Therefore, the results support Hypothesis 4.

In order to further display the moderating effect of the host country institutional environment, I then plot the impact of the host country institutional environment on the relationship between hierarchical complexity and information transparency. On a graph, I show the moderating effect by plotting hierarchical complexity between the range of 1 and 9 for strong host country institutions (+ 1 S.D. above the mean), the mean score of host country institutions and weak host country institutions (-1 S.D. below the mean). This interaction is displayed in Figure 3.

Figure 5.3. Moderating effect of the host country institutional environment on information transparency and hierarchical complexity



It can be seen from the graph that the host country institutional environment positively moderates the relationship between hierarchical complexity and information transparency. This suggests that an increase in the quality of host country institutions, which is indicated by more strict regulatory policies and a more transparent institutional environment, seems to alleviate the effect of hierarchical complexity on firm opaqueness.

Panel 1: Main results using information transparency as the dependent variable

Table 2 of Panel 1. Main results of regressions using information transparency

Regression of information transparency on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency
L.Hierarchical complexity	-0.0381*	-0.0503*	-0.0499**	-0.0229	-0.0744***
	(0.013)	(0.012)	(0.007)	(0.797)	(0.001)
L. Firm size	-0.4215***	-0.4162***	-0.4194***	-0.4214***	-0.4061***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	0.2317**	0.2263*	0.2243*	0.2315**	0.2504**
	(0.006)	(0.010)	(0.012)	(0.006)	(0.003)
L. Profitability	-0.1754	-0.1741	-0.1770	-0.1756	-0.1611
	(0.096)	(0.104)	(0.098)	(0.096)	(0.129)
L. Capital expenditure	0.0443	0.0382	0.0359	0.0440	0.0388
	(0.522)	(0.581)	(0.605)	(0.525)	(0.575)
L. Book-to-market ratio	0.8643***	0.9011***	0.9237***	0.8637***	0.8907***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 2 of Panel 1. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency
L. Research & Development	-0.0006	-0.0005	-0.0005	-0.0006	-0.0005
	(0.772)	(0.790)	(0.806)	(0.775)	(0.795)
L. Share price	0.0020*	0.0020*	0.0021*	0.0020*	0.0021*
	(0.026)	(0.035)	(0.030)	(0.027)	(0.017)
L. Scaled Amihud illiquidity	-0.0296	-0.0259	-0.0267	-0.0295	-0.0291
	(0.051)	(0.098)	(0.089)	(0.052)	(0.055)
L. Firm age	-0.0247	-0.0278	-0.0250	-0.0246	-0.0185
	(0.347)	(0.302)	(0.382)	(0.348)	(0.485)
L. Related diversification entropy		-0.4195*			
		(0.010)			
L. Hierarchical complexity* L. Related diversification entropy		0.0728			
		(0.090)			

Table 2 of Panel 1. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency
L. Unrelated diversification entropy			-0.3643*		
			(0.029)		
L. Hierarchical complexity* L. Unrelated diversification entropy			0.0664		
			(0.128)		
L.Home country institutional environment				0.7830	
				(0.708)	
L. Hierarchical complexity* L.Home country institutional environment				-0.0292	
				(0.869)	
L.Host country institutional environment					-0.2514***
					(0.000)

Table 2 of Panel 1. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency
L. Hierarchical complexity* L.Host country institutional environment					0.0520** (0.002)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
State fixed-effects	Yes	Yes	Yes	Yes	Yes
N	2534	2435	2399	2534	2534
F	87.502	72.730	74.648	76.255	77.467
p	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

5.4 Robustness tests

So far, I have examined the impact that hierarchical complexity has on the corporate opaqueness of firms, as well as the influence of moderator variables on the relationship. However, the study may suffer from endogeneity bias to some extent. There are three types of endogeneity bias that may apply in this case. First, some variables may be omitted in the models. Second, reverse causality may exist in the models. Third, there may be measurement bias which applies to the measures of variables. Thus, in this section, following the main analysis, I perform the robustness tests and address the problems above.

5.4.1 Fixed effects interaction tests

In the previous section, I run the regressions by including year fixed effects and state fixed effects which reduces the impact of omitted variables that are not included in the models. In this part, I perform the analysis by including industry fixed effects into the models. In the analysis, I use lagged explanatory variables which include the lagged independent variables, lagged control variables and lagged moderator variables to address the influence of potential reverse causality. Table 1 and Table 2 in Panel 2 present the results with the opaqueness index and information transparency being the dependent variables.

As is displayed in the results of Table 1, Column (1) shows that the coefficient estimate on hierarchical complexity is positive and significant (α=0.0039, p=0.036), which suggests a positive relationship between hierarchical complexity and opaqueness index.

Column (2) and Column (3) present the results when the related and unrelated corporate diversification entropy variables are included as the moderators. It can be seen from the results that the coefficient estimates on the interaction term between hierarchical complexity and the related corporate diversification entropy variable is negative and significant (α=-0.0131, p=0.009), while the coefficient estimates on the moderating term in regard to unrelated

corporate diversification is insignificant (α=-0.0045, *p*=0.505). Thus, the results suggest that related corporate diversification could mitigate the positive relationship between hierarchical complexity and opaqueness index, while unrelated corporate diversification cannot effectively affect such relationship.

In regard to the moderating effect of the quality of the home country institutional environment, the results in Column (4) show that the coefficient estimate on the moderating term between hierarchical complexity and the home country institutional environment variable remains insignificant (α=0.0027, *p*=0.884). The results indicate that the quality of home country institutions cannot moderate the relationship between hierarchical complexity and opaqueness index.

In terms of the host country institutional environment variables, Columns (5) through (6) present the moderating effect of the two indicators used to proxy host country institutional environments quality. In addition to the host country institutions variable that is calculated on total assets of subsidiary companies, which is used in the main analysis, I use the host country institutions variable which is calculated on the number of employees of subsidiaries in Column (6) for robustness test purposes. It can be seen from Column (5) that the coefficient estimate on the interaction term between hierarchical complexity and the total assets-based host country institutional environment variable is negative and significant (α=-0.0037, *p*=0.029). Moreover, as is shown in Column (6), the coefficient estimate on the moderating term between hierarchical complexity and the second host country institutional environment variable, which is the number of employees-based, is negative and significant (α=-0.0034, *p*=0.043). The results suggest that increases in the quality of the host country's institutional environment where the subsidiaries operate could reduce the level of opaqueness which is due to hierarchical complexity.

Panel 2: Robustness tests results using fixed effects interactions

Table 1 of Panel 2. Regressions using the opaqueness index with year and industry fixed effect

Regression of the opaqueness index on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index	(6) Opaqueness index
L. Hierarchical complexity	0.0039*	0.0069**	0.0050*	0.0025	0.0061*	0.0045
	(0.036)	(0.004)	(0.027)	(0.797)	(0.012)	(0.052)
L. Firm size	-0.0125***	-0.0137***	-0.0138***	-0.0125***	-0.0141***	-0.0133***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	-0.0313**	-0.0339**	-0.0329**	-0.0309**	-0.0325**	-0.0331**
	(0.004)	(0.003)	(0.004)	(0.005)	(0.003)	(0.002)
L. Profitability	0.1219***	0.1198***	0.1211***	0.1216***	0.1225***	0.1211***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Capital expenditure	-0.0082	-0.0079	-0.0079	-0.0082	-0.0079	-0.0076
	(0.268)	(0.284)	(0.286)	(0.266)	(0.285)	(0.308)
L. Book-to-market ratio	-0.0635***	-0.0649***	-0.0655***	-0.0636***	-0.0654***	-0.0689***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 1 of Panel 2. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index	(6) Opaqueness index
L. Research & Development	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001
	(0.774)	(0.864)	(0.874)	(0.787)	(0.788)	(0.806)
L. Share price	0.0005***	0.0005***	0.0006***	0.0005***	0.0005***	0.0006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Scaled Amihud illiquidity	-0.0010	-0.0007	-0.0007	-0.0010	-0.0011	-0.0012
	(0.437)	(0.584)	(0.591)	(0.447)	(0.408)	(0.394)
L. Firm age	0.0071*	0.0070*	0.0062	0.0071*	0.0064	0.0057
	(0.037)	(0.043)	(0.086)	(0.038)	(0.062)	(0.096)
L. Related diversification entropy		0.0292				
		(0.166)				
L. Hierarchical complexity* L. Related diversification entropy		-0.0131**				
		(0.009)				

Table 1 of Panel 2. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index	(6) Opaqueness index
L. Unrelated diversification entropy			0.0367			
			(0.126)			
L. Hierarchical complexity* L. Unrelated diversification entropy			-0.0045			
			(0.505)			
L. Home country institutional environment				0.0319		
				(0.516)		
L. Hierarchical complexity* L. Home country institutional environment				0.0027		
				(0.884)		
L. Host country institutional environment					0.0203*	
					(0.018)	

Table 1 of Panel 2. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index	(4) Opaqueness index	(5) Opaqueness index	(6) Opaqueness index
L. Hierarchical complexity* L. Host country institutional environment					-0.0037*	
					(0.029)	
L.Host country institutional environment1						0.0313***
						(0.000)
L. Hierarchical complexity* L. Host country institutional environment1						-0.0034*
						(0.043)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
N	2535	2434	2397	2535	2535	2535
F	20.956	18.310	17.489	17.481	18.176	18.682
p	0.000	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Note: Models in Column (5) include the host country institutional environment variable which is calculated based on the total assets of subsidiaries. For robustness test purposes, Models in Column (6) use the host country institutional environment variable calculated by the number of employees of subsidiaries.

Table 2 presents the results by using the information transparency of firms as the dependent variable. Results in Column (1) show that the coefficient estimate on hierarchical complexity is negative but insignificant (α=-0.0083, *p*=0.608), which suggests that hierarchical complexity is insignificantly associated with information transparency when including industry fixed effects in the models.

I then include the corporate diversification entropy variables into the models and the results are displayed in Column (2) and Column (3). The results show that the coefficient estimates on the moderating terms regarding related and unrelated corporate diversification are insignificant (α=0.0188, *p*=0.722; α=-0.0030, *p*=0.956, respectively). Thus, the results indicate that increases in firms' related and unrelated corporate diversifications cannot effectively moderate the relationship between hierarchical complexity and information transparency.

I then examine the moderating effect of the home country institutional environment quality. Column (4) reports the results by including the home country institutional environment quality indicator into the models. It can be seen from the results that the coefficient estimate on the interaction term between hierarchical complexity and the home country institutional environment variable is insignificant (α=0.0752, *p*=0.651), which indicates that institutional rules of the home country could not effectively affect the linkage between hierarchical complexity and information transparency.

Columns (5) through (6) present the moderating effect of the host country institutional environments quality. As is displayed in the results, the coefficient estimates are insignificant regarding the moderating terms of total assets-based host country institutional environment and employee number-based host country institutional environment (α=0.0208, *p*=0.222; α=0.0038, *p*=0.824). The results show that the quality of the institutional environment of host countries

could not effectively influence the linkage between hierarchical complexity and information transparency of firms when including industry fixed effects in the models.

Panel 2: Robustness tests results using fixed effects interactions

Table 2 of Panel 2. Regressions using information transparency with year and industry fixed effect

Regression of information transparency on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency	(6) Information transparency
L. Hierarchical complexity	-0.0083	-0.0108	-0.0068	-0.0472	-0.0233	-0.0027
	(0.608)	(0.609)	(0.738)	(0.587)	(0.323)	(0.909)
L. Firm size	-0.4475***	-0.4476***	-0.4568***	-0.4471***	-0.4406***	-0.4457***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	0.2655**	0.2729*	0.2701*	0.2694**	0.2723**	0.2692**
	(0.009)	(0.011)	(0.012)	(0.008)	(0.007)	(0.008)
L. Profitability	0.0131	0.0079	0.0209	0.0101	0.0121	0.0159
	(0.909)	(0.946)	(0.859)	(0.930)	(0.916)	(0.890)
L. Capital expenditure	0.0519	0.0504	0.0509	0.0517	0.0510	0.0504
	(0.531)	(0.543)	(0.539)	(0.533)	(0.538)	(0.543)
L. Book-to-market ratio	1.1544***	1.1877***	1.1838***	1.1524***	1.1640***	1.1690***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 2 of Panel 2. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency	(6) Information transparency
L. Research & Development	-0.0006	-0.0006	-0.0007	-0.0006	-0.0006	-0.0006
	(0.794)	(0.787)	(0.779)	(0.786)	(0.797)	(0.804)
L. Share price	0.0044***	0.0044***	0.0044***	0.0044***	0.0044***	0.0043***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Scaled Amihud illiquidity	-0.0332*	-0.0306*	-0.0311*	-0.0330*	-0.0327*	-0.0330*
	(0.027)	(0.049)	(0.044)	(0.028)	(0.030)	(0.028)
L. Firm age	-0.0557	-0.0561	-0.0643	-0.0563	-0.0533	-0.0514
	(0.073)	(0.081)	(0.057)	(0.070)	(0.087)	(0.098)
L. Related diversification entropy		-0.1748				
		(0.393)				
L. Hierarchical complexity* L. Related diversification entropy		0.0188				
		(0.722)				

Table 2 of Panel 2. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency	(6) Information transparency
L. Unrelated diversification entropy			0.1378			
			(0.535)			
L. Hierarchical complexity* L. Unrelated diversification entropy			-0.0030			
			(0.956)			
L. Home country institutional environment				0.2322		
				(0.637)		
L. Hierarchical complexity* L. Home country institutional environment				0.0752		
				(0.651)		
L. Host country institutional environment					-0.0870	
					(0.258)	

Table 2 of Panel 2. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency	(4) Information transparency	(5) Information transparency	(6) Information transparency
L. Hierarchical complexity* L. Host country institutional environment					0.0208	
					(0.222)	
L.Host country institutional environment1						-0.0882
						(0.239)
L. Hierarchical complexity* L. Host country institutional environment1						0.0038
						(0.824)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
N	2521	2420	2383	2521	2521	2521
F	62.080	50.293	51.675	51.964	52.685	51.533
p	0.000	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

5.4.2 Dynamic panel regressions using general method of moments (GMM)

In the previous sections, I draw on the interactions of fixed effects to reduce the potential bias derived from endogenous variables, the hierarchical complexity variable and the corporate diversification variable. I also regress the dependent variable on lagged explanatory variables so as to diminish the impact of potential reverse causality. Economic literature shows that the endogenous variable bias can be alleviated by including fixed effects in panel data regressions and reverse causality can be reduced or avoided by excluding contemporaneous values of explanatory variables (Green, Malpezzi, & Mayo, 2005, Hayo, Kutan, & Neuenkirch, 2010, Spilimbergo, 2009, Wooldridge, 2010). However, although employing fixed effects and excluding contemporaneous explanatory variables can decrease the impact of potential endogeneity to some extent, these two methods are not enough to address the potential endogeneity in the models. Therefore, in this section, I further address potential endogeneity by performing additional tests.

Another approach I use to address potential endogeneity is to employ dynamic panel regression models. Following Abdallah, Goergen and O'Sullivan (2015), I use dynamic panel regressions with difference - general method of moments (GMM) which correct for the endogenous variable bias, reverse causality bias and dynamic endogeneity bias so as to obtain consistent and unbiased estimation results (Abdallah, Goergen, & O'Sullivan, 2015, Blundell & Bond, 1998).

In Panel 3, I use the Arellano-Bond test for autocorrelation of residuals to test for first-order correlation and second-order correlation in the residuals. I use the Sargan test to confirm the validity of the instruments. I report the *p*-values of the first-order ($m1$) and second-order ($m2$) Arellano-Bond test and the Sargan test at the bottom of the Panel. The regression results of the dynamic panel regressions with difference- GMM are correct and credible only when there are no second-order correlations of the residuals and when the over-identifying restrictions are

valid (Chen, 2010). In the dynamic panel regressions, I use firm age variable mostly as the predetermined variable, which is determined by the firm's year of establishment and is prior to the current period. I include all other independent variable and control variables as well as the interaction terms between independent variable and moderator variables mostly as endogenous variables, because the values of these variables are determined or influenced by other variables within the regression models. I firstly perform the analysis with the opaqueness index as the dependent variable and the results are displayed in Table 1 of Panel 3. Models in Column (1) include hierarchical complexity as the endogenous independent variable and its maximum three period lagged values as the instruments. The coefficient estimate on hierarchical complexity is positive and significant (α=0.0181, *p*=0.037). The *p*-value of the second-order Arellano-Bond test for autocorrelation is 0.095 which cannot reject the null hypothesis that there is no autocorrelation in residuals. The *p*-value of the Sargan test is 0.143 which cannot reject the null assumption that all instruments are valid. The results suggest that the opaqueness index could be positively related to hierarchical complexity.

Models in Column (2) and (3) include the interactions between hierarchical complexity and corporate diversification. The interaction terms between the hierarchical complexity variable and corporate diversification variables are regarded as endogenous and the maximum three period lagged values are used as instruments. The results show that the coefficient estimate on the interaction term between hierarchical complexity and related corporate diversification is negative but slightly insignificant (α=-0.0371, *p*=0.077). The *p*-value of the second-order Arellano-Bond test for autocorrelation is 0.362, which shows that there is no autocorrelation in residuals. The *p*-value of the Sargan test is 0.751, which cannot reject the assumption that all instruments are valid. In terms of the moderating effect of unrelated corporate diversification, the coefficient estimate of the interaction term in Column (3) is insignificant (α=-0.0281, *p*=0.131). The results indicate that firms' related corporate diversification could have some

weak but insignificant influence on the linkage between hierarchical complexity and the opaqueness index which mitigates the relationship to a limited extent.

Panel 3: Robustness test results using dynamic panel GMM regressions

Table 1 of Panel 3. Regressions of the opaqueness index using dynamic panel GMM regressions

Regression of the opaqueness index on hierarchical complexity, the related corporate diversification entropy variable, the unrelated corporate diversification entropy variable and their interactions

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index
L.Opaqueness index	0.2872***	0.2662**	0.1327
	(0.000)	(0.004)	(0.052)
Firm size	-0.0586*	-0.1415**	-0.1365***
	(0.049)	(0.002)	(0.000)
Firm age	-0.0093	0.2394	0.5241**
	(0.449)	(0.246)	(0.004)
Leverage	-0.0645*	-0.0124	-0.0151
	(0.016)	(0.649)	(0.575)
Profitability	0.0564	0.2575***	0.2029***
	(0.166)	(0.000)	(0.000)
Capital expenditure	-0.0015	-0.0746*	-0.0520*
	(0.943)	(0.011)	(0.035)

Table 1 of Panel 3. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index
Book-to-market ratio	-0.0115	0.0190	0.0457
	(0.806)	(0.710)	(0.283)
Research & Development	0.0000	0.0024	0.0020*
	(0.967)	(0.054)	(0.048)
Share price	0.0010**	0.0024***	0.0011
	(0.010)	(0.000)	(0.086)
Scaled Amihud illiquidity	0.0014	-0.0001	0.0002
	(0.687)	(0.909)	(0.862)
Hierarchical complexity	0.0181*	0.0168	0.0231
	(0.037)	(0.054)	(0.052)
L. Firm age		-0.1660	-0.3592**
		(0.245)	(0.005)
L. Firm size		0.0379	
		(0.243)	
L. Capital expenditure		0.0008	0.0218
		(0.978)	(0.448)

Table 1 of Panel 3. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index
L. Research & Development		-0.0014	-0.0022**
		(0.063)	(0.002)
L. Share price		-0.0002	-0.0001
		(0.662)	(0.842)
Related diversification entropy		0.1428	
		(0.164)	
Hierarchical complexity* Related diversification entropy		-0.0371	
		(0.077)	
Unrelated diversification entropy			-0.0435
			(0.660)

Table 1 of Panel 3. Continued

	(1) Opaqueness index	(2) Opaqueness index	(3) Opaqueness index
Hierarchical complexity* Unrelated diversification entropy			-0.0281
			(0.131)
m1	0.000	0.000	0.000
m2	0.095	0.362	0.548
Sargan test (P-value)	0.143	0.751	0.875
N	1712	1496	1460
p	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Note: In this section of analysis, the interaction between hierarchical complexity and home country institutional environment variable and host country institutional environment variables are not included in the models due to data unavailability in 2016. Specifically, the data of the home country institutional environment variable and host country institutional environment variables cover the 4-year period from 2012 to 2015. Thus, after taking the difference, the Arellano-Bond test for autocorrelation results could not be calculated because the maximum number of observations per group is 2. In the table above, *m*1 and *m*2 stand for the *p*-value of the Arellano-Bond test for first and second order autocorrelation of residuals, respectively.

Next, I perform the analysis with the information transparency of firms as the dependent variable and the results are displayed in Table 2 of Panel 3. Models in Column (1) of Table 2 regard hierarchical complexity as the endogenous independent variable and use its one period lagged values as the instrument. The results show that the coefficient estimate on hierarchical complexity is negative and significant (α=-0.7002, *p*=0.043), with the *p*-value of the second-order autocorrelation test to be 0.982 and the Sargan test to be 0.170 which cannot reject the null assumptions that there is no autocorrelation in residuals and all instruments are valid. Thus, increases in hierarchical complexity could reduce the level of information transparency of firms.

Models in Column (2) and (3) include the interaction terms between the hierarchical complexity variable and corporate diversification entropy variables. The interaction terms between the hierarchical complexity variable and corporate diversification entropy variables are endogenous and maximum three period lagged values are used as the instruments. In terms of related corporate diversification, the results in Column (2) show that the coefficient estimate on the moderating term is insignificant (α=-0.7710, *p*=0.160), suggesting that increases in related corporate diversification could not significantly influence the relationship between hierarchical complexity and information transparency.

The results in Column (3) show that the coefficient estimate on the moderating term regarding unrelated corporate diversification is insignificant (α=0.4361, *p*=0.229). Thus, the results suggest that the degree of unrelated corporate diversifications cannot effectively moderate the relationship between hierarchical complexity and information transparency of firms.

Panel 3: Robustness test results using dynamic panel GMM regressions

Table 2 of Panel 3. Regressions of information transparency using dynamic panel GMM regressions

Regression of information transparency on hierarchical complexity, the related corporate diversification entropy variable, the unrelated corporate diversification entropy variable and their interactions

	(1) Information transparency	(2) Information transparency	(3) Information transparency
L. Information transparency	0.1714	0.0245	-0.0315
	(0.096)	(0.692)	(0.630)
Firm size	3.6963*	1.0985	0.9589
	(0.013)	(0.169)	(0.235)
L. Firm size	-2.6637*	-1.9391***	-2.1372**
	(0.015)	(0.000)	(0.002)
Leverage	0.7150	0.2054	-0.3297
	(0.405)	(0.739)	(0.573)
L. Leverage	3.0213	-0.8253	-0.1828
	(0.053)	(0.402)	(0.862)
Profitability	-1.6969	-2.0075**	-1.6974
	(0.358)	(0.002)	(0.127)

Table 2 of Panel 3. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency
L. Profitability	4.7573*		-0.0112
	(0.018)		(0.981)
Capital expenditure	1.7740**	0.5192	0.2278
	(0.008)	(0.054)	(0.466)
L. Capital expenditure	-1.7990	0.2850	0.3750
	(0.067)	(0.420)	(0.347)
Book-to-market ratio	0.5431	0.3464	0.6250
	(0.714)	(0.725)	(0.562)
L. Book-to-market ratio	6.2035***	6.0683***	5.3149***
	(0.000)	(0.000)	(0.000)
Research & Development	-0.0113	-0.0110	-0.0067
	(0.704)	(0.411)	(0.655)
L. Research & Development	0.0913*	-0.0036	-0.0029
	(0.031)	(0.806)	(0.845)

Table 2 of Panel 3. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency
Share price	0.0167	0.0173	-0.0138
	(0.512)	(0.285)	(0.440)
L. Share price	-0.0321	0.0093	0.0226*
	(0.065)	(0.426)	(0.032)
Scaled Amihud illiquidity	-0.3495*	-0.1059	-0.1725**
	(0.013)	(0.081)	(0.005)
L. Scaled Amihud illiquidity	-0.4305*	-0.2456*	-0.1701
	(0.010)	(0.017)	(0.114)
Firm age	0.2951	-3.4575	-3.2639
	(0.676)	(0.403)	(0.424)
Hierarchical complexity	-0.7002*	0.1114	0.0294
	(0.043)	(0.558)	(0.895)
L. Firm age		1.7870	1.4644
		(0.514)	(0.590)

Table 2 of Panel 3. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency
Related diversification entropy		0.5503	
		(0.870)	
L. Related diversification entropy		0.9193	
		(0.638)	
Hierarchical complexity* Related diversification entropy		-0.7710	
		(0.160)	
Unrelated diversification entropy			2.6211
			(0.334)
L. Unrelated diversification entropy			-0.2152
			(0.920)

Table 2 of Panel 3. Continued

	(1) Information transparency	(2) Information transparency	(3) Information transparency
Hierarchical complexity* Unrelated diversification entropy			0.4361
			(0.229)
m1	0.000	0.000	0.000
m2	0.982	0.620	0.972
Sargan test (P-value)	0.170	0.062	0.059
N	1571	1454	1408
p	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

5.4.3 Reverse causality checks

In this section, I check for the presence of reverse causality in the relationship between hierarchical complexity and corporate opaqueness and perform additional robustness tests to address reverse causality. I firstly examine whether the linkage between hierarchical complexity and corporate opaqueness suffers from reverse causality through two ways. One way is to use the hierarchical complexity variable as the dependent variable and regress the hierarchical complexity variable on opaqueness variables. The second way is to use the firms' change of dividends paying as the moderator to check for the presence of reverse causality. The results are displayed in Panel 4.

Table 1 in Panel 4 shows the results by regressing the hierarchical complexity variable on opaqueness variables. Models in Column (1) includes the opaqueness index as the independent variable. The results show that the coefficient estimate on the opaqueness index is positive and significant (α=0.5180, p=0.030), suggesting that the hierarchical complexity variable could also be related to the opaqueness index variable and thus reverse causality can exist in the relationship between the opaqueness index variable and the hierarchical complexity variable.

Models in Column (2) use information transparency as the independent variable. It can be seen from the results that the coefficient estimate on information transparency is insignificant (α=-0.0141, p=0.455), which suggests that the hierarchical complexity variable is not significantly related to the information transparency variable and thus the relationship between the information transparency variable and the hierarchical complexity variable does not suffer from reverse causality.

Conclusively, the results in Table 1 of Panel 4 suggest that the hierarchical complexity variable is positively and significantly related to the opaqueness index. Thus, the results indicate that the linkage between the hierarchical complexity variable and the opaqueness index can be bi-

directional. I perform robustness tests to further check for the presence of reverse causality in the next section.

Panel 4: Robustness test results checking for the presence of reverse causality

Table 1 of Panel 4. Checking for reverse causality using regressions of the hierarchical complexity variable on corporate opaqueness variables

Regressions of hierarchical complexity on the opaqueness index and information transparency

	(1) Hierarchical complexity	(2) Hierarchical complexity
Opaqueness index	0.5180*	
	(0.030)	
Firm size	0.5340***	0.5222***
	(0.000)	(0.000)
Leverage	0.1321	0.1249
	(0.177)	(0.215)
Profitability	-0.4542***	-0.3841***
	(0.000)	(0.000)
Capital expenditure	-0.0381	-0.0333
	(0.330)	(0.391)
Book-to-market ratio	0.3719**	0.3561**
	(0.004)	(0.006)

Table 1 of Panel 4. Continued

	(1) Hierarchical complexity	(2) Hierarchical complexity
Research & Development	0.0005	0.0005
	(0.686)	(0.711)
Share price	-0.0038**	-0.0034**
	(0.004)	(0.009)
Scaled Amihud illiquidity	-0.0035	-0.0044
	(0.778)	(0.732)
Firm age	0.1470***	0.1437***
	(0.000)	(0.000)
Information transparency		-0.0141
		(0.455)
Year fixed-effects	Yes	Yes
Industry fixed-effects	Yes	Yes
N	3470	3462
F	38.003	38.071
p	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Next, I use the change of dividends of firms as the moderator to further check for the presence of reverse causality in the relationship between hierarchical complexity and corporate opaqueness. Previous studies show that dividends are an effective way to reduce the level of firm opaqueness. Increasing dividend payouts alleviates agency conflicts between firms and outside investors and thus reduces firm opaqueness (Jensen, 1986, Lang & Litzenberger, 1989, Morris & Roseman, 2015). Therefore, in this study, I use the change of dividends as the moderator to check whether reverse causality exists in the relationship between hierarchical complexity and firm opaqueness.

I calculate the sample firms' change of dividends within the sample years. I use dummy variables to indicate the change of dividends. In terms of the increases of firms' dividends paying, I use value 1 to indicate that there is an increase in dividend payout while value 0 indicates the situations otherwise. Similarly, in terms of decreases of dividend payout, I use value 1 to indicate that there is a decrease and value 0 indicates the situations otherwise. In this additional test, I include firm growth as the control variable to control for the product and investment growth factors that may affect the paying of dividends (Morris & Roseman, 2015). The firm growth variable is calculated as the annual percentage change of total assets.

The second approach for checking reverse causality using dividends consists of two parts. Models in Part 1 regress opaqueness variables on the hierarchical complexity variable with changes of dividends as the moderators. Models in Part 2 regress the hierarchical complexity variable on the opaqueness index and information transparency with changes of dividends payouts as the moderators so as to examine whether opaqueness variables can affect the hierarchical complexity variable in a reverse direction. The results are displayed in Table 2 and Table 3 of Panel 4.

Models in Column (1) and (2) of Table 2 include the opaqueness index and information transparency as the dependent variable and use increases in dividends as the moderator. The results in Column (1) show that the coefficient estimate on the interaction term between hierarchical complexity and increases in dividends is negative and significant (α=-0.0129, *p*=0.000) which suggests that increasing dividends can effectively reduce the level of the opaqueness index due to hierarchical complexity. When using information transparency as the dependent variable, the results in Column (2) show that the coefficient estimate on the interaction term between hierarchical complexity and increases in dividends is insignificant (α=-0.0140, *p*=0.573). Thus, the results suggest that increases in dividends cannot significantly increase the level of information transparency of firms.

Models in Column (3) and (4) include the opaqueness index and information transparency as the dependent variable and use decreases in dividends as moderators. The results in Column (3) and (4) show that by using the opaqueness index and information transparency as the dependent variables, the coefficient estimates are insignificant in terms of the interaction term between hierarchical complexity and decreases in dividends (α=-0.0021, *p*=0.497; α=0.0040, *p*=0.874, respectively). Thus, the results suggest that decreases in dividends do not affect the level of opaqueness index and information transparency of firms.

Panel 4: Robustness test results checking for the presence of reverse causality

Table 2 of Panel 4. Checking for reverse causality using dividends, part 1 of 2

Regression of the opaqueness index and information transparency on hierarchical complexity, increases of dividends paying, decreases of dividends paying and their interactions

	(1) Opaqueness index	(2) Information transparency	(3) Opaqueness index	(4) Information transparency
Hierarchical complexity	0.0094***	-0.0061	0.0053*	-0.0149
	(0.000)	(0.749)	(0.029)	(0.432)
Dividends_ increase	0.0534***	-0.1209		
	(0.000)	(0.187)		
Hierarchical complexity*Dividends_increase	-0.0129***	-0.0140		
	(0.000)	(0.573)		
Firm size	-0.0173***	-0.4128***	-0.0163***	-0.4194***
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.0259*	0.1180	-0.0268**	0.1259
	(0.011)	(0.110)	(0.009)	(0.089)
Profitability	0.1089***	0.0369	0.1111***	0.0333
	(0.000)	(0.720)	(0.000)	(0.745)

Table 2 of Panel 4. Continued

	(1) Opaqueness index	(2) Information transparency	(3) Opaqueness index	(4) Information transparency
Capital expenditure	0.0018	0.0621	0.0016	0.0614
	(0.779)	(0.197)	(0.794)	(0.205)
Book-to-market ratio	-0.0556***	0.9192***	-0.0584***	0.9335***
	(0.001)	(0.000)	(0.000)	(0.000)
Research & Development	-0.0001	-0.0016	-0.0001	-0.0016
	(0.708)	(0.349)	(0.698)	(0.352)
Share price	0.0007***	0.0015	0.0008***	0.0016
	(0.000)	(0.078)	(0.000)	(0.070)
Scaled Amihud illiquidity	-0.0013	-0.0099	-0.0014	-0.0100
	(0.260)	(0.446)	(0.234)	(0.437)
Firm age	-0.0046	-0.0368	-0.0043	-0.0484
	(0.260)	(0.195)	(0.298)	(0.085)
Growth	-0.0064	0.1337**	-0.0092*	0.1416**
	(0.158)	(0.005)	(0.042)	(0.003)

Table 2 of Panel 4. Continued

	(1) Opaqueness index	(2) Information transparency	(3) Opaqueness index	(4) Information transparency
Dividends_ decrease			0.0343**	0.0853
			(0.003)	(0.412)
Hierarchical complexity* Dividends_ decrease			-0.0021	0.0040
			(0.497)	(0.874)
Year fixed-effects	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	Yes	Yes	Yes
N	3454	3446	3454	3446
F	12.573	48.719	12.049	48.595
p	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Next, I use hierarchical complexity as the dependent variable and corporate opaqueness as the independent variable. I regress the hierarchical complexity variable on the opaqueness index and information transparency with changes in dividends as the moderators. The results are displayed in Table 3 of Panel 4.

Models in Column (1) and (2) include the opaqueness index as the independent variable while models in Column (3) and (4) include information transparency as the independent variable. Results from Column (1) and (2) show that the coefficient estimates on the interaction terms between the opaqueness index and increasing and decreasing dividends paying are insignificant (α=-0.5900, *p*=0.319; α=-1.0111, *p*=0.146, respectively). Moreover, results from Column (3) and (4) show that the coefficient estimates on the interaction terms between information transparency and increasing and decreasing dividends paying are insignificant (α=-0.0154, *p*=0.717; α=-0.0796, *p*=0.163, respectively). These results suggest that, on average, corporate opaqueness cannot effectively cause hierarchical complexity. However, it can be seen from the models in Column (1) and (2) that the coefficient estimates on the opaqueness index are positive and significant (α=0.6013, *p*=0.013; α=0.6205, *p*=0.010, respectively), which suggests that the opaqueness index can positively influence the hierarchical complexity variable to some extent.

Therefore, it can be seen that the two approaches provide mixed results in terms of reverse causality. Specifically, results from the first approach which regresses hierarchical complexity on the opaqueness index and information transparency indicate that the relationship between hierarchical complexity and the opaqueness index can be bi-directional. However, results from the second approach using dividends suggest that, on average, corporate opaqueness cannot effectively lead to hierarchical complexity. This can be seen from the results that the changes of dividends paying cannot significantly affect the relationship between the hierarchical complexity variable and corporate opaqueness variables, although the results also show that

the opaqueness index can affect the hierarchical complexity variable to some extent. In this case, generally, the results above cannot reject that there is no reverse causality in the relationship between hierarchical complexity and corporate opaqueness variables. Thus, I perform additional robustness tests to address reverse causality in the next section.

Panel 4: Robustness test results checking for the presence of reverse causality

Table 3 of Panel 4. Checking for reverse causality using dividends, part 2 of 2

Regression of hierarchical complexity on the opaqueness index and information transparency, increases of dividends paying, decreases of dividends paying and their interactions

	(1) Hierarchical complexity	(2) Hierarchical complexity	(3) Hierarchical complexity	(4) Hierarchical complexity
Opaqueness index	0.6013*	0.6205**		
	(0.013)	(0.010)		
Dividends_ increase	0.4951		0.1925	
	(0.167)		(0.066)	
Opaqueness_index_Dividends_increase	-0.5900			
	(0.319)			
Firm size	0.5227***	0.5307***	0.5143***	0.5196***
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	0.1406	0.1384	0.1369	0.1305
	(0.147)	(0.158)	(0.171)	(0.195)
Profitability	-0.4686***	-0.4690***	-0.3923***	-0.3831***
	(0.000)	(0.000)	(0.000)	(0.000)

Table 3 of Panel 4. Continued

	(1) Hierarchical complexity	(2) Hierarchical complexity	(3) Hierarchical complexity	(4) Hierarchical complexity
Capital expenditure	-0.0391	-0.0398	-0.0347	-0.0344
	(0.317)	(0.312)	(0.371)	(0.377)
Book to market ratio	0.3891**	0.3668**	0.3740**	0.3512**
	(0.003)	(0.005)	(0.005)	(0.008)
Research & Development	0.0006	0.0006	0.0005	0.0005
	(0.657)	(0.647)	(0.676)	(0.679)
Share price	-0.0037**	-0.0037**	-0.0034*	-0.0033*
	(0.005)	(0.005)	(0.010)	(0.012)
Scaled Amihud illiquidity	-0.0032	-0.0044	-0.0042	-0.0039
	(0.795)	(0.729)	(0.746)	(0.763)
Firm age	0.1406***	0.1446***	0.1364***	0.1418***
	(0.000)	(0.000)	(0.001)	(0.000)
Growth	0.0505	0.0333	0.0488	0.0302
	(0.203)	(0.400)	(0.238)	(0.462)

Table 3 of Panel 4. Continued

	(1) Hierarchical complexity	(2) Hierarchical complexity	(3) Hierarchical complexity	(4) Hierarchical complexity
Dividends_ decrease		0.6747		0.2252
		(0.109)		(0.092)
Opaqueness_in dex_Dividends _decrease		-1.0111		
		(0.146)		
Transparency			-0.0097	-0.0043
			(0.627)	(0.805)
Transparency _Dividends_inc rease			-0.0154	
			(0.717)	
Transparency _Dividends_ decrease				-0.0796
				(0.163)
Year fixed-effects	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	Yes	Yes	Yes
N	3454	3454	3446	3446
F	30.239	31.200	30.385	31.117
p	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

The results in the prior section suggest that reverse causality can exist in the relationship between hierarchical complexity and corporate opaqueness to some extent. Thus, I perform additional robustness tests to address reverse causality. In this section, I use the orthogonal approach to address the reverse causality problem.

I investigate the relationship between hierarchical complexity and corporate opaqueness by orthogonalizing the complexity variable. The orthogonalized hierarchical complexity variable can exclude the factors in opaqueness variables that may affect the hierarchical complexity variable. Thus, employing orthogonalized hierarchical complexity in the models allows me to examine whether the level of firm opaqueness is affected only by hierarchical complexity. Second, I use the changes of dividends paying of firms to check whether hierarchical complexity varies with the level of firm opaqueness and then examine the relationship between hierarchical complexity and opaqueness by excluding reverse causality between the two variables.

First, I orthogonalize hierarchical complexity by regressing the complexity variable at time *t* on opaqueness index variable at time *t-1* and *t-2*. I then extract the residuals from the models. In the regressions, the unobservable factors in the opaqueness index variable that do not affect the complexity variable are included in the error term, and thus I use the residuals from the regressions to capture the part of hierarchical complexity that is not affected by the opaqueness index. Second, I then include residuals into the models as the independent variable and regress the opaqueness index on the residuals. In this section of analysis, the sample number *N* becomes smaller because I use lagged opaqueness variables in the regression that produced these residuals. I perform similar steps for the information transparency variable. The results are displayed in Table 1 of Panel 5.

Models in Column (1) include the opaqueness index as the dependent variable. It can be seen from the results that the coefficient estimate on residuals is insignificant (α=-0.0006, *p*=0.861) which suggests that the opaqueness index does not vary with hierarchical complexity. Models in Column (2) use information transparency as the dependent variable. The results show that the coefficient estimate on residuals is negative and significant (α=-0.0806, *p*=0.047), suggesting that information transparency is negatively associated with hierarchical complexity.

In conclusion, the models above remove the influence of reverse causality between the complexity variable and firm opaqueness variables by excluding unobservable factors in firm opaqueness variables that affect hierarchical complexity. After excluding the influence of corporate opaqueness on complexity, the results show that firms' level of information transparency decreases with greater hierarchical complexity. Thus, from the perspective of information transparency, hierarchical complexity can cause firms to be less transparent and more opaque.

Panel 5: Robustness test results addressing reverse causality using the orthogonal approach

Table 1 of Panel 5. Addressing reverse causality using orthogonalized hierarchical complexity

Regression of the opaqueness index and information transparency on orthogonalized hierarchical complexity

	(1) Opaqueness index	(2) Information transparency
Residuals_ opaqueness_ index	-0.0006	
	(0.861)	
Firm size	-0.0129***	-0.4075***
	(0.000)	(0.000)
Leverage	-0.0192	0.0484
	(0.059)	(0.647)
Profitability	0.1161***	0.0491
	(0.000)	(0.697)
Capital expenditure	-0.0016	0.0976
	(0.774)	(0.209)
Book-to-market ratio	-0.0566***	1.1142***
	(0.000)	(0.000)

Table 1 of Panel 5. Continued

	(1) Opaqueness index	(2) Information transparency
Research & Development	0.0001	-0.0037
	(0.345)	(0.083)
Share price	0.0006***	0.0029**
	(0.000)	(0.001)
Scaled Amihud illiquidity	-0.0012	-0.0622**
	(0.463)	(0.006)
Firm age	-0.0001	-0.0553
	(0.984)	(0.213)
Residuals_ information_ transparency		-0.0806*
		(0.047)
Year fixed-effects	Yes	Yes
Industry fixed-effects	Yes	Yes
N	2266	1951
F	20.914	42.195
p	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

5.4.4 Sensitivity checks

In this section, I perform additional tests using alternative dependent variables to examine the robustness of the results in the previous analysis. In the sensitivity checks, I use the idiosyncratic risk of the firms and the R^2 values which are drawn from market model regressions as the alternative measures of firm opaqueness. The lagged explanatory variables are used in the analysis of this section.

Idiosyncratic risk reflects the degree of idiosyncratic volatility of the firms' stock prices (Ferreira & Laux, 2007). Higher idiosyncratic risk and volatility suggest that there is a greater synchronicity of prices and returns between firms' stock and the market index. High idiosyncratic volatility is associated with more efficient capital allocation and more optimized equity structures. Moreover, higher idiosyncratic volatility also indicates that the stock prices contain more information about the firms' future earnings and reflect larger amount of firm specific information (Aabo, Pantzalis, & Park, 2015, Durnev, Morck, Yeung, & Zarowin, 2003, Ferreira & Laux, 2007). This is because in the market model, when stock prices move more synchronously with the prices of the market index, less idiosyncratic risk and volatility contain less amount of firm specific information and firms can thus become more opaque and less transparent to outside investors (Durnev, Errunza, & Molchanov, 2009, Morck, Yeung, & Yu, 2000). In addition, the values of R^2 from the market model indicate the degree of synchronicity between firms' stock returns and the market index returns. Therefore, it follows that an increase in opaqueness is related to lower idiosyncratic risk and to higher R^2 (Aabo, Pantzalis, & Park, 2015).

First, I use the idiosyncratic risk of firms as the alternative indicator of corporate opaqueness. Table 1 of Panel 6 displays the regression results using idiosyncratic risk as the dependent variable. In Table 1, the model in Column (1) examines the baseline hypothesis by including only the dependent, independent and control variables. It can be seen from the results that the

coefficient estimate on hierarchical complexity is negative and significant (α=-0.0540, *p*=0.000). Since lower idiosyncratic risk is associated with a higher level of firm opaqueness, the results suggest that hierarchical complexity can increase the level of opaqueness of firms.

Column (2) through (6) in Table 1 of Panel 6 investigate the moderating effects of firms' corporate diversifications, home country institutional environment quality and host country institutional environment quality. I start from examining the moderating effect of firms' corporate diversifications. As is displayed in Column (2) and (3), the coefficient estimate of the interaction term between hierarchical complexity and the related corporate diversification entropy variable is positive and significant (α=0.1158, *p*=0.000) and the coefficient estimate on the interaction term, in terms of unrelated corporate diversification, is positive and significant (α=0.0845, *p*=0.002). Thus, the results suggest that increases in related corporate diversifications could mitigate the relationship between hierarchical complexity and firm opaqueness. The results also suggest that increases in unrelated corporate diversification cannot strengthen the relationship.

In terms of the effect of the home country institutional environment quality, results in Column (4) show that the coefficient estimate on the moderating term between hierarchical complexity and the home country institutional environment is insignificant (α=-0.1876, *p*=0.063), which suggests that improvement in the quality of the home country institutional environment could not significantly influence the relationship between hierarchical complexity and corporate opaqueness.

Columns (5) through (6) present the moderating effect of the indicators used to proxy host country institutional environments quality. It can be seen from the results in Column (5) that the coefficient estimate on the interaction terms between hierarchical complexity and the total assets-based host country institutional environment variable is positive and significant

(α=0.0259, *p*=0.001). Moreover, results from Column (6) show that the coefficient estimate is positive and significant in terms of the moderating term between hierarchical complexity and the employee number-based host country institutional environment variable (α=0.0253, *p*=0.002). The results suggest that stronger regulations of the host countries where subsidiaries are located can significantly weaken the relationship between hierarchical complexity and the corporate opaqueness of firms.

Panel 6: Robustness test results using alternative dependent variables

Table 1 of Panel 6. Results of regressions using idiosyncratic risk

Regression of idiosyncratic risk on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) Idiosyncratic risk	(2) Idiosyncratic risk	(3) Idiosyncratic risk	(4) Idiosyncratic risk	(5) Idiosyncratic risk	(6) Idiosyncratic risk
L. Hierarchical complexity	-0.0540***	-0.0825***	-0.0747***	0.0440	-0.0693***	-0.0707***
	(0.000)	(0.000)	(0.000)	(0.403)	(0.000)	(0.000)
L. Firm size	-0.2219***	-0.2064***	-0.2058***	-0.2218***	-0.2130***	-0.2183***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	0.1959**	0.1969**	0.1898**	0.1968**	0.2061***	0.2063***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
L. Profitability	-0.7511***	-0.7416***	-0.7504***	-0.7528***	-0.7447***	-0.7391***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Capital expenditure	0.0928**	0.0920**	0.0906**	0.0930**	0.0897**	0.0895**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)
L. Book-to-market ratio	0.2980***	0.2748***	0.2956***	0.3005***	0.3115***	0.3284***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 1 of Panel 6. Continued

	(1) Idiosyncratic risk	(2) Idiosyncratic risk	(3) Idiosyncratic risk	(4) Idiosyncratic risk	(5) Idiosyncratic risk	(6) Idiosyncratic risk
L. Research & Development	-0.0001	-0.0002	-0.0002	-0.0001	-0.0001	-0.0001
	(0.919)	(0.824)	(0.847)	(0.892)	(0.947)	(0.937)
L. Share price	-0.0027***	-0.0030***	-0.0030***	-0.0027***	-0.0027***	-0.0027***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Scaled Amihud illiquidity	-0.0071	-0.0040	-0.0048	-0.0070	-0.0069	-0.0063
	(0.337)	(0.596)	(0.521)	(0.348)	(0.349)	(0.386)
L. Firm age	-0.1335***	-0.1355***	-0.1279***	-0.1329***	-0.1292***	-0.1289***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Related diversification entropy		-0.4672***				
		(0.000)				
L. Hierarchical complexity* L. Related diversification entropy		0.1158***				
		(0.000)				

Table 1 of Panel 6. Continued

	(1) Idiosyncratic risk	(2) Idiosyncratic risk	(3) Idiosyncratic risk	(4) Idiosyncratic risk	(5) Idiosyncratic risk	(6) Idiosyncratic risk
L. Unrelated diversification entropy			-0.4493***			
			(0.000)			
L. Hierarchical complexity* L. Unrelated diversification entropy			0.0845**			
			(0.002)			
L. Home country institutional environment				0.8564		
				(0.470)		
L. Hierarchical complexity* L. Home country institutional environment				-0.1876		
				(0.063)		
L. Host country institutional environment					-0.1431***	
					(0.001)	

Table 1 of Panel 6. Continued

	(1) Idiosyncratic risk	(2) Idiosyncratic risk	(3) Idiosyncratic risk	(4) Idiosyncratic risk	(5) Idiosyncratic risk	(6) Idiosyncratic risk
L. Hierarchical complexity* L. Host country institutional environment					0.0259**	
					(0.001)	
L.Host country institutional environment1						-0.1386**
						(0.002)
L. Hierarchical complexity* L. Host country institutional environment1						0.0253**
						(0.002)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
State fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
N	2534	2435	2399	2534	2534	2534
F	252.770	210.950	212.280	210.180	212.170	212.330
p	0.000	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Second, I perform the sensitivity tests using R^2 as the dependent variable. Table 2 of Panel 6 reports the results by regressing R^2 on lagged independent variables, lagged control variables and lagged moderator variables.

As is shown in the results in Column (1), the coefficient estimates on hierarchical complexity are significantly positive (α=0.0094, *p*=0.000) which suggests that hierarchical complexity is positively related to firm opaqueness. Thus, the results are consistent with findings which are reported in previous analysis.

I then include the related and unrelated corporate diversification entropy variable into the models so as to examine the impact of firms' corporate diversifications on the relationship between hierarchical complexity and opaqueness. Results in Column (2) show that the coefficient estimate on the interaction term between hierarchical complexity and the related diversification entropy variable is insignificant (α=-0.0062, *p*=0.314), while the coefficient estimate on the interaction term regarding unrelated diversification in Column (3) is negative and significant (α=-0.0139, *p*=0.009). The results indicate that firms' engagement in related corporate diversifications cannot effectively weaken the linkage between hierarchical complexity and opaqueness. The results also suggest that firms' increases in unrelated corporate diversification cannot strengthen such a relationship.

Models in Column (4) include the home country institutional environment variable. As is shown in the results, the coefficient estimate on the moderation term between hierarchical complexity and the home country institutions variable is negative but insignificant (α=-0.0003, *p*=0.986). The results suggest that improvement in the quality of the home country institutional environment cannot significantly influence the linkage between hierarchical complexity and opaqueness.

Column (5) through Column (6) report the results by including host country institution variables into the models. As is displayed in the results, the coefficient estimates are significantly negative on the interaction terms between hierarchical complexity and host country institution variables (α=-0.0050, *p*=0.009; α=-0.0043, *p*=0.026, respectively). Thus, the results are consistent with previous findings, suggesting that improved host country institutions with strict regulatory policies and transparent institutional environment can significantly reduce firm opaqueness due to hierarchical complexity.

Generally, the results and findings in the tests above remain consistent and quantitatively the same to those reported in the previous analysis which is indicated by the same coefficient signs and significance.

Panel 6: Robustness test results using alternative dependent variables

Table 2 of Panel 6. Results of regressions using R^2

Regression of R^2 on lagged hierarchical complexity, lagged related corporate diversification entropy variable, lagged unrelated corporate diversification entropy variable, lagged home country institutional environment variable, lagged host country institutional environment variables and their interactions

	(1) R^2	(2) R^2	(3) R^2	(4) R^2	(5) R^2	(6) R^2
L. Hierarchical complexity	0.0094***	0.0104***	0.0118***	0.0096	0.0104***	0.0114***
	(0.000)	(0.000)	(0.000)	(0.358)	(0.000)	(0.000)
L. Firm size	0.0455***	0.0442***	0.0434***	0.0455***	0.0429***	0.0448***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L. Leverage	-0.0186*	-0.0167*	-0.0166*	-0.0186*	-0.0212**	-0.0208**
	(0.013)	(0.030)	(0.032)	(0.013)	(0.004)	(0.006)
L. Profitability	-0.0001	-0.0002	0.0013	-0.0001	-0.0008	-0.0025
	(0.981)	(0.978)	(0.849)	(0.980)	(0.902)	(0.724)
L. Capital expenditure	-0.0043	-0.0039	-0.0035	-0.0043	-0.0035	-0.0036
	(0.209)	(0.263)	(0.323)	(0.210)	(0.297)	(0.292)
L. Book-to-market ratio	-0.0691***	-0.0684***	-0.0757***	-0.0690***	-0.0720***	-0.0758***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 2 of Panel 6. Continued

	(1) R^2	(2) R^2	(3) R^2	(4) R^2	(5) R^2	(6) R^2
L. Research & Development	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.253)	(0.257)	(0.274)	(0.256)	(0.293)	(0.281)
L. Share price	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.505)	(0.658)	(0.534)	(0.505)	(0.461)	(0.480)
L. Scaled Amihud illiquidity	0.0006	0.0003	0.0003	0.0006	0.0006	0.0005
	(0.421)	(0.703)	(0.638)	(0.424)	(0.417)	(0.530)
L. Firm age	0.0099***	0.0102***	0.0080**	0.0099***	0.0082**	0.0088***
	(0.000)	(0.000)	(0.003)	(0.000)	(0.001)	(0.001)
L. Related diversification entropy		0.0499*				
		(0.012)				
L. Hierarchical complexity* L. Related diversification entropy		-0.0062				
		(0.314)				

Table 2 of Panel 6. Continued

	(1) R^2	(2) R^2	(3) R^2	(4) R^2	(5) R^2	(6) R^2
L. Unrelated diversification entropy			0.0990***			
			(0.000)			
L. Hierarchical complexity* L. Unrelated diversification entropy			-0.0139**			
			(0.009)			
L. Home country institutional environment				-0.0288		
				(0.895)		
L. Hierarchical complexity* L. Home country institutional environment				-0.0003		
				(0.986)		
L. Host country institutional environment					0.0404***	
					(0.000)	

Table 2 of Panel 6. Continued

	(1) R^2	(2) R^2	(3) R^2	(4) R^2	(5) R^2	(6) R^2
L. Hierarchical complexity* L. Host country institutional environment					-0.0050**	
					(0.009)	
L.Host country institutional environment1						0.0304***
						(0.000)
L. Hierarchical complexity* L. Host country institutional environment1						-0.0043*
						(0.026)
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
State fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
N	2534	2435	2399	2534	2534	2534
F	136.070	111.960	116.840	114.100	118.080	115.040
p	0.000	0.000	0.000	0.000	0.000	0.000

p-values based on robust-standard errors are in parentheses
* p<0.05, ** p<0.01, *** p<0.001

5.5 Discussion

In this section, I discuss the results on the relationship between hierarchical complexity and corporate opaqueness and the robustness tests. In order to better discuss the results above, I provide tables that summarize all these results from different tests. Table 5.4 presents the results on whether the hypotheses are supported from different tests, Table 5.5 presents the results in terms of reverse causality tests.

Table 5.4 Results of hypotheses based on different tests

Tests / Hypotheses	Main results	Robustness test: Interaction of fixed effects	Robustness test: dynamic panel GMM regressions	Robustness test: Sensitivity checks using idiosyncratic risk	Robustness test: Sensitivity checks using idiosyncratic risk R^2
Hypothesis 1	Supported	Partly supported	Supported	Supported	Supported
Hypothesis 2a	Partly supported	Partly supported	Partly supported	Supported	Not supported
Hypothesis 2b	Not supported	Not supported	Not supported	Not supported	Not supported
Hypothesis 3	Not supported	Not supported	Not applicable	Not supported	Not supported
Hypothesis 4	Supported	Partly supported	Not applicable	Supported	Supported

Generally, the analyses performed above show that hierarchical complexity is positively related to the corporate opaqueness of firms. Based on the empirical analysis results, Hypothesis 1 is supported which indicates that firms' higher degree of hierarchical complexity is positively associated with increasing corporate opaqueness. Hierarchical complexity decreases the quantity and quality of firm-specific information obtained by outside investors which makes hierarchically complex firms be more opaque and less transparent.

Hypothesis 2a posits that a higher degree of related corporate diversification mitigates the relationship between hierarchical complexity and opaqueness. Results, including related corporate diversification, find partial support for Hypothesis 2a. First, in both the main analysis and the robustness tests using fixed effect interactions, results in terms of Hypothesis 2a are significant with the opaqueness index as the dependent variable. Second, in the robustness tests, results are moderately significant in the dynamic panel regression models with the opaqueness index as the dependent variable. Moreover, results are also significant in the sensitivity tests using idiosyncratic risk as the dependent variable. Therefore, the results show Hypothesis 2a is partly supported, suggesting that increases in related corporate diversification could mitigate the relationship between hierarchical complexity and corporate opaqueness to a limited extent. Further, the graph in Figure 1 shows that the moderating effect of related corporate diversification on the relationship between hierarchical complexity and the opaqueness index is more pronounced with more complex firms. This is because firm specific information of more complex firms tends to be less accessible to outside investors due to a higher degree of hierarchical complexity which makes complex firms become more opaque and less transparent. In this case, increases in related corporate diversification could help release relatively larger amounts of firm specific information to outsiders, since business information among related business and industry segments shares more commonalities when firms have related corporate diversification. This reduces the costs and difficulty for management and analysts to analyse the firm. Such reduced difficulty in analysing firm activities and performance could be more noticeable and valuable when it comes to more complex firms which are more opaque. Thus, the mitigating impact of related corporate diversification on the relationship between hierarchical complexity and the opaqueness index is more pronounced in more complex firms.

Following this, results from the previous analysis do not find evidence for Hypothesis 2b which proposes that a higher level of unrelated corporate diversification strengthens the relationship

between hierarchical complexity and opaqueness. This may be because the effect of hierarchical complexity which prevents management from being comprehensively informed of firm operations and performance is already strong and thus compared with such an effect, the roles played by unrelated corporate diversification in increasing the difficulty for management to process and analyse firm operations and performance may not be that significant. Therefore, the impact of unrelated corporate diversification on the relationship between hierarchical complexity and opaqueness is not significant or evident.

Hypothesis 3 posits that increasing the quality of the home country institutional environment weakens the relationship between hierarchical complexity and opaqueness. However, results from the models, including the home country institutional environment variable as the moderator variable, show that Hypothesis 3 is not supported. Results on the interaction term between hierarchical complexity and the home country institutional environment are insignificant in the main analysis and remain insignificant in the robustness tests. This is because the imperceptible and subtle influence from the state institutional environment is not effective and powerful enough to motivate firms to mitigate the information asymmetry between firms and outside investors. Moreover, the regulations from the individual state government may not be so strong as to make firms increase information disclosure to outsiders. Thus, the results do not provide evidence on the hypothesis that increases in the quality of the home country institutional environment could weaken the relationship between hierarchical complexity and the corporate opaqueness of firms.

Moreover, Hypothesis 4 states that improving the quality of the host country institutional environment can weaken the relationship between hierarchical complexity and opaqueness. The investigations into the moderating effect of the host country institutional environment quality show that Hypothesis 4 is supported. Results on the interaction terms between hierarchical complexity and the host country institutional environment variables are significant

in the main analysis with the opaqueness index and information transparency as the dependent variables. The results are also significant in the robustness tests with the opaqueness index and idiosyncratic risk as the dependent variables. Thus, the results suggest that increasing the quality of the host country institutional environment represented by more strict regulatory policies and transparent institutions can effectively weaken the relationship between hierarchical complexity and corporate opaqueness. Improvements in the quality of the host country institutions provide stronger regulations on company behaviours and this reduces corporate opaqueness and increases the transparency of firms. Further, the graph in Figure 2 shows that the mitigating impact of the host country institutional environment quality on the relationship between hierarchical complexity and opaqueness is more evident with less complex firms. This is because compared to more complex firms, it is easier and more practical for regulating authorities to monitor and regulate the behaviours of less complex firms, since there could be less regulation barriers and auditing difficulties for less complex firms. Thus, the moderating effect of the quality of the host country institutional environment on the relationship between hierarchical complexity and opaqueness is more pronounced with less complex firms.

Further, in terms of reverse causality in the relationship between hierarchical complexity and corporate opaqueness, Table 5.5 displays the results of the related robustness tests that examine the presence of reverse causality.

Table 5.5 Reverse causality checks

Tests / Reverse causality	**Test 1: Using hierarchical complexity as the dependent variable**	**Test 2: Using changes of dividends paying as the moderator**
Presence of reverse causality	Yes	Mixed

In the robustness test section, I perform additional robustness tests to check and address reverse causality in the relationship between hierarchical complexity and corporate opaqueness. I employ two approaches to check for the existence of reverse causality. The first approach uses hierarchical complexity as the dependent variable and regresses the hierarchical complexity variable on the opaqueness index variable and information transparency variable. The second approach uses the changes of dividends paying as moderator to check for the presence of reverse causality. It can be seen from Table 5.5 that the two approaches provide mixed results.

Specifically, in terms of the first approach, regressing the hierarchical complexity variable on the opaqueness index variable and information transparency variable, the results on the opaqueness index are significant. Thus, the results suggest that the relationship between hierarchical complexity and the opaqueness index can be bi-directional. In other words, increases in hierarchical complexity are related to a greater opaqueness index, while increasing the opaqueness index is also associated with a higher degree of hierarchical complexity. However, in the second approach using changes of dividends as the moderator, results in Part 1 suggest that increases in dividends paying can significantly mitigate the linkage between hierarchical complexity and the opaqueness index. Following this, results in Part 2 further reveal that when using hierarchical complexity as the dependent variable, results are insignificant on the interaction term between the opaqueness index and increases in dividends

paying. Thus, although the results provide some evidence suggesting that the opaqueness index can influence hierarchical complexity to some extent, which can be seen from the significant results in Column (1) and (2) in Table 3 of Panel 4, the results of the second approach suggest that, on average, the opaqueness index cannot significantly lead to hierarchical complexity.

In general, the mixed results in terms of reverse causality checks suggest that the relationship between hierarchical complexity and corporate opaqueness can be bi-directional at least to some extent. This is because it is possible that more opaque firms tend to become more hierarchically complex. When firms are opaque, outside investors' limited access to firm specific information can provide the firm and controlling shareholders with opportunities to undertake tunnelling activities that expropriate the wealth of outside investors and minority shareholders. In particular, firms tend to have little motivation to pay the investment returns to investors because they can use the corporate resources either for their own benefit or for the further growth (Jensen & Meckling, 1976, Lang, Lins, & Miller, 2004). In this case, one effective way for firms to transfer corporate resources and expropriate outside investors' wealth is to set up a larger number of self-owned intermediary subsidiary companies, since firms can legally take advantage of these intermediary companies to transfer corporate resources, such as assets and profits, to the controlling shareholders through undertaking related party transactions (Johnson, La Porta, Lopez-de-Silanes, & Shleifer, 2000, Shleifer, Vishny, La Porta, & Lopez-de-Silanes, 2000). In addition, apart from undertaking real transactions between related parties, firms can also hide and distort financial information through adding a number of companies into the their ownership linkages (Johnson, La Porta, Lopez-de-Silanes, & Shleifer, 2000). Consequently, the tendency of getting involved in tunnelling and expropriation activities leads opaque firms to develop more complex hierarchical structures and have a higher degree of hierarchical complexity. Thus, it can be possible for more opaque firms to have greater hierarchical complexity.

Given that the relationship between hierarchical complexity and corporate opaqueness may be bi-directional, I perform additional robustness tests to address this issue. Through using the orthogonal approach, the results provide some evidence that increasing hierarchical complexity can lead to a reduced level of information transparency. Thus, after excluding the factors through which corporate opaqueness variables can affect hierarchical complexity, firms' information transparency decreases with hierarchical complexity which is driven by the uni-directional nature of the relationship.

Chapter 6 Conclusions

6.1 Conclusions

In this thesis, I examine the impact of hierarchical complexity on corporate opaqueness and investigate the moderating effect of corporate diversification, the quality of the home country institutional environment and the host country institutional environment. I utilize a sample of U.S. firms from 42 industries to investigate the relationship between hierarchical complexity and corporate opaqueness. My descriptive analysis shows that hierarchical complexity is positively correlated to the opaqueness index and is negatively correlated to information transparency. I then perform multivariate analysis to examine the relationship between hierarchical complexity and corporate opaqueness. The empirical results show that hierarchical complexity is positively associated with the opaqueness index and is negatively associated with information transparency. These findings indicate that hierarchical complexity is positively related to corporate opaqueness. Following this, I then investigate the moderating impact of corporate diversification, the quality of the home country institutional environment and the host country institutional environment on the relationship between hierarchical complexity and opaqueness. In terms of the moderating effect of corporate diversification, the results show that related corporate diversification can mitigate the relationship between hierarchical complexity and opaqueness to some extent, while unrelated corporate diversification cannot significantly influence such a relationship. In terms of the effect of the home country institutional environment, the results indicate that increasing the quality of the home country institutional environment cannot significantly affect the relationship between hierarchical complexity and opaqueness. In regard to the moderating effect of the host country institutional environment, the results reveal that increasing the quality of the host country institutional environment effectively weakens the linkage between hierarchical complexity and opaqueness.

Specifically, I first find a positive relationship between hierarchical complexity and corporate opaqueness. Increasing hierarchical complexity reduces the quality of outside investors' information environment and increases the information asymmetry between the firms and outside investors, since less firm-specific information is accessible and available to outsiders. As a result, it can be difficult for outside investors to be aware of the firms' activities. Thus, hierarchical complexity is found to be positively associated with firm opaqueness.

Second, I investigate the impact of related and unrelated corporate diversification on the relationship between hierarchical complexity and corporate opaqueness. When firms have corporate diversifications in related industry segments, information similarities among firms' industry and business segments can reduce the costs and difficulty for management and financial analysts to collect and analyse information which increases the quantity and quality of firm-specific information available to outside investors. Thus, related corporate diversification is found to be able to mitigate the linkage between hierarchical complexity and opaqueness to some extent. However, the results also show that the effect of related corporate diversification in alleviating the level of corporate opaqueness due to hierarchical complexity is limited. This can be seen in the results showing that Hypothesis 2a is only partly supported. This is because although related corporate diversification can reduce top management's and analysts' information processing difficulty and challenges to some extent, firms which expand business activities to more than one industry segment are more complex than focused firms. Thus, the roles played by related corporate diversification in mitigating the linkage between hierarchical complexity and opaqueness is limited.

In terms of unrelated corporate diversification, the results do not provide empirical evidence that unrelated corporate diversification can strengthen the relationship between hierarchical complexity and opaqueness. This may be because the effect of hierarchical complexity in increasing the level of corporate opaqueness and deteriorating outside investors' information

environment is already significant enough. Thus, although corporate diversification is found to be able to increase the information asymmetry between the firms and outside investors on the capital market, the effect of unrelated corporate diversification in decreasing the quality of the outside investors' information environment might not be that significant compared with the impact brought by hierarchical complexity. Therefore, I do not find significant empirical evidence indicating that unrelated corporate diversification can strengthen the linkage between hierarchical complexity and opaqueness.

Third, the results show that the quality of the home country institutional environment cannot effectively weaken the relationship between hierarchical complexity and corporate opaqueness. This is because despite federal states constantly promoting auditing independence and firm information disclosure, such regulatory policies and law enforcement at the federal state level in regulating firms' behaviours and activities may not be that strong and obligatory. Additionally, the institutional environment quality may not be significantly different across different federal states. Thus, the regulation powers of the federal bodies in increasing firm transparency and improving the quality of outside investors' information environment are not significant. Consequently, improvement in the quality of the home country institutional environment in the United States has no significant effect in mitigating the level of opaqueness caused by hierarchical complexity.

Finally, the results provide evidence indicating that increasing the quality of the host country institutional environment can significantly weaken the relationship between hierarchical complexity and opaqueness. In particular, when firms have foreign subsidiaries which are located in countries with strict regulation policies and institutional rules, the strict regulatory policies, legal enforcement and the transparent institutional environment of the host country can effectively regulate and discipline the behaviours of subsidiaries. Thus, increasing the

quality of the host country institutional environment is found to be able to significantly mitigate the linkage between hierarchical complexity and opaqueness.

In summary, this thesis makes the following contributions to the existing literature. First, this thesis advances the research which examines the impact of organizational complexity on firms. As one important type of organizational complexity, hierarchical complexity reflects the complex hierarchical structural characteristics of the subsidiary companies of the firms. It also reflects the interactions of management and business operations and activities between the parent company and subsidiary companies as well as those among the subsidiary companies. Compared with previous literature which implicitly investigates organizational complexity from the perspectives of corporate diversification and international diversification (Bushman, Chen, Engel, & Smith, 2004, Duru & Reeb, 2002, Jennings, Seo, & Tanlu, 2014, Naveen, 2006), hierarchical complexity reveals the critical features of organizational complexity which corporate diversification and international diversification do not. Specifically, both types of diversification depend on the diversification of sales across industry divisions and geographical segments to reflect the organizational complexity of firms. While the diversification of sales can partly uncover some operational information about the firm's complexity, such diversification only directly reflects the sales variety of the firm and cannot indicate the dimensions of organizational complexity that exist in the internal subsidiary structures of the firm. Hierarchical complexity which focuses on firms' internal subsidiary structures reflects a more complete picture of the organizational complexity of firms. This is in keeping with the definition of organizational complexity which states that organizational complexity is the differentiations and interactions of the internal components that constitute the organization (Dooley, 2002, Thompson, 1967). Hierarchical complexity more comprehensively reflects organizational complexity by capturing the complexity of the firms' subsidiaries as well as their interactions in business operations and activities from the perspective of chain of

subsidiaries ownership linkages. Thus, focusing on hierarchical complexity allows me to extend the empirical studies of organizational complexity. Therefore, this thesis contributes to the literature on organizational complexity and provides a more comprehensive understanding of firms' complex hierarchical subsidiary structures.

Second, this thesis contributes to the literature examining the impact of firms' complex business and operational characteristics on information asymmetry between firms and outsiders on the capital market. Despite the importance of hierarchical complexity and corporate opaqueness, there are no prior studies that comprehensively examine the linkage between hierarchical complexity and corporate opaqueness. By revealing that increasing hierarchical complexity can increase the costs and difficulty for outside investors to access, process and analyse firm information, hierarchical complexity is shown to make it difficult for outsiders to be aware of the activities and performance of firms, causing them to become opaque and less transparent. Thus, by exploiting several features of the relationship between hierarchical complexity and corporate opaqueness, this study fills the void in literature by finding the positive relationship between hierarchical complexity and corporate opaqueness. Additionally, by providing evidence that complexity stemming from firms' complex hierarchical structures is positively associated with corporate opaqueness, this thesis extends previous literature which finds that increases in firms' international diversification can lead to greater information asymmetry between the firms and the capital market (Aabo, Pantzalis, & Park, 2015, Duru & Reeb, 2002).

Third, this thesis provides some evidence on the controversies in the literature which investigates the influence of complex organizational forms on top management's information availability and cognition capabilities. Although I do not directly examine the impact of hierarchical complexity on management behaviours of firms, this thesis provides some indirect evidence in terms of whether hierarchical complexity can affect the parent company

management's information availability and information processing capabilities by addressing hierarchical complexity, both conceptually and empirically. Specifically, the findings in this thesis show that increasing hierarchical complexity can aggravate management unrelatedness and information disconnections between the parent company management and subsidiary management which consequently deteriorates the parent company management's information availability and information analysing and processing capabilities. Therefore, these findings provide support for and extend past studies which argue that firms' hierarchical structures can reduce the parent company management information availability and hamper management's information processing capabilities (Bartlett & Ghoshal, 2002, Campbell, Datar, & Sandino, 2009, Dikolli & Vaysman, 2006, Glenn & Malott, 2004, Prahalad & Doz, 1981). Meanwhile, the findings of the thesis also challenge previous studies which argue that adopting hierarchical structures can provide parent company management with information advantages, since authorizing business decision making powers to middle level management enabled by hierarchical structures can improve the information availability and reliability of top management (Chandler, 1990, Hoskisson, Harrison, & Dubofsky, 1991, Mahajan, 1986, Mihm, Loch, Wilkinson, & Huberman, 2010, Siggelkow & Rivkin, 2005, Simon, 2013, Wang & von Tunzelmann, 2000, Williamson, 1985).

Fourth, by seeking to explore the variations of the relationship with different moderators, this thesis supports some research in previous literature. Previous studies provide conflicting results in terms of the question of whether increases in corporate diversification are positively correlated to information asymmetry between firms and outsiders (Clarke, Fee, & Thomas, 2004, Gilson, Healy, Noe, & Palepu, 2000, Habib, Johnsen, & Naik, 1997, Krishnaswami & Subramaniam, 1999, Nanda & Narayanan, 1999, Thomas, 2002). By including corporate diversification as the moderator and differentiating corporate diversification into related and unrelated corporate diversification, this study shows that related corporate diversification can

alleviate information asymmetry between firms and the capital market. This provides partial support for the strand of literature which finds that increases in corporate diversification may not be correlated to more severe information asymmetry (Clarke, Fee, & Thomas, 2004, Thomas, 2002). Thus, this study extends the previous studies and provides support to literature examining the linkage between corporate diversification and information asymmetry.

This study has several implications. Firstly, this study provides implications for firm management and executives. Increases in corporate opaqueness can influence firms, since increases in opaqueness and reduction in transparency are found to increase the equity costs of the firms and negatively affect the firms' capital structures and investment policies. Thus, the information environment of outside investors is of great concern to firms (Aabo, Pantzalis, & Park, 2015, Barron, Sheng, & Thevenot, 2012, Durnev & Mangen, 2009, Francis, Nanda, & Olsson, 2008, Shyam-Sunder & Myers, 1999). As a result, managers of firms frequently express their desire to mitigate information asymmetry between firms and outside investors so as to reduce equity costs and optimise capital structures (Gilson, Healy, Noe, & Palepu, 2000, Habib, Johnsen, & Naik, 1997). The findings in this study show that increases in firms' hierarchical complexity can be positively related to higher levels of opaqueness and thus hierarchically complex firms are more likely to become opaque to outside investors on the capital market. Therefore, these findings provide a reference for firm management to take firm opaqueness into account when making corporate development strategies which may add to hierarchical complexity.

Second, the study shows that increasing the quality of the host country institutional environment can mitigate the relationship between hierarchical complexity and opaqueness. These findings suggest that the protection of investors relies not only on the strict investor protection laws and regulations of the home country government which requires and promotes firm specific information disclosures but also on the increasing quality of the host country's

institutional environment. Hence, in cases where firms of the host country become hierarchically complex and have subsidiary companies operating in foreign countries, investor protection of the host country also depends on the improved institutional environment of other countries. Therefore, it is important for regulators and authorities of all countries to apply strict institutional rules and regulatory policies to regulate the behaviours of companies. The application of strict regulatory policies and the subsequent increase in the quality of the institutional environment together protect the interest and benefit of investors, both in the host country and the home country.

6.2 Limitations and future research

As with all studies, this study has several limitations which provide opportunities for further research. First, the study is restricted to US firms and only considers the impact of US firms' hierarchical complexity on opaqueness. It should be noted that US firms may only represent exceptional cases in terms of the effects of complex organizational forms on corporate opaqueness. Since the sample of firms is only from one country which has a relatively larger percentage of complex firms, the US sample may only consider the most complex firms. Therefore, although the findings of the study reveal a positive relationship between hierarchical complexity and corporate opaqueness for US firms, this study calls for more research on the effects of hierarchical complexity on opaqueness in more diversified backgrounds. In particular, future research might extend the sample to other countries or regions to further examine whether such a relationship holds for firms from other developed countries or for firms from developing countries.

Second, the robustness tests provide some mixed results in terms of checking for the presence of reverse causality in the relationship between hierarchical complexity and opaqueness. Thus,

the direction of causality could not be clearly identified in all robustness tests, although I adopt a series of strategies to address this. As indicated in the discussion section of the last chapter, it may be possible that more opaque firms are more likely to become hierarchically complex. This is because such firms tend to be involved in expropriation and tunnelling activities through establishing a greater number of self-owned intermediary companies and thus increasing the degree of hierarchical complexity (Johnson, La Porta, Lopez-de-Silanes, & Shleifer, 2000, Shleifer, Vishny, La Porta, & Lopez-de-Silanes, 2000). Future research that investigates the linkage between firm transparency and complex organizational forms and characteristics would be able to address the issue of potential reverse causality in the hypothesized relationships.

Third, because this thesis focuses on the effects of hierarchical complexity on corporate opaqueness, which is defined as the ease with which firm specific information is released to outside investors on the capital market, I have invested most effort into investigating the hierarchical complexity of the firms and the information friction of outside investors. As a result, this study does not consider the more detailed roles played by management and chief executives in this relationship. As previous studies have suggested, management and chief executives may take advantage of firms' complex characteristics to pursue self-interests such as increasing personal wealth and gaining prestige and power, among other self-serving interests at the expense of shareholders (Callen, Hope, & Segal, 2005, Jensen & Murphy, 1990, Lang, Lins, & Miller, 2004). Future studies could investigate the roles played by management in undertaking entrenchment activities in order to provide a more comprehensive picture of firms' complex organizational forms and information asymmetry.

Fourth, in regard to the firms' hierarchical structures and the associated hierarchical complexity, this thesis only considers the levels of hierarchy and the number of subsidiaries located on each hierarchical level, and does not consider the span of control. Thus future research can further investigate hierarchical complexity by including the span of control into considerations.

Finally, although this thesis has further examined how the relationship between hierarchical complexity and opaqueness varies with the moderating effect of the home country institutional environment, the quality of the home country institutional environment is measured by the total number of accounting and auditing professionals, financial analyst professionals and legal professionals scaled by the total number of firms that are geographically located in each US state. While this measure can provide some useful information about the institutional environment quality of each US state, it might not be able to fully reflect the institutional environment of the state. Thus, future studies could use more fine-grained measures that allow for capturing the US state's institutional environment quality more comprehensively. Additionally, in terms of the moderating effect of the quality of the host country institutional environment, the potential dual moderation between host country institutional environment and firms' experience in that host country could be investigated. Further, the panel data used in this study has a time period of 5 years between 2012 and 2016. Future research that uses longitudinal data spanning a longer period of time would be able to examine the hypothesized relationships more systematically.

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