UNCERTAINTY, COMPLEXITY, AND APPROPRIABILITY OF CROSS-BORDER INNOVATION

By Tung-Min Hung

A dissertation submitted to the

Graduate School-Newark

Rutgers, The State University of New Jersey

in partial fulfillment of requirements

for the degree of

Doctor of Philosophy

Graduate Program in Management

Written under the direction of

Farok J. Contractor

And approved by

_____

_____

_____

_____

Newark, New Jersey

October, 2020

ABSTRACT OF DISSERTATION

Uncertainty, Complexity, and Appropriability of Cross-Border Innovation

By Tung-Min Hung

Dissertation director: Professor Farok J. Contractor

Conducting innovation activities across national borders, firms face political, social, economic, financial, technological, or demand uncertainties. To manage the costs stemming from uncertainties in foreign countries, the conventional wisdom of transaction cost economics suggests that firms should internalize the practice of cross-border innovation to substitute the external hazards. However, many firms do outsource innovation activities to independent contract providers in countries with high uncertainty. Why? To resolve this paradox, I draw upon the theory of real options, the perspective of appropriable rents, and the literature of international expansion. I argue that firms use outsourcing as an option to incrementally invest in cross-border innovation and capture the value of a growth option through learning by outsourcing under uncertainty. In addition, firms could develop the architecture of system-specific outsourcing to secure their entrances to countries with high uncertainty. Moreover, firms benefit from expanding cross-border innovation along with an implementation of a global strategy in a long run. My premises are validated by testing a unique dataset from the Corporate Client Survey of Offshoring Research Network, the International Country Risk Guide, the Index of Economic Freedom, the Patent Protection Index, and the Special 301 reports by the United States Trade Representative.

Acknowledgement

I would like to express my deepest gratitude to the following people and organizations for teaching, guiding, and supporting me to complete my dissertation. First and foremost, I want to thank my dissertation adviser, Dr Farok Contractor, and committee members, Dr. Ajai Gaur, Dr. Sinéad Monaghan, and Dr. Gwendolyn Lee who always provide me with the insightful advices on my research in a timely manner. Second, I appreciate the critical comments on my dissertation research from the panel of STR doctoral consortium led by Dr. Andrew Delios and the panel of IM doctoral consortium led by Prithwiraj Choudhury at the Academy of Management Annual Conference in Chicago. Third, I am thankful for the financial support and research funding from the MGB department chaired by Dr. Petra Christmann and the dissertation fellowship granted by the Graduate School-Newark at Rutgers University. Fourth, I am grateful for the access to the data managed by Dr. Arie Lewin in CIBER at Duke University. Lastly and most importantly, I wholeheartedly thank my family for encouraging and giving me their utmost support whenever I need it during my doctoral study. Thanks to these enormous helps and great supports, my dissertation is completed.

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

List of Tables

List of Tables (Continued)

List of Figures

1. Introduction

1.1 One paradox

Conducting cross-border innovation activities such as research and development (R&D), engineering, and design is a fascinating theme and critical practice in strategic management and international business (Contractor, Kumar, Kundu, & Pedersen, 2010, 2011). Conducting innovation activities across national borders, firms face political, social, economic, financial, technological, or demand uncertainties. While uncertainties might increase management costs and lead to downside losses, firms determine whether, where, how, and why to conduct cross-border innovation under uncertainty.

While firms make decisions on the location, scale, and scope of conducting cross-border innovation under uncertainty, they could either implement through their own investments, including subsidiaries and joint ventures, or outsource to independent contract providers in foreign countries. Before that, firms normally analyze the benefits of conducting cross-border innovation as well as the costs of so doing. The benefits and costs are associated with business, corporate, international, and institutional levels (Table 1.1). The benefits of conducting cross-border innovation might overweigh the costs especially when firms are able to manage the costs associated with uncertainty.

To manage the costs stemming from uncertainties in foreign countries, the conventional wisdom of transaction cost economics (TCE) suggests that firms should internalize the practice of cross-border innovation to substitute the external hazards (e.g., Alcácer & Zhao, 2012; Berry, 2017; Feinberg & Gupta, 2009; Nandkumar & Srikanth, 2016; Schotter & Teagarden, 2014; Zhao, 2006). That is, firms should implement innovation activities through their own subsidiaries in foreign countries under uncertainty.

However, many firms outsource innovation activities to independent contract providers in foreign countries with high uncertainty. This reveals a paradox between the theory and the phenomenon.

Table 1.1: The benefits and costs of conducting cross-border innovation

Levels	**Benefits**	**Costs**
Business	• Spreading overheads (Contractor, Kundu, & Hsu, 2003) • Access to idiosyncratic resources (Andersson & Pedersen, 2010; Contractor et al., 2003; Rugman & Verbeke, 2001) • Tap into local knowledge (Almeida & Phene, 2012; Hsu, Lien, & Chen, 2015; Lahiri, 2010; Penner-Hahn & Shaver, 2005; Steinberg Procher & Urbig, 2017) • Access to new technology (Belderbos Lokshin & Sadowski, 2015; Berry & Kaul, 2015; Grimpe & Kaiser, 2010; Kotabe et al., 2007; Steinberg et al., 2017) • Obtain varied ideas (Kotabe et al., 2007) • Conduct non-local search (Singh, 2008) • Access to markets and customers (Berry & Kaul, 2015; Cloodt, Hagedoorn & Van Kranenburg, 2006; Hsu et al., 2015; Sartor & Beamish, 2014; Singh, 2008) • Labor specialization (Lai, Riezman & Wang, 2009; Mayer, Somaya & Williamson, 2012) • Access to talent (Andersson & Pedersen, 2010; Ernst, 2006; Lewin, Massini & Peeters, 2009; Tallman & Phene, 2007) • Gain crucial inputs (Nieto & Rodrı´guez, 2011)	• Initial costs (Contractor et al., 2003; Roza, Van den Bosch & Volberda, 2011) • Transaction costs (Feinberg & Gupta, 2004; Steinberg et al., 2017) • Irreversible investment (Feinberg & Gupta, 2004) • Complication of tacitness (Penner-Hahn & Shaver, 2005) • Transferability of knowledge (Hurtado-Torres, Van den Bosch & Volberda, 2018; Nieto & Rodrı´guez, 2011; Penner-Hahn & Shaver, 2005; Singh, 2008) • Knowledge outflow (Grimpe & Kaiser, 2010; Hennart, 2007; Kotabe et al., 2007; Lai et al., 2009) • Expose the variety of ideas (Kotabe et al., 2007) • Myopic focus on local adaptations (Singh, 2008) • Extra overheads (Bertrand & Mol, 2013; Singh, 2008) • Specification costs (Andersson & Pedersen, 2010) • Design costs (Andersson & Pedersen, 2010) • Knowledge transfer costs (Andersson & Pedersen, 2010; Thompson & Fox-Kean, 2004) • Developmental costs (Roza et al., 2011) • Operational complexity (Hsu et al., 2015) • Information leakage (Steinberg et al., 2017)

Table 1.1: The benefits and costs of conducting cross-border innovation (Continued)

Levels	Benefits	Costs
Corporate	• Greater learning (Contractor et al., 2003) • Accumulated experience (Contractor et al., 2003) • Better appropriability regime (Contractor et al., 2003) • Improve local responsiveness (Kotabe et al., 2007) • Acquire complementary resources (Kotabe et al., 2007) • Avoid group thinking (Singh, 2008) • New partners (Jensen, 2009; Kedia & Lahiri, 2007; Manning, Massini & Lewin, 2008) • Adapt R&D to production (Lai et al., 2009) • Economies of scale (Lai et al., 2009) • Innovation speed (Carlsson, 2006; Hsuan & Mahnke, 2011; Lai et al., 2009) • Increase the value of knowledge development activities in the firm (Andersson & Pedersen, 2010) • Greater efficiency (Currie, Michell & Abanishe, 2008; Mukherjee, Gaur & Datta, 2013; Nieto & Rodrı´guez, 2011; Rodríguez & Nieto; 2016) • Greater flexibility (Albertoni et al., 2017; Nieto & Rodrı´guez, 2011; Rodríguez & Nieto; 2016) • Overcome resource constraints (Roza et al., 2011) • Increase the depth of knowledge (Hsu et al., 2015; Mihalache et al., 2012) • Increase the breadth of knowledge (Hsu et al., 2015; Mihalache et al., 2012) • Cost savings (Lewin, Massini & Peeters, 2009; Steinberg et al., 2017) • Increase the stock of knowledge (Hurtado-Torres et al., 2018) • Raise opportunities for collaboration (Hurtado-Torres et al., 2018; Monaghan, Gunnigle & Lavelle, 2018) • Reinforce legitimization (Hurtado-Torres et al., 2018)	• Coordination and governance costs (Andersson & Pedersen, 2010; Contractor et al., 2003; Hsu et al., 2015; Singh, 2008) • Managerial constraints (Contractor et al., 2003) • Communicating costs (Hsu et al., 2015; Kotabe et al., 2007; Penner-Hahn & Shaver, 2005) • Costly integration (Fifarek & Veloso, 2010; Kotabe et al, 2007; Massini et al., 2010; Mihalache et al., 2012) • Investment in both R&D and subsidiaries (Singh, 2008) • Diseconomies of scale and scope (Singh, 2008) • Lack of control (Lai et al., 2009; Massini, Perm-Ajchariyawong & Lewin, 2010) • Control costs (Andersson & Pedersen, 2010) • Management costs (Kapler & Puhala, 2011) • Hard to internalize (Nieto & Rodrı´guez, 2011) • Become hollow corporations (Mihalache et al., 2012) • Duplication (Berry, 2014; Chen, Huang & Lin, 2012) • Difficult integration of knowledge (Hurtado-Torres et al., 2018; Mihalache et al., 2012; Thakur-Wernz & Samant, 2017) • Complexity of management (Larsen, Manning & Pedersen, 2013; Steinberg et al., 2017) • Agency- and transaction-related costs (Bunyaratavej et al., 2011; Steinberg et al., 2017)

Table 1.1: The benefits and costs of conducting cross-border innovation (Continued)

Levels	Benefits	Costs
International	• Develop global scanning (Contractor et al., 2003) • Cross-subsidization (Contractor et al., 2003) • Arbitrage potential (Contractor et al., 2003) • Host country factor endowments (Feinberg & Gupta, 2004) • Capitalize location-specific advantages (Dunning, 1988; Kotabe et al., 2007) • New locations (Manning et al., 2008) • Augment R&D internationalization (Nieto & Rodrı´guez, 2011)	• Barriers to international expansion (Contractor et al., 2003) • Liability of foreignness (Contractor et al., 2003; Hsu et al., 2015) • Initially unfamiliar environments (Kotabe et al., 2007) • Considerable barriers (Alcácer, Cantwell & Piscitello, 2016; Mihalache et al., 2012; Teagarden, von Glinow & Mellahi, 2018)
Institutional	• Knowledge spillovers (Feinberg & Gupta, 2004; Lai et al., 2009) • Tap into national innovation systems (Kotabe et al., 2007) • Foreign government incentives (Kotabe et al., 2007) • Reach to socially and culturally embedded knowledge (Kotabe et al., 2007) • Subnational institution benefits (Monaghan et al., 2018)	• Appropriability hazards (Contractor, 2019; Nandkumar & Srikanth, 2016; Quan & Chesbrough, 2010; Sartor & Beamish, 2014) • Ineffective institutions (Hoskisson et al., 2000; Lu, Tsang & Peng, 2008; Peng & Heath, 1996) • Weak information protection (Alcácer & Zhao, 2012; Alcácer, Cantwell & Piscitello, 2016; Gooris & Peeters, 2016; Hennart, 2007; Ivus, Park & Saggi, 2017; Keupp, Beckenbauer & Gassmann, 2009; Zhao, 2006)

1.2 Three questions

(1) Why do firms adopt outsourcing to conduct cross-border innovation under uncertainty? Although internalizing cross-border innovation could mitigate the management costs, it might magnify the downside losses due to the irreversible investment under the unfavorable uncertainty. Contrary to the TCE assertion, outsourcing cross-border innovation requiring less investment contains the downside losses under the unfavorable uncertainty. In addition to the containment of downside losses, the availability of managerial flexibility also distinguishes outsourcing cross-border innovation from internalizing cross-border innovation. Since outsourcing requires less initial investment, it provides more managerial flexibility for firms to adjust under uncertainty.

While firms outsource cross-border innovation under uncertainty, the follow-up question is: (2) How do firms manage the management costs as well as the opportunity costs associated with uncertainty, given that innovation activities are complicated, knowledge intensive, and intellect driven? For example, the high uncertainty incurs significant costs such as (un)intended technology leakage, lowering the benefits of outsourcing innovation activities under uncertainty (e.g., Schotter & Teagarden, 2014). Nonetheless, we do not have a systematic understanding and empirical evidence about how firms manage and protect the property of outsourced innovations under uncertainty.

(3) What is the impact of conducting cross-border innovation on firm performance? As firms aim to reap the returns from conducing cross-border innovation which involves the strategic arrangements of make-or-buy decisions and location choices, the perspective of optimized internationalization (an inverted U-shape) argues that too much arrangements of cross-border innovation damage firm performance due to the increasing complexity (e.g., Grimpe & Kaiser, 2010; Lahiri, 2010). Although the costs of expanding cross-border innovation might exceed the benefits at some point in time, firms are able to turn around this situation of decreasing margins just as they are able to manage the costs associated with uncertainty. Even when a firm encounters the decreasing returns associated with new complexities at higher levels of cross-border arrangement, the impact of expanding cross-border innovation might be continued in a cyclical fashion.

1.3 Dissertation structure

The dissertation consists of three essays. Drawing upon the theory of real options (RO), the first essay aims to answer why firms adopt outsourcing to conduct cross-border

innovation under uncertainty. There are many distinctions between TCE and RO from the theoretical basis to operational differences (Table 1.2). Applying to the RO reasoning, for one thing, firms conducting cross-border innovation often confront substantial environmental uncertainty, a critical factor of the RO research (McDonald & Siegel, 1986). For another thing, the choice of governance modes to conduct cross-border innovation is embedded with several options and determines the potential of firm growth (Bowman & Hurry, 1993). That is, outsourcing cross-border innovation is one of option-based choices which could be elaborated by the RO theory (Trigeorgis & Reuer, 2017).

Table 1.2: The critical comparison between TCE and RO

Comparison	**TCE**	**RO**
• Theoretical basis	Market failure	Market volatility
• Uncertainty emphasis	Endogenous	Exogenous and Endogenous
• Strategic mechanism	Internalization	From internalization to outsourcing
• Strategic merit	Economies of scale	Economies of timing
• Operational difference	1. Heavy investment	1. Small investment
	2. Efficiency	2. Flexibility
	3. Win big or lose big	3. Win some or lose some

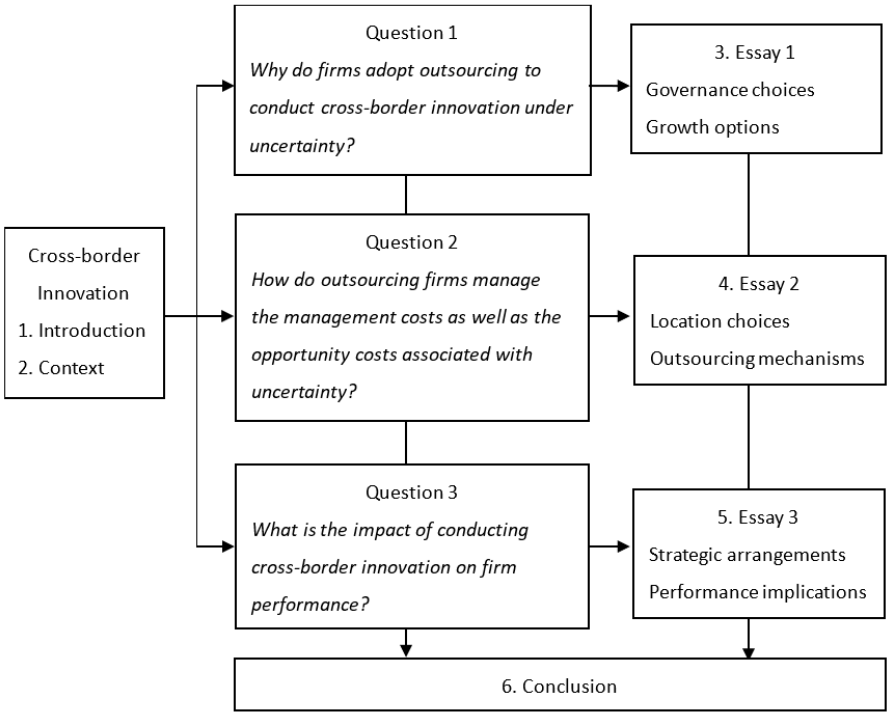
The second essay explores how outsourcing firms manage the management costs as well as the opportunity costs associated with uncertainty. Departing from the theory of disaggregation positing that firms can fine slide innovation activities (e.g., Contractor et al., 2010, 2011), the second essay offers a theoretical perspective of appropriable rents and empirical evidence about how firms manage the innovation activities outsourced to foreign contract providers in countries with high uncertainty. It thus provides an explanation of outsourcing which firms consider an alternative of conducting cross-border innovation.

The third essay investigates the impact of conducting cross-border innovation on firm performance. Extending from the recent work on location-specific advantages (e.g., Hsuan & Mahnke, 2011; Nieto & Rodríguez, 2011; Rodríguez & Nieto, 2016) and hidden costs

(Larsen, Manning & Pedersen, 2013), the third essay considers both the positive and negative impact of complexity stemming from cross-border innovation. Although the benefit of cross-border innovation comes at a price in terms of increased complexities, new complexities increase the depth of knowledge, diverse the base of knowledge, and add the cross-fertilization of ideas so as to facilitate innovation (Damapour, 1996). Moreover, the third essay also explores mechanisms which could be used for managing cross-border innovation to further explain the variance of firm innovativeness.

This dissertation consists of six sections (Figure 1.1). Introduction is the first section (Section 1). The next section considers the empirical context and setting (Section 2). Following are three essays along with the hypothesis development, statistical analyses as well as discussions to answer the abovementioned critical research questions (Section 3, 4, and 5). Then, this dissertation presents the conclusion in the last section (Section 6).

Figure 1.1: The dissertation structure

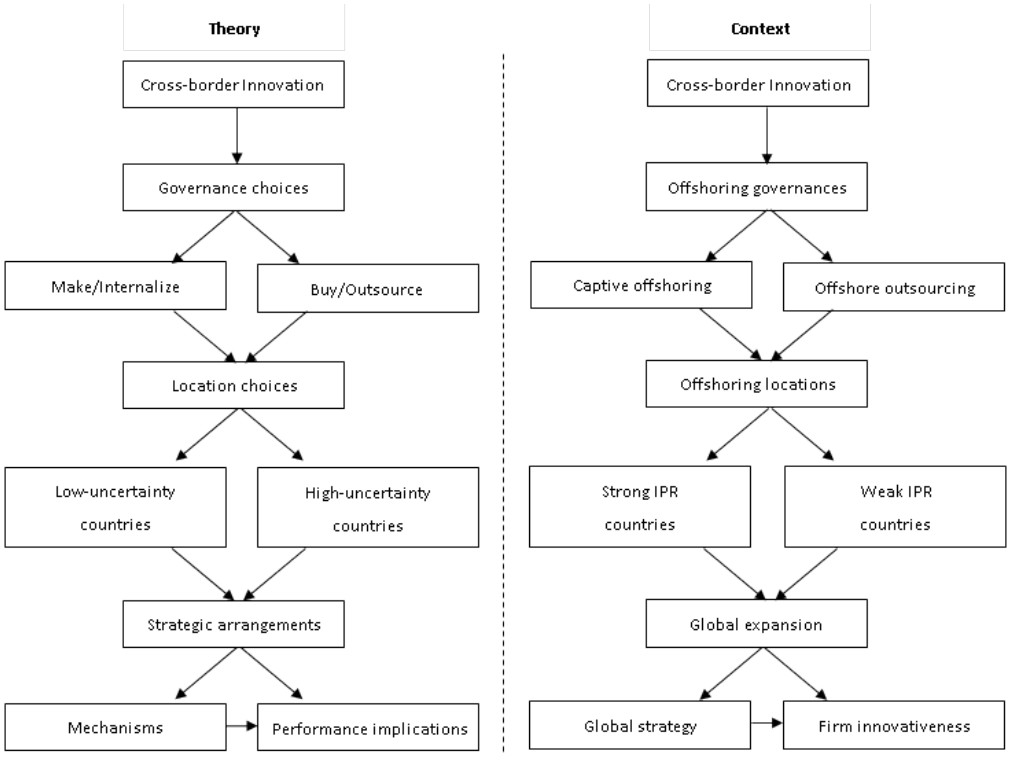


2. Empirical Context and Dataset

2.1 Context

This dissertation explores the abovementioned research questions of cross-border innovation by investigating the context of global offshoring such as offshoring governances, locations, and structures (Figure 2.1). Global offshoring is a process to manage and configure business activities, including innovation activities, inside and outside firm boundaries across national borders. It involves strategic arrangements influenced by external uncertainty, internal governance, and global strategy (Bunyaratavej, Doh, Hahn, Lewin, & Massini, 2011; Contractor et al., 2010; Doh, 2005; Ernst, 2006; Holcomb & Hitt, 2007; Jensen & Pedersen, 2011; Mudambi & Venzin, 2010; Mukherjee, Gaur & Datta, 2013; Srikanth & Puranam, 2011). The major building blocks of the context are elaborated as following.

Figure 2.1: Theory and context



2.1.1 Innovation activities

According to Oslo Manual 2018 (OECD, 2018: 87), innovation activities cover eight broad types of activities: "*R&D activities, engineering, design and other creative work activities, marketing and brand equity activities, intellectual-property related activities, employee training activities, software development and database activities, activities related to the acquisition or lease of tangible assets, and innovation management activities*." As innovation involves many discrete activities, some activities are highly sensitive, complex, and proprietary in nature while others can be mundane. In line with Oslo Manual (OECD, 2018), this dissertation defines that cross-border innovation are the activities of R&D, engineering, product design, software development, information technology (IT), and analytical and knowledge services (AKS).

2.1.2 Uncertainties, offshoring governances and offshoring locations

Firms face different environmental uncertainties since devolving innovation activities in offshore locations. Demirbag and Glaister (2010) define environmental uncertainties as the extent to which a country's political, institutional, legal, cultural, and economic environments threaten the stability of performing innovation. Besides, there are two major governance modes. While innovation activities can be conducted in-house by firms in foreign locations, they can be outsourced to external contract providers in host countries (Contractor et al., 2010; Kedia & Mukherjee, 2009; Lewin et al., 2009; Sartor & Beamish, 2014). If a firm has a foreign subsidiary, the firm can devolve innovation activities to its subsidiary. This is called "captive offshoring". If a firm devolves innovation activities to foreign contract providers, on the other hand, that is called "offshore outsourcing".

In light of Demirbag and Glaister (2010), this dissertation explores the impact of environmental uncertainties on governance choices in the first essay. Furthermore, this dissertation explores the mechanism of outsourcing innovation activities that are complicated, knowledge intensive, and intellect driven by zooming in the countries (regimes) with the varied protection of intellectual property right (IPR). While the IPR protection is associated with different uncertainties, this dissertation covers legal, political, social, trade, investment, laws, orders, and rights of a regime to categorize the countries with strong IPR protection and those with weak IPR protection in the second essay.

2.1.3 Global expansion

Conducting cross-border innovation, firms relocate their high-value activities to different units including subsidiaries and contract providers in different locations. It is a step of global expansion that firms extend the functional boundaries from one domain to another, the organizational boundaries from one organization to another, and the geographical boundaries from one country to another. Firms determine when and where to expand cross-border innovation with what kind of activities managed by which governance modes. Firms must develop the requisite capabilities and design the requisite mechanisms to manage and benefit from the expansion. The benefits of expanding cross-border innovation can lead firms to have a better appropriability regime (Contractor et al., 2003), innovation speed (Carlsson, 2006; Hsuan & Mahnke, 2011), greater efficiency (Currie et al., 2008; Mukherjee et al., 2013; Nieto & Rodrı´guez, 2011), greater flexibility (Albertoni et al., 2017; Rodríguez & Nieto; 2016), and reinforce legitimization (Hurtado-Torres et al., 2018).

2.2 Dataset

This dissertation constructs a unique dataset by collecting data from different sources to observe the offshoring arrangements of a focal firm and to measure the characteristics of offshoring locations. Specifically, this dataset consists of the Corporate Client Survey of Offshoring Research Network (ORN) collecting offshoring data at the project level and firm level, the International Country Risk Guide (ICRG) from Political Risk Services (PRS) collecting the data of environmental uncertainties at the country level, the Index of Economic Freedom (IEF) collecting the data of property protection at the country level, the Patent Protection Index (PPI) collecting the data of patent protection at the country level, and the Special 301 reports from the United States Trade Representative (USTR) collecting the data of copyright and trademark at the country level. In a whole, this dataset covers the country level data regarding legal, political, social, trade, and investment environments, laws, orders, and rights, and the project level as well as the firm level data of offshoring innovation activities.

2.2.1 ORN data

The ORN survey data, one of the most comprehensive surveys across industries and countries, is managed by Duke University with other international universities in Australia, Belgium, Brazil, China, Denmark, Germany, France, Italy, Japan, Korea, the Netherlands, the United Kingdom, and Spain (Albertoni, Elia, Massini, & Piscitello, 2017; Roza et al., 2011). The ORN survey is a multi-year international collaborative project tracking the offshoring activities by multinational corporations (MNCs). The offshoring activities traced by the ORN include R&D, product design, engineering, human resource services,

legal services, finance services, accounting services, IT, software development, call center services, marketing services, procurement services, and AKS.

Moreover, the ORN survey contains comprehensive information including the factors influencing offshoring activities, such as drivers and risks, offshoring locations, offshoring functions, and offshoring tasks, offshoring outcomes and future offshoring plans. In short, the ORN survey covers questions including when, how and where to offshore innovation activities, an important feature of the data (Table 2.1).

The participating companies are from the industries such as Aerospace and Defense, Arts, Entertainment and Recreation, Automotive, Construction, Energy, Utilities and Mining, Financial Service, Government and Public Services, Manufacturing, Healthcare, Pharmaceuticals and Life Sciences, Professional Services, Retail and Consumer Goods, Software and IT Services, Telecommunications, or Transportation and Logistics.

In addition, 383 participating companies are from developed countries as well as developing countries including Australia, Austria, Bahrain, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Luxembourg, Mexico, Netherlands, Norway, Philippines, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, and United States. Among those countries do the participating companies come from United States (Table 2.2). For this dissertation study, the dataset includes 2,121 observations from different industries across 97 countries. Among the offshoring locations is India the most popular country, accounting for 14.38% of observations, while China and Philippines account for 11.74% and 8.10% respectively (Figure 2.2).

Table 2.1: The ORN survey categorized items

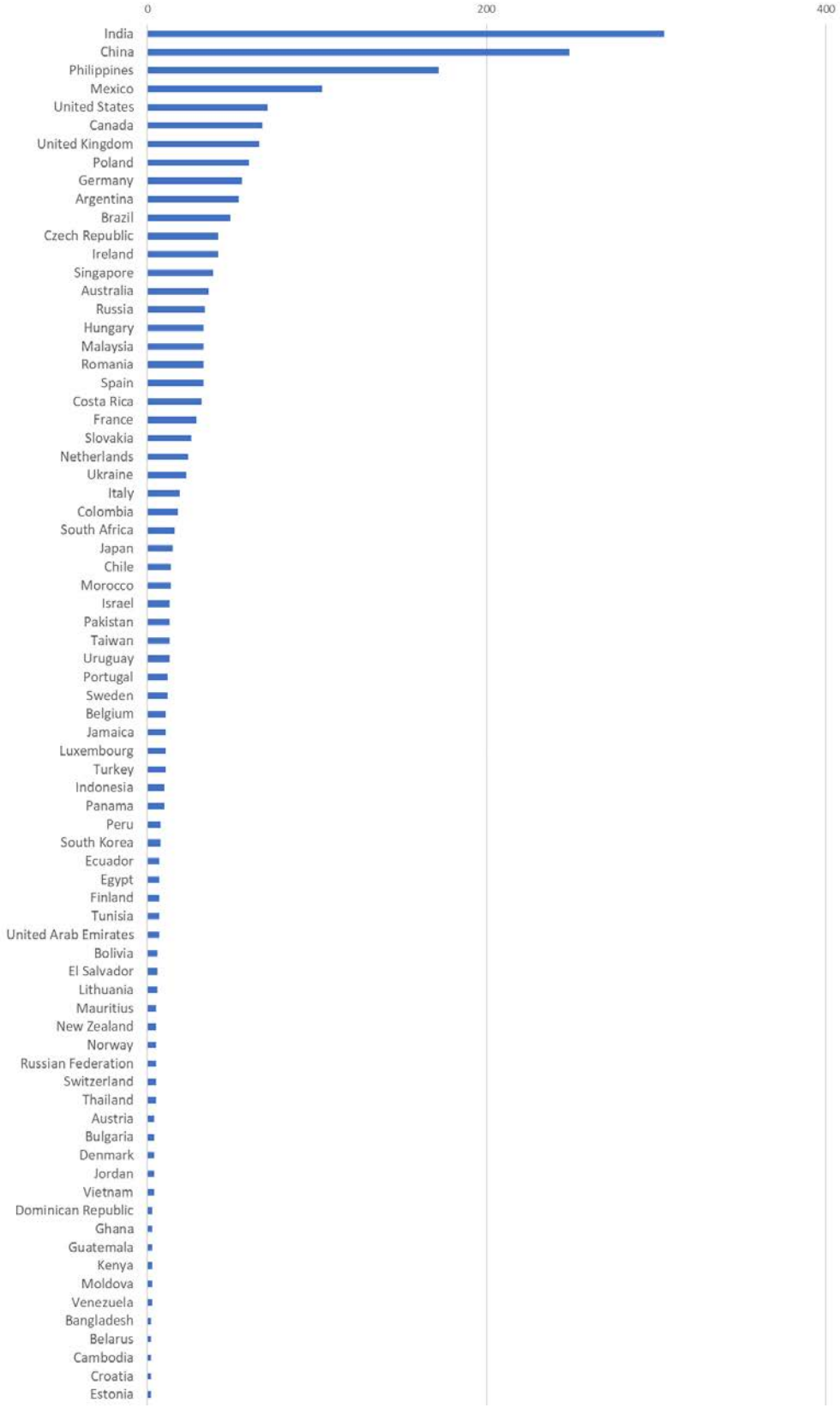
A. Company Information		**B. Offshoring Information**	
1	Name	1.	Function offshored
2	Headquarters location	2.	Launch Year
3	Total Number of Employees Worldwide	3.	Launch month
4	Industry	4.	Service model (Governance Mode)
C. Offshoring Drivers		**D. Offshoring Risks**	
1	Access to qualified personnel	1	Loss of internal capabilities/process knowledge
2	Enhance capacity for innovation	2	Cultural differences
3	Competitive pressure	3	Lack of acceptance from customers
4	Increase organizational flexibility	4	Data security
5	Growth strategy	5	Increasing difficulty in finding qualified personnel offshore
6	Labor cost savings	6	Legal/contractual risks
7	Exploit location-specific advantages	7	Loss of synergy across firm activities
8	Access to new markets	8	Loss of managerial control
9	Domestic shortage of qualified personnel	9	Political instability
10	Increasing speed to market	10	High employee turnover
E. Location Characteristics		**F. Outcomes**	
1	Collocating with existing manufacturing plant offshore	1	Increased productivity/efficiency
2	High level of expertise	2	Firm growth
3	Government incentives	3	Better focus on core competencies
4	Quality of infrastructure	4	Better access to qualified personnel
5	Low cost of labor	5	Improved organizational flexibility
6	Matches language requirements	6	Improved service quality
7	Access to local market	7	Better access to new markets
8	Cultural proximity	8	Breakthrough process improvement(s)
9	Geographical proximity	9	Major product innovation(s)
10	Talent pool available		
G. Future Plans			
1	Expanding		
2	Relocating to another offshore location		
3	Transfer to 3rd party service provider		
4	Transfer to a wholly owned subsidiary		

Table 2.2: The participating companies in ORN survey

Nationality	**Percentage of whole companies**
United States	43.8%
Netherlands	12.6%
Australia	9.5%
Spain	8.8%
United Kingdom	6.8%
Germany	2.7%
Switzerland	2.6%
Denmark	2.3%
Sweden	1.8%
France	1.8%
India	1.2%
Belgium	1.0%
Canada	0.8%
Italy	0.8%
Norway	0.6%
Other	2.9%

Note: N=383

Figure 2.2: The number of observations across countries



2.2.2 ICRG data

The ICRG index is published by the PRS group. The ICRG index has been used to measure the environment uncertainty facing MNCs (e.g., Demirbag & Glaister, 2010). It has monitored over 140 countries and published the ratings of country composite risk index since 1980. The index is consisting of three types of risks – political, financial, and economic risks (Table 2.3).

Table 2.3: The ICRG components

Political Risk (100 points)		
No	*Items*	*Points*
1	Government Stability	12
2	Socioeconomic Conditions	12
3	Investment Profile	12
4	Internal Conflict	12
5	External Conflict	12
6	Corruption	6
7	Military in Politics	6
8	Religious Tensions	6
9	Law and Order	6
10	Ethnic Tensions	6
11	Democratic Accountability	6
12	Bureaucracy Quality	4
Economic Risk (50 points)		
No	*Items*	*Points*
1	GDP per Head	5
2	Real GDP Growth	10
3	Annual Inflation Rate	10
4	Budget Balance as a Percentage of GDP	10
5	Current Account as a Percentage of GDP	15
Financial Risk (Points)		
No	*Items*	*Points*
1	Foreign Debt as a Percentage of GDP	10
2	Foreign Debt Service as a Percentage of Exports of Goods and Services	10
3	Current Account as a Percentage of Exports of Goods and Services	15
4	Net International Liquidity as Months of Import Cover	5
5	Exchange Rate Stability	10

Firstly, the political risk of a host country includes 12 weighted indicators covering both political and social attributes – government stability, socioeconomic conditions,

investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality. As for the financial risk of a host country, it includes the following 5 weighted indicators: foreign debt as a percentage of gross domestic product (GDP), foreign debt service as a percentage of exports of goods and services, current account as a percentage of exports of goods and services, net international liquidity as months of import cover, and exchange rate stability. The final risk category is the economic risk of a host country, which includes the weighted 5 indicators such as GDP per head, real GDP growth, annual inflation rate, budget balance as a percentage of GDP, and current account as a percentage of GDP. Overall, the ICRG's 22 indicators account for 200 points, of which political risk comprises for 100 points, financial risk index 50 points, and economic risk 50 points. The total points from these three indices are divided by 200 to produce the weights for inclusion in the composite country risk score.

2.2.3 IEF data

The IEF is under the Heritage Foundation. It analyzes the economic policy development in 186 countries and evaluate 12 measures of economic freedom related to the rule of law, the government size, the regulatory efficiency, and the openness of markets (Table 2.4). The rule of law includes indicators to evaluate property rights, judicial effectiveness, and government integrity. The government size includes indicators to evaluate tax burden, government spending, and fiscal health. The regulatory efficiency includes 3 indicators to evaluate business, labor, and monetary freedom. The openness of markets includes indicators to evaluate trade, investment, and financial freedom.

Table 2.4: The IEF indicators

Rule of Law	
• Property Rights	The property rights component assesses physical property rights, intellectual property rights, strength of investor protection, risk of expropriation, and quality of land administration.
• Judicial Effectiveness	Judicial effectiveness component assesses judicial independence, quality of the judicial process, and likelihood of obtaining favorable judicial decisions.
• Government Integrity	Government Integrity component assesses public trust in politicians, irregular payments and bribes, transparency of government policymaking, absence of corruption, perceptions of corruption, and governmental and civil service transparency.
Government Size	
• Tax Burden	Tax Burden component assesses the top marginal tax rate on individual income, the top marginal tax rate on corporate income, and the total tax burden as a percentage of GDP.
• Government Spending	Government Spending component assesses captures the burden imposed by government expenditures, which includes consumption by the state and all transfer payments related to various entitlement programs.
• Fiscal Health	Fiscal Health component assesses the average deficits as a percentage of GDP for the most recent three years and the debt as a percentage of GDP.
Regulatory Efficiency	
• Business Freedom	Business Freedom component measures the extent to which the regulatory and infrastructure environments constrain the efficient operation of businesses.
• Labor Freedom	The labor freedom component is a quantitative measure that considers various aspects of the legal and regulatory framework of a country's labor market.
• Monetary Freedom	Monetary freedom combines a measure of price stability with an assessment of price controls.
Open Markets	
• Trade Freedom	Trade freedom is a composite measure of the extent of tariff and nontariff barriers that affect imports and exports of goods and services.
• Investment Freedom	Investment Freedom evaluates a variety of regulatory restrictions that typically are imposed on investment.
• Financial Freedom	Financial freedom is an indicator of banking efficiency as well as a measure of independence from government control and interference in the financial sector.

Among 12 indicators is the index of property rights one source to measures the extent to which the legal systems and institutions of a given country allow people and organizations to freely and securely accumulate private property and intellectual property (Miller & Kim, 2017). It includes five components – physical property rights, intellectual property rights, strength of investor protection, risk of expropriation, and quality of land administration. More specifically, it assesses the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It also assesses the degree to which a country's laws protect private property rights and the degree to which

its government enforces those laws. In addition, it assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts.

2.2.4 PPI data

Ginarte and Park (1997) and Park (2008) have developed the PPI data, examining the economic variables that determine the protection of patent rights. The PPI data also shows that the adoption of strict patent laws and regulations, and the composition of patent applications and rights vary across countries due to the different levels of national economic development. More specifically, Ginarte and Park (1997) and Park (2008) construct the five underlying variables which are the inventions that are patentable, the involvement in international treaties, the restrictions of exercising the right, the duration of protection, and the enforcement mechanisms at the country level.

2.2.5 Special 301 reports

The USTR Special 301 report contains five categories of countries in the Priority Foreign Country (PFC), Priority Watch List (PWL), Watch List (WL), Monitoring (MT), and Pending (PD). Among these five, a country in the PFC category is the worst nation, which is classified by the USTR's comment, which is a foreign country that denies adequate and effective IPR protection or fair and equitable market access for to the US persons and companies. The classification from 1994 to 2017 by USTR is summarized in Table 2.5.

Table 2.5: The nations classified by the Special 301 reports

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria															*WL	*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Armenia							WL	WL	WL															
Argentina	PFC	WL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Australia	WL		WL	WL	WL	WL																		
Azerbaijan							WL	WL	WL	WL	WL	WL	*											
Bahamas		WL	WL	WL	WL			WL	WL	PWL	PWL	WL	WL	*										
Barbados																				*WL	WL	WL	WL	WL
Belarus						WL	WL		WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*	*WL	*	
Belize											WL	WL	*PWL	*WL	*									
Bolivia			MT	WL		WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Brazil		PWL	WL			WL	WL	WL	PWL	PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Brunei																*WL	WL	WL	WL	*				
Bulgaria		MT	MT	WL	PWL						WL	WL	WL	*						*WL	WL	WL	WL	WL
Canada		WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL
Chile	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
China	PFC	WL	PFC	MT	MT	MT	MT	MT	MT	MT	MT		*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Colombia	WL	WL	WL	WL	WL	WL	WL	WL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Costa Rica		WL	WL	WL	WL	WL	WL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Croatia										WL	WL	WL	WL	*										
Cyprus	WL	MT	MT																					
Czech Republic					WL	WL	WL								*WL	WL	*							
Denmark				WL	WL	WL	WL																	
Dominican Republic			MT	WL	PWL	PWL	PWL	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Ecuador			WL	PWL	PWL	WL	WL			WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*PWL	*WL	WL
Egypt	WL	WL	WL	PWL	PWL	PWL	PWL	PWL	PWL	WL	PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
El Salvador	WL	WL	WL																					
European Union	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	WL	WL	*										
Finland																*WL	WL	WL	WL	WL	WL	*		
Germany		MT	MT																					
Greece	WL	PWL	PWL	PWL	PWL	PWL	PWL	WL	WL						*WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Guatemala	WL	WL	WL	WL	WL	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Honduras		MT	MT	WL	WL																			
Hong Kong			MT	WL	WL																			
Hungary						WL	WL	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	*							
India	PFC	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Indonesia	WL	WL	PWL	PWL	PWL	PWL	WL	PWL	PWL	PWL	PWL	PWL	PWL	*WL	WL	*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Ireland			MT	WL	WL	WL	WL																	
Israel		MT	MT	WL	PWL	PWL	PWL	PWL	PWL	WL	WL	PWL	PWL	PWL	PWL	PWL	*PD	*PWL	PWL	*WL	*			
Italy	WL	WL	WL	WL	PWL	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*			
Jamaica					WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Japan	PWL	PWL	PWL	WL	WL	WL																		
Jordan		MT	MT	WL	WL	WL																		
Kuwait		MT	WL	WL	PWL	PWL	WL	WL	WL	WL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	WL	*PWL	PWL	PWL
Kazakhstan							WL	WL	WL	WL	WL	WL	*											
Latvia							WL	WL	WL	WL	WL	WL	WL	*										
Lebanon			MT			WL	WL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Lithuania							WL	WL	WL	WL	WL	WL	WL	WL	*									
Luxembourg				WL																				
Macau					PWL	PWL	WL	WL																
Moldova							WL																	
Malaysia							PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*					
Mexico			MT			WL				WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
New Zealand						WL		WL	WL															
Norway															WL	WL	WL	WL	WL	*				
Oman		MT	WL	WL		WL	WL																	
Pakistan	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	PWL	PWL	*WL	WL	*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	*WL	WL
Panama			MT	WL																				
Paraguay		MT	WL	PWL		MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	MT	*WL	WL	WL	*	
Peru	WL	WL	WL	WL	WL	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Philippines	WL	WL	WL	WL	WL	WL	WL	PWL	PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	*			
Poland	WL	WL	WL	WL	WL	WL	PWL	WL	WL	PWL	WL	WL	WL	WL	WL	WL	*							
Portugal			MT																					
Qatar		MT	MT		WL	WL	WL		WL															
Romania		WL	MT			WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Russia		WL	WL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
San Marino				WL																				
Saudi Arabia	PWL	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*							
Singapore		WL	WL	WL		WL	WL																	
Slovakia								WL	WL	WL	WL	WL	*											
South Africa		WL	MT		WL	WL																		
South Korea	PWL	PWL	PWL	WL	WL	WL	PWL	PWL	WL	WL	PWL	WL	WL	WL	WL	*								
Spain	WL					WL	WL								*WL	WL	WL	WL	*					
Switzerland																							*WL	WL
Sweden				WL	WL	WL																		
Taiwan	WL	WL	MT			WL	WL	PWL	PWL	PWL	PWL	WL	WL	WL	WL	*								
Tajikistan							WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*	
Thailand	PWL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	*PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Trinidad and Tobago																				*WL	WL	WL	*	
Turkey	PWL	PWL	PWL	PWL	PWL	PWL	PWL	WL	WL	WL	PWL	PWL	PWL	PWL	*WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Turkmenistan							WL		WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Ukraine					WL	PWL	PWL	PFC	PFC	PFC	PFC	PFC	*PWL	PWL	*WL	WL	WL	WL	*PWL	*PFC	PFC	*PWL	PWL	PWL
UAE	WL	WL	WL	WL	WL	WL		WL																
Uruguay						WL	WL	PWL	PWL	WL	WL	WL	*											
Uzbekistan							WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
Venezuela	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL	PWL
Vietnam		MT	MT	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL

*Note: * Change in status*

3. Uncertainties, Governances and Real Options

3.1 Theoretical Background

The RO theory is one of the theoretical approaches for evaluating a firm's investment in uncertain environments. Applying the theory of financial options to management issues, Myers (1977) began the initial RO research. For example, Myers (1977) evaluated how a firm allocates its financial resources and budgets on operational and R&D activities. Derived from the theory of financial options, the normative RO model assumes that firms are consistently facing the equivalent probability of change with the uniformly risk neutral preference (Cox, Ross, & Rubinstein, 1979). This is consistent with the Black-Sholes pricing model and follows a geometric Brownian motion under the equivalent, risk-neutral probability as the following equation:

$$dS_t = rS_t dt + \sigma S_t dW_t \qquad (A1)$$

where

S_t is the state variable

dS_t denotes the change in the state variable S_t in a small-time increment

r is the market's risk-neutral discount rate

dt is an increment of a unit time

σ is the standard deviation of the change per time increment reflecting uncertainty

W_t is a standard Wiener process under the equivalent, risk-neutral probability

dW_t denotes the change in the standard Wiener process W_t in a small-time increment

Equation (A1) indicates that the value of the state variable is mostly determined by σ, uncertainty, a critical factor for the RO research (McDonald & Siegel, 1986). According to this normative model, the RO theory argues that firms keep the option of low initial

investment to make additional investments, abandon the investment, or continue to wait when uncertainty creates an unpredictable situation (Ipsmiller, Brouthers & Dikova, 2019), while the value of option-based investments are increasing in uncertainty (Posen, Leiblein & Chen, 2018).

Several RO notions can be applied for strategic management and international business. Firstly, as opportunity costs associated with irreversible investment under uncertainty incur, firms tend to keep a limited investment while waiting for uncertainty to be resolved (Belderbos, Tong, & Wu, 2019; McDonald & Siegel, 1986; McGrath, 1997; McGrath, Ferrier & Mendelow, 2004; Trigeorgis & Reuer, 2017). Secondly, the option-based investment creates economic value for an investing firm through flexibility to delay, stage, switch or terminate its investments and actions in the future (Kogut, 1991; Li, James, Madhavan & Mahoney, 2007; Leiblein, 2003; Trigeorgis & Reuer, 2017). Thirdly, the option-based investment provides an investing firm a privileged access to resources and knowledge about the investment opportunity that a non-investing firm cannot or will not obtain (Brouthers, Brouthers, & Werner, 2008; Trigeorgis & Reuer, 2017). Fourthly, the option-based investment allows an investing firm to leverage the upside benefits with containing the downside risks from uncertainty (Trigeorgis, 1996; Reuer & Tong, 2007). Lastly, the option-based investment leads an investing firm to proactively confront rather than to avoid uncertainty over time (Ipsmiller et al., 2019; Leiblein, 2003; Reuer & Tong, 2007; Trigeorgis & Reuer, 2017).

3.2 Hypothesis Development

3.2.1 Initial options of cross-border innovation and governance choices

Cross-border innovation has been associated with substantial uncertainty, such as the regulatory hazard of internationalization (Coeurderoy & Murray, 2008; Delios, Xu & Beamish, 2008; Henisz & Delios, 2001; Zhang, Li, Hitt, & Cui, 2007; Zhao, 2006), the economic, political, and financial instabilities of a host country (Brouthers et al., 2008; Demirbag & Glaister, 2010; Quan & Chesbrough, 2010; Schotter & Teagarden, 2014), and technological and demand uncertainties (Sartor & Beamish, 2014). To manage cross-border innovation, firms majorly rely upon two governance modes – internalize vs. outsource. From the RO perspective, internalizing and outsourcing cross-border innovation present differences in four dimensions – uncertainty emphasis, resource commitment, flexibility, and risk in downside loss (Table 3.1). All these differences determine a firm's initial option to conduct cross-border innovation.

Table 3.1: The RO perspective of internalizing and outsourcing

Dimensions	**Make/ Internalize**	**Buy/ Outsource**	**References**
Uncertainty emphasis	Endogenous	Exogenous & Endogenous	Chi et al. (2019); Leiblein (2003); Li et al. (2007); Majd & Pindyck (1987); Zhao (2006);
Resource commitment	High	Low	Belderbos et al. (2019); Brouthers & Dikova (2010); Fisch (2008); Kogut (1991); Trigeorgis & Reuer (2017)
Flexibility	Low	High	Choi et al. (2018); Kotabe & Mol, 2009); Nieto & Rodríguez (2011); Rodríguez & Nieto (2016)
Risk in downside loss	High	Low	Brouthers et al. (2008); Fisch (2008); King (2004); Leiblein (2003); Trigeorgis & Reuer (2017)

Generally, uncertainty is a function of time for exogenous reasons and endogenous reasons (Chi et al., 2019). For example, the velocity of changes in opportunities is the exogenous uncertainty. Besides, a partner's unknown behavior is the endogenous uncertainty. While exogenous uncertainty implies the desirability of waiting for uncertainty to be resolved, endogenous uncertainty connotes the opportunity of learning for uncertainty (Majd & Pindyck, 1987; Li et al., 2007). Internalizing is towards to the emphasis of endogenous uncertainty because this mode substitute market failure due to opportunism (Williamson, 1975, 1979, 1985). For example, internalizing is adopted by some MNCs to avoid the endogenous hazards such as the knowledge leakage of individuals (Zhao, 2006) and the information unverifiability of a joint venture (Luo, 2007). Outsourcing is towards to both endogenous and exogenous uncertainty because its value is simultaneously determined by the exogenous environmental uncertainty and endogenous informational uncertainty. For instance, some MNCs reduce organizational control and adopt outsourcing to minimize information and production costs and to learn from the host-country partners in emerging countries with technological and demand uncertainties (Sartor & Beamish, 2014).

Internalizing involves more direct investment and resource commitment than does outsourcing (Rivoli & Salorio, 1996). For example, greenfield investment, one of internalizing strategies, requires a firm's resources to establish its operations such subsidiaries, facilities, and laboratories from the ground up in a foreign country (Brouthers & Dikova, 2010). Most of such investments are irreversible and tie up capital with a new recruitment of personnel and a new setup of a facility (King, 2004). By contrast, outsourcing requires less direct investment and resource commitment since its operation is

through the arm's length relationship with independent contract providers (Kedia & Mukherjee, 2009).

Regarding flexibility, internalizing is less flexible than does outsourcing. On the one hand, internalizing requires significant resource commitment and irreversible investment which confers less flexibility, and which rules out a possible delay of an investment (Leiblein, 2003). On the other hand, outsourcing involves few commitments so as to provide more flexibility to increase, abandon, or continute an investment under the rapidly changing environment and heightened uncertainty (King, 2004). For example, Choi et al. (2018) point out the flexibility of outsourcing to contract out business activities for a fixed but renewable term. That is, the focal firm can terminate or renew the contract based on market conditions. Thus, outsourcing affords more managerial and organizational flexibility for firms to respond to uncertainty (Choi et al., 2018; Fisch, 2008).

Another major difference between internalizing and outsourcing is the potential downside loss. Since internalizing involves relatively large capital investment and resource commitment, it can benefit more under the stable environment but suffer more under the volatile environment (Uhlenbruck, Rodriguez, Doh, & Eden, 2006). So internalizing would be seen as a risky strategy when there is potential downside loss due to the unfavored environment with heightened uncertainty (King, 2004).

Based on the RO theory, outsourcing is the preferred strategy to conduct cross-border innovation (Lo & Hung, 2020). To make the choice between internalizing and outsourcing, firms must take account of the existence of resource commitment, flexibility, and downside loss. First of all, outsourcing offers a firm a valuable option to delay or defer an irreversible investment under uncertainty. For example, since the uncertain condition lowers a firm's

incentive to invest, outsourcing providers an opportunity of waiting for new information about that condition before committing more resources (Li et al., 2007). Second, firms prefer to adopt flexible approaches in business situations where the uncertainty is very high. Outsourcing offers flexibility for a firm to shift activities from one contract provider to another or to switch its governance mode to internalizing when uncertain environmental conditions evolve (Reuer & Tong, 2007). Third, the downside loss of outsourcing is relatively lower than internalizing. Accordingly, firms can contain their losses to the initial investment in outsourcing innovation activities (Choi et al., 2018). On the basis of less resource commitment, high flexibility, and containable downside loss, outsourcing becomes a useful strategic option for firms to conduct cross-border innovation. Therefore, the first hypothesis is proposed:

Hypothesis 1: Environmental uncertainty increases the probability of adopting outsourcing to conduct cross-border innovation.

3.2.2 Growth options of cross-border innovation and learning by outsourcing

As the choice of outsourcing cross-border innovation is an initial option, it can be further considered a growth option as well as an incremental investment strategy (Bowman & Hurry, 1993). Since outsourcing confers the right, but not the obligation, to make additional investments, abandon the existing investment, or continue the existing investment, it creates the value for firms by offering the opportunities of follow-on investment and expansion (Leiblein, 2003). While prior studies have examined the value of growth options (Chi & Seth, 2009; Czarnitzki & Toole, 2011; Folta & O'Brien, 2004; Li & Chi, 2013; Tong, Reuer, & Peng, 2008), little has paid attention to the dynamics of outsourcing in the sequential phase (Hätönen, 2009; Lo & Hung, 2020; Mudambi & Venzin, 2010). To

advance our understanding of how firms exercise growth options through outsourcing requires a framework integrating the concepts of uncertainty and learning by outsourcing (Trigeorgis & Reuer, 2017). As a real option provides learning curve advantages (Brouthers et al., 2008), learning by outsourcing involves three dimensions: capability-based, system-based, and network-based learning (Table 3.2).

Table 3.2: Learning by outsourcing

Learning by outsourcing	**Allow to expand**	**Uncertainties resolved**	**References**
Capability-based	New abilities; Competence enhancement	Endogenous	Chi & Seth (2009); Kedia, & Mukherjee, (2009); Kogut & Kulatilaka (2001); Majd & Pindyck (1987); Nieto & Rodríguez, (2011); Rodríguez & Nieto (2016); Tong & Li (2013)
System-based	New ways; New processes, Redefine business; Organizational change	Endogenous / Behavioral	Chi & McGuire (1996); Fisch, (2008); Kedia & Lahiri (2007); Lewin & Peeters (2006); Mudambi & Tallman (2010); Nieto & Rodríguez, (2011); Sartor & Beamish (2014)
Network-based	New networks; New markets; Boundary span	Exogenous	Di Gregorio et al. (2009); Hätönen (2009); Kedia, & Mukherjee, (2009); Sartor & Beamish (2014)

Firstly, outsourcing provides firms access to idiosyncratic resources (e.g., Andersson & Pedersen, 2010; Contractor et al., 2003), knowledge (Penner-Hahn & Shaver, 2005; Steinberg et al., 2017), and new technology (Kotabe et al., 2007; Steinberg et al., 2017), which possessed by foreign contract providers. Through access to new resource, knowledge, and technology, firms are able to enhance their abilities and competences. For example, Nieto and Rodríguez (2011) show that the Spanish manufacturing and services firms increase their innovation capabilities by R&D outsourcing. Rodríguez and Nieto (2016) also find the similar evidence in the R&D outsourcing by Spanish small- and medium-sized enterprises (SMEs). As outsourcing leads firms to develop new abilities and

competences, in addition, they are more likely to invest in future opportunities (Kedia, & Mukherjee, 2009; Kogut & Kulatilaka, 2001). It is the typical example that Apple firstly contracted out IC design to Imagination, a UK-based, silicon and software IP company, and develops its own IC latterly to handle with the technological uncertainty while expanding its business. This example is consistent with Bovraian and Hurry's reasoning (1993), showing that a firm achieves greater control over the uncertainty as its capabilities grow over time.

In addition, outsourcing involves externalization which is a process of contracting out current business to independent contract providers (Kedia, & Mukherjee, 2009). Adopting the form of externalization, firms remain flexible and learn about the value of this process while developing new ways to disintegrate and integrate, relocate and allocate, and configure and reconfigure their value chain (Jensen, 2009; Maskell et al., 2007; Mudambi & Tallman, 2010; Mukherjee et al., 2013). The new ways include improving process, increasing productivity, and system changes. For example, Lewin and Peeters (2006) argue that outsourcing is a new way to change organizational system and to experiment new business. Kedia and Lahiri (2007) also indicate that firms like Procter and Gamble, Cisco Systems, and Marriot work closely with outsourcing providers to free valuable human resources and relocate business capital to redefine their businesses. Dell computer is another classical case. Dell contracts out computer design and R&D functions to invest in the new system supporting customer service and supplier relationships. As outsourcing implies opportunities for learning new ways and systems, it actually encourages firms to invest in the future (Hätönen, 2009; Jensen, 2009; Manning et al., 2008).

Since outsourcing extends the boundaries of a firm and increases the international

contacts of a firm, firms are able to construct much wider geographical and intellectual networks. As firms enlarge their networks by extending and stretching organizational boundaries to contract providers across countries, they learn not only the local context (Kotabe et al., 2007; Lewin, et al 2009) but also the changes of the environment (Angeli & Grimaldi, 2010; Fisch, 2008). For example, Sartor and Beamish (2014) investigate Japanese companies which learn about the marketplace of emerging economies from the host-country partners. In addition, the growing need for enhanced innovation capability is pushing firms to expand technology sourcing and interaction among a diverse set of geographically dispersed actors. More than that, the wider geographical and intellectual networks aid firms on their subsequent investments or follow-on expansions (Di Gregorio et al., 2009; Hätönen, 2009; Rodríguez & Nieto, 2016). For instance, Demirbag and Glaister (2010) find MNCs that established R&D outsourcing networks in India and China continued further expansion in those emerging countries.

On the whole, learning by outsourcing is a function of new capabilities, new systems, and new networks. Based on the RO theory, firms can learn by outsourcing to evaluate the investment regarding the technology, systems, markets, competition, partners, local context or other factors affected by uncertainty (Trigeorgis & Reuer, 2017). Accordingly, outsourcing improve the odds of follow-on actions on increasing its investment in the future. As the value of outsourcing, a potential growth option, hinges on reduced uncertainty through learning (Belderbos et al., 2019), an increase in learning by outsourcing would be expected to influence the firm's decision to expand. Therefore, the second hypothesis is proposed:

Hypothesis 2: Learning by outsourcing increases the further expansion of cross-border innovation

3.3 Methodology

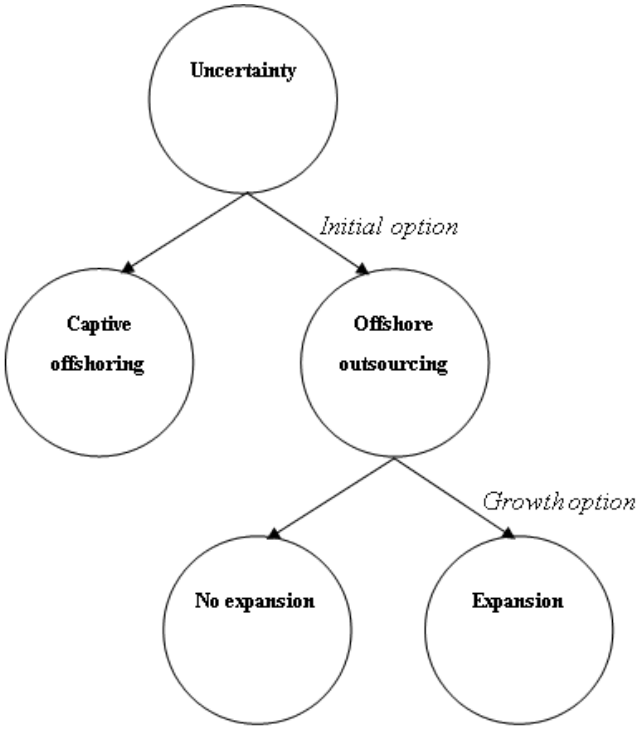
3.3.1 Sample

The primary data is from the ORN survey, which has been used in many prior studies (e.g., Gooris & Peeters, 2016; Larsen et al., 2013; Lewin et al., 2009; Massini et al., 2010). Offshoring refers to the practice undertaken by a company to conduct business activities or functions outside the home country through captive offshoring or offshore outsourcing (Contractor et al., 2010; Kedia & Mukherjee, 2009). The ORN survey provides the appropriate empirical setting for my research since it contains the cases of offshore outsourcing in countries with high uncertainty and those with low uncertainty. To specify the host-country uncertainty, the data includes ICRG data by following Demirbag and Glaister (2010). The dataset consisting of 336 firms that have offshored innovation projects related to R&D, software development, product design, engineering, AKS, or IT. In total, 2,121 firm-choice observations were offshored to 80 host countries during 1995 to 2010.

3.3.2 Estimation

In this chapter, I used the Heckman (1979) two-stage Probit model to investigate the choices of initial option and growth option, which involve a two-stage decision and analysis (Figure 3.1).

Figure 3.1: The decision tree of offshore outsourcing innovation



In the first stage, I estimated the probability that a focal firm adopts offshore outsourcing to conduct cross-border innovation. In the second stage, I introduced to the ordinary least squares regression a selection correction term constructed with the first-stage results. That is, I controlled for sample selection bias in estimating the probability that a focal firm plans to expand its operation. The two-stage approach for correcting the self-selection bias is appropriate under this context where firms make a discrete choice to conduct cross-border innovation, after which their actions and outcomes are observed (Greene, 2000; Hamilton & Nickerson, 2003).Specifically, I estimated the first stage with the following equation:

$$\boldsymbol{S_i = W_i\alpha + Z_i\gamma + \vartheta_i} \qquad \textbf{(A2)}$$

where

$\boldsymbol{S_i}$ is a binary dependent variable with a value of 1 if firm *i* adopts the

mode of offshore outsourcing; 0 otherwise.

$\boldsymbol{W_i}$ represents the independent and control variables that affect firm *i*'s choice to adopt the mode of offshore outsourcing.

$\boldsymbol{Z_i}$ represents the instrumental variables

$\boldsymbol{\vartheta_i}$ represents the error term.

In the second stage, I estimated the following equation.

$$\boldsymbol{Y_i = X_i\beta + W_i\sigma + \epsilon i} \quad \textbf{(A3)}$$

where

$\boldsymbol{Y_i}$ is the dependent variable of expansion with a value of 1 if firm *i* determines to expand; 0 otherwise.

$\boldsymbol{X_i}$ represents factors that affect the dependent variable.

$\boldsymbol{W_i}$ represents the selection correction term.

$\boldsymbol{\epsilon_i}$ represents the error term.

3.3.3 Measurement

Dependent variables In the first stage estimation, the dependent variable "offshore outsourcing" is a binary variable indicating whether a focal firm adopts the mode of outsourcing to conduct cross-border innovation. The value of this variable is coded as 1 if a focal firm adopts offshore outsourcing; otherwise 0.

In the second stage estimation, the dependent variable "expansion" is a binary variable indicating whether a focal firm determines to expand after offshore outsourcing. The value of this variable is coded as 1 if a focal firm determines to expand after offshore outsourcing; otherwise 0.

Independent variables In the first stage estimation, the independent variable "uncertainty" is the extent to which a country's political, legal, cultural, and economic environments influence the stability of a business operation. Following Demirbag and Glaister (2010), I reversed the ICRG index to measure "uncertainty".

In the second stage estimation, there are three independent variables – capability-based learning, system-based learning, and network-based learning – to capture learning by outsourcing. Each of the dimensions has a corresponding item in the ORN Survey. Capability-based learning is to measure the extent to which a focal firm reports the increased productivity/efficiency. System-based learning is to measure the extent to which a focal firm reports the breakthrough process improvement. Network-based learning is to measure the extent to which a focal firm reports the better access to new markets.

Control variables Several control variables are also included to reflect the characteristics of a contract provider, a focal firm, and an outsourced project. First, I controlled the characteristics of a contract provider including "geographic proximity", "co-location (with a manufacturing plant)", "cultural similarity", and "language similarity" (Gooris & Peeters, 2016; Teagarden et al., 2018). These variables are measure using the ORN survey questions in a Likert 5-point scale. I also controlled the characteristics of a focal firm such as, "firm experience", "firm size", "nationality", and "industry". I controlled a focal firm's past experience since recent research has also found that a firm's experience could affect its the choice of offshore location (Larsen et al., 2013). I measured firm experience by calculating the number of years from the time of the focal firm's first launch to the time of the focal project outsourced. Because big firms have more resources

to manage offshoring activities in different countries (Massini, et al., 2010), I then controlled firm size by measuring the logarithm of the focal firm's employees in home country. I controlled a focal firm's nationality because several studies have found that firms from different nationalities presented different offshoring patterns (Massini et al., 2010). In this chapter, I used a dummy variable to measure the nationality of a focal firm. Specifically, the reference group of nationality is US. Besides, I controlled "industry" in this study. The industry where a focal firm operates has also the influence on the offshoring decisions (Lewin et al., 2009). Specifically, the reference group of industry is the software sector. I further controlled the characteristics of an outsourcing project such as "governance incentive", and "project type". For measuring "governance incentive", I used the ORN survey questions in a Likert 5-point scale. I used dummy variables to control the different types of innovation activities outsourced offshore and the reference group of activity is IT. Last but not least, I included the calendar years from 1995 to 2010 in order to control the possible temporal effects during the observed period.

3.4 Analytical Results

Using the Heckman two-stage model with the Probit estimation, I tested the relationships between the hypothesized effects of independent variables and dependent variables. The descriptive statistics of each variable in the main models and the bivariate correlation between any two variables are listed in Table 3.3 while Table 3.4 presents main models.

Table 3.3: The descriptive statistics

	Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Offshore outsourcing	0.52	0.50	1.00														
2	Expansion	0.58	0.50	0.02	1.00													
3	Uncertainty	1.62	0.61	0.02	-0.20	1.00												
4	Capability-based learning	3.53	1.16	0.04	0.04	-0.03	1.00											
5	System-based learning	2.65	1.46	0.07	-0.02	-0.02	0.22	1.00										
6	Network-based learning	2.52	1.39	0.09	-0.07	-0.08	0.14	0.14	1.00									
7	Geographic proximity	2.68	1.40	-0.11	-0.03	-0.03	0.02	0.05	0.08	1.00								
8	Co-location	2.39	1.45	-0.13	-0.05	0.03	0.02	0.06	0.11	0.12	1.00							
9	Cultural similarity	2.75	1.31	-0.09	0.06	0.05	0.03	0.07	0.05	0.08	0.11	1.00						
10	Language similarity	2.99	1.35	-0.07	0.07	0.08	0.06	0.07	0.10	0.06	0.16	0.16	1.00					
11	Firm experience	2.46	0.77	-0.05	-0.05	0.09	-0.11	0.03	0.10	0.04	0.05	0.05	-0.06	1.00				
12	Firm size	7.22	3.00	0.11	0.11	-0.05	0.00	0.05	-0.13	0.03	0.00	0.04	0.04	0.14	1.00			
13	Nationality (Ref: US)	0.50	0.47	0.08	0.07	-0.09	0.08	0.11	-0.07	0.03	0.03	-0.10	0.05	0.07	0.08	1.00		
14	Industry (Ref: Software)	0.27	0.43	0.03	0.10	-0.02	0.00	-0.11	-0.01	-0.03	-0.07	-0.04	-0.08	0.01	-0.03	0.04	1.00	
15	Government incentive	2.33	1.30	0.09	-0.02	-0.07	0.13	0.11	0.10	0.04	0.12	0.13	0.11	0.05	0.11	0.07	-0.06	1.00
16	Project type (Ref: IT)	0.19	0.13	0.04	0.04	0.04	0.09	0.04	0.01	-0.08	0.00	0.01	-0.07	-0.02	0.03	-0.05	-0.06	0.04

Note: N=2,121; Correlations with absolute value greater than 0.15 are significant at $p < 0.05$, and those greater than 0.19 are significant at $p < 0.01$ (two-tailed test).

Table 3.4: The Heckman two-stage model

The first stage estimation (DV: Offshore outsourcing; N=2,121)		
	Coefficients	Standard Errors
Uncertainty	1.25**	0.42
Geographic proximity	-0.30*	0.15
Co-location	0.45**	0.16
Cultural similarity	0.36**	0.13
Language similarity	0.34**	0.13
Firm experience	0.00	0.01
Firm size	-0.03	0.02
Nationality (Ref: US)	0.32*	0.13
Industry (Ref: Software)	0.68***	0.14
Government incentive	0.00	0.16
Project type (Ref: IT)	0.46***	0.05
Temporal dummies	Included	Included
Constant	0.90	0.38

The second stage estimation (DV: Expansion; N= 1,102)		
	Coefficients	Standard Errors
Capability-based learning	0.49*	0.20
System-based learning	0.41^{+}	0.24
Network-based learning	0.46**	0.16
Geographic proximity	0.21	0.23
Co-location	0.33^{+}	0.19
Cultural similarity	0.32	0.20
Language similarity	0.10	0.19
Firm experience	0.03***	0.01
Firm size	0.05	0.04
Nationality (Ref: US)	0.10	0.21
Industry (Ref: Software)	-0.42^{+}	0.24
Government incentive	-0.02	0.21
Project type (Ref: IT)	-0.35***	0.09
Temporal dummies	Included	Included
Constant	-0.37	0.39
Log likelihood	-468.48	
Wald chi^{2}	99.22***	

*Note: +p <0.1, *p<0.05, **p<0.01; ***p<0.001. Clustered robust standard errors are reported.*

3.4.1 Uncertainty and offshore outsourcing

In the first stage estimation (Table 3.4), the analysis includes an investigation of the firm's choice to outsource innovation under uncertainty. According to the first stage analysis, the results show that co-location, cultural similarity, language similarity, nationality, industry, and project type have significant impacts on the likelihood of adopting outsourcing to conduct cross-border innovation. The results also show that the negative coefficient of geographic proximity on the adoption of offshore outsourcing. To support Hypothesis 1, the results shown in the first stage estimation indicate that the independent variable "uncertainty" has significant positive impact on the probability that a focal firm adopts the mode of offshore outsourcing to conduct cross-border innovation ($ß$=1.25, p-value<0.01). That is, the higher the uncertainty, the more likelihood a firm outsources innovation activities to host countries. In line with the RO prediction, I find that firms facing offshore countries with high uncertainty are more likely to choose the mode of offshore outsourcing to conduct cross-border innovation.

3.4.2 Learning by outsourcing and expansion

I included three independent variables – capability-based learning, system-based learning, and network-based learning to predict the probability of expansion after offshore outsourcing in the second stage estimation (Table 3.4). According to the results, the three independent variables have positive effects on the probability that a focal firm plans to expand its operation of cross-border innovation. Specifically, the variable "capability-based learning" has significant positive impact on the probability of further expansion

(ß=0.49, p-value<0.05). The variable “system-based learning” has marginally significant positive impact on expansion (ß=0.41, p-value<0.1). The variable “network-based learning” has significant positive impact on the probability that a focal firm plans to expand its operation of cross-border innovation (ß=0.46, p-value<0.01). Therefore, Hypothesis 2 is supported.

3.4.3 Additional robustness checks

To confirm the robustness of the results, I further conducted several robustness checks by running the conditional logistic regression with fixed effects. Table 3.5 provides the results of the regression analysis to confirm the results from the abovementioned first-stage estimation. Table 3.6 provides the results of the regression analysis to confirm the results from the previous Heckman second-stage model. According to Table 3.5 and Table 3.6, all previously reported main effects sustain.

Table 3.5: Conditional logistic regression predicting offshore outsourcing

Variables	Coefficients	Standard Errors
Uncertainty	0.59**	0.22
Geographic proximity	-0.44	0.50
Co-location	-0.34	0.42
Cultural similarity	0.10	0.41
Language similarity	0.26	0.37
Firm experience	-0.41	0.29
Firm size	0.39	0.55
Government incentive	0.43	0.51
Log likelihood	-148.83	
LR chi ^{2}	16.59***	
Pseudo R^2	0.05	

*Note: N=2,121; +p <0.1, *p<0.05, **p<0.01; ***p<0.001. Clustered robust standard errors are adopted.*

Table 3.6: Conditional logistic regression predicting expansion

Variables	Coefficients	Standard Errors
Capability-based learning	0.69**	0.26
System-based learning	0.50^{+}	0.29
Network-based learning	0.67*	0.28
Geographic proximity	-0.44	0.50
Co-location	-0.34	0.42
Cultural similarity	0.10	0.41
Language similarity	0.26	0.37
Firm experience	-0.01	0.20
Firm size	-2.53^{+}	1.49
Government incentive	-0.99	0.64
Log likelihood	-191.38	
LR chi ^{2}	19.47***	
Pseudo R^2	0.10	

*Note: N=1,102; +p <0.1, *p<0.05, **p<0.01; ***p<0.001. Clustered robust standard errors are adopted.*

4. Manage outsourcing in countries with high uncertainty

4.1 Theoretical Background

Firms have been increasingly conducting innovation activities in countries with high uncertainty (i.e. weak IPR protection country). The theory of internalization asserts that an multinational corporation (MNC) can use strong internal linkages (Alcácer & Zhao, 2012; Zhao, 2006), intrafirm integration (Feinberg & Gupta, 2009; Nandkumar & Srikanth, 2016), and expatriate rotation (Berry, 2017; Schotter & Teagarden, 2014) to substitute for instable and unsound institutions in countries with high uncertainty. However, this conventional perspective does not offer an explanation of outsourcing which firms consider an alternative strategy. Indeed, portions or all of innovation activities are outsourced to countries with high uncertainty (Contractor et al., 2010, 2011; Mudambi, Narula & Santangelo, 2018). Nonetheless, we do not have a systematic theoretical understanding and empirical evidence about why firms outsource innovation activities in countries with high uncertainty and how they protect those activities. This chapter is going to tackle these two questions by focusing on weak IPR protection countries, a proxy of high uncertainty countries.

Drawing upon the perspective of appropriable rents (Klein, Crawford & Alchian, 1978), I elaborate on why and why not to outsource innovation in weak IPR countries, compared with strong IPR countries. In the first place, outsourcing innovation activities to a foreign contract provider creates appropriable rents for a focal firm when the value generated from that provider lies above the costs caused by that provider. Focusing on the access to human capital, studies have indicated that the availability of low-salary, high-skilled talent creates more value for focal firms by outsourcing innovation activities to

contract providers in developing countries than in developed countries (Demirbag & Glaister, 2010; Lewin et al., 2009). However, they might overlook the costs of doing so not only because the turnover of talent in developing countries is higher than that in developed countries (Elkjaer & Filmer, 2015) but also because the IPR protection in developing countries is weaker than that in developed countries (Ivus, Park & Saggi, 2017; Nandkumar & Srikanth, 2016; Zhao, 2006). The high turnover with weak IPR protection incurs significant costs caused by (un)intended technology leakage from employee mobility, lowering the rents that focal firms can appropriate through outsourcing innovation activities in developing countries (Contractor, 2019; Keupp et al., 2009).

Integrating the perspective of appropriable rents with the perspective of disaggregation (Contractor et al., 2010; Kedia & Mukherjee, 2009), I then posit that a focal firm can design the architecture of system-specific outsourcing to manage innovation disaggregated and outsourced to contract providers in weak IPR countries. As this architecture entails innovation systems and activities, each system has its own activities. Because the product of each activity is specific to a certain system, it will only be put into the same system-specific use. Accordingly, the product of each activity has the first-best value only when it can be used to the focal system, but it has zero or little value for other systems. For a focal firm, such a design creates quasi rents (Klein et al., 1978).

4.2 Hypothesis Development

4.2.1 Appropriable rents of outsourcing innovation

Outsourcing innovation activities to a foreign contract provider creates appropriable rents for a focal firm when the value gained from that provider is higher than the costs caused

by that provider. In line with Dunning's (1988) work, studies have indicated that a firm decides to outsource innovation based on the value derived from foreign contract providers that have location-specific advantages including accessible raw materials and local knowledge (Hsuan & Mahnke, 2011; Nieto & Rodríguez, 2011; Rodríguez & Nieto, 2016). To further explain a firm's outsourcing decisions, Graf and Mudambi (2005) integrate the dimension of human capital, including availability, quality and cost, which foreign contract providers rely upon to generate the advantage of specialization. According to Sturman, Walsh, and Cheramie (2008), human capital is held by individuals that own knowledge and skills through education, training, and experience. Since innovation has its own value chain, contract providers hire and train their employees who specialize in different activities along the chain (Quan & Chesbrough, 2010). In the pharmaceutical industry, for example, contract providers recruit and train scientists to support their specializations in distinct therapeutic areas such as anticancer, biotechnology, and neurology (Howells, Gagliardi & Malik, 2008). As innovation activities have a strong need for human capital, Lewin et al. (2009) indeed find that the firm's decisions on outsourcing innovation are driven by the access to offshore qualified scientists and engineers.

Nonetheless, contract providers in developing countries provide the relatively competitive human capital such as low-salary scientists and engineers, distinguished from those in developed countries (Table 4.1). For instance, Demirbag and Glaister (2010) identify the availability of low-wage technicians and scientists as an important explanatory factor for the increase in offshoring R&D in developing countries, even with weak IPR protection. Kapler and Puhala (2011) indicate that outsourcing clinical trials, a part of the pharmaceutical R&D activities, to India allows some pharmaceutical companies to have

cost saving by 50 percent because of the availability of lower salary labor and scientists from the Indian contract providers. Rodríguez and Nieto (2016) also point out that the savings of offshore outsourcing derived from lower wages and other factor costs are substantial in developing countries.

Table 4.1: Appropriable rents of outsourcing cross-border innovation

Appropriable rents	Dimensions	Developed countries (Strong IPR)	Developing countries (Weak IPR)	References
Value	Human capital availability	−	+	Lewin et al. (2009); Demirbag & Glaister (2010); Kapler & Puhala (2011); Rodríguez & Nieto (2016)
Costs	Human capital turnover	+	−	Yang & Jiang (2007); Schotter & Teagarden (2014); Elkjaer & Filmer (2015);
Costs	IPR protection	+	−	Zhao (2006); Keupp et al. (2009); Nandkumar & Srikanth (2016); Ivus et al. (2017)

Note: + denotes relative positive impact; − denotes relative negative impact

While this stream of research emphasizes the value side of appropriable rents when outsourcing innovation in developing countries, it overlooks the cost side of so doing. The major costs include the loss of IP and the leakage of technology. I elaborate on this argument by continuing the focus on human capital. Compared with developed countries, many developing countries are characterized by the relatively high turnover of human capital. For example, Yang and Jiang (2007) show that the average employee turnover rate in some developing countries is generally above 12% while the turnover rate is around 3% in the US. Using the McKinsey & Co. study, in addition, Schotter and Teagarden (2014) report that the turnover rates of staff in the Chinese high-tech industries normally exceed 20%. More recently, Elkjaer and Filmer's (2015) survey on the turnover rates of workforces across countries shows 13% in China, 11% in India, and 3.6% in Germany. The high

turnover signifies not only the loss of a contract provider's investment in the training given to its skilled workers, but also the potential of IP loss and technology leakage. For instance, technology leakage from a focal firm's contract provider to other companies or to its competitors often occurs through employee mobility and staff transfers (Agarwal, Ganco & Ziedonis, 2009; Schotter & Teagarden, 2014). In addition, local employees with assimilated knowledge of their companies have the potential to quit and join rival companies or create their own new ventures (Nandkumar & Srikanth, 2016).

Besides, the development of legal systems providing a basis for effective corporate governance, law enforcement, and IPR protection has been lagged in developing countries (Hoskisson et al., 2000; Peng & Heath, 1996). This hinders a firm's abilities to capture value from its innovation activities and lowers its incentive to conduct innovation activities in developing countries (Ivus et al., 2017; Lu et al., 2008). Since most developing countries often feature ineffective legal systems with weak IPR protection, this feature increases the costs of enforcing contracts in those countries (Keupp et al., 2009; Schotter & Teagarden, 2014; Zhao, 2006). Although some companies try to mitigate the problem of skilled employee mobility with non-compete or non-disclosure contracts imposed on a new hire, such agreements often do not work and cannot be enforced in nations with weak legal systems (Gilson, 1999; Nandkumar & Srikanth, 2016). Therefore, the high turnover of human capital leads to the significant risk of technology leakage and increases the costs of outsourcing innovation in countries with weak IPR protection.

Firms have to gain the most appropriable rents by assessing both the value and costs of outsourcing innovation. Compared with those in the developed countries, the contract providers in the developing countries are characterized by the availability of low-salary

engineers and scientists to attract outsourcing firms but many are also characterized by the high employee turnover with weak IPR protection. Since firms must take into account the availability and turnover of human capital prior to making decisions on outsourcing, they face the dilemma whether to outsource innovation to foreign contract providers in countries with weak IPR protection. Thus, I propose the following hypotheses:

> ***Hypothesis 1a: Compared with a contract provider in a strong IPR country, a contract provider in a weak IPR country has a greater likelihood to be selected by a focal firm for innovation outsourcing when it has a greater availability of human capital, all else equal.***

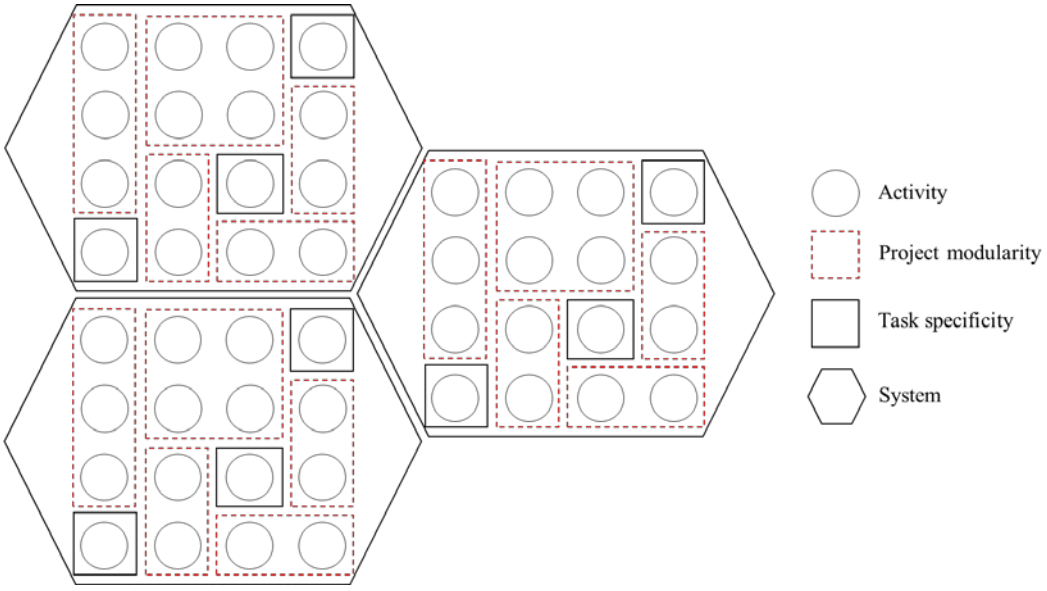
> ***Hypothesis 1b: Compared with a contract provider in a strong IPR country, a contract provider in a weak IPR country has a less likelihood to be selected by a focal firm for innovation outsourcing when it has a greater turnover of human capital, all else equal.***

4.2.2 System-specific outsourcing

How do firms capture the most appropriable rents given the value of outsourcing innovation activities to weak IPR countries against the costs of so doing? I argue that firms can design the architecture of system-specific outsourcing to secure the most rents of outsourcing innovation. The basic idea of my argument is rooted in the perspective of disaggregation (Contractor et al., 2010; Kedia & Mukherjee, 2009). In general, innovation can be disaggregated and sliced into many activities. Fine slicing the biopharmaceutical research provides an example. Specifically, the biopharmaceutical research can be broken up into several activities, starting with the discovery phase involving blue-sky genomics, big data, artificial intelligence, or in-vitro lab analyses, all of which build up highly valuable core knowledge. The next phase includes clinical trials of the compound, which are more routine and independent. Through disaggregation, firms can better decide which innovation activities to retain in-house versus which ones may be devolved to independent

contract providers (Jensen, Larsen & Pedersen, 2013; Mukherjee et al., 2013). Moreover, the biopharmaceutical research activities can be disaggregated and hived off to a contract provider without revealing too much key information (Choi & Contractor, 2016).

Figure 4.1: The architecture of system-specific outsourcing



Advancing this line of research, I assert that firms can design the architecture of system-specific outsourcing (See Figure 4.1). This architecture encompasses innovation systems and activities. Some activities perform interdependently and others perform independently in a system as the product of each activity is specific to that system. To elaborate this concept, I assume three activities –building compounds, analoging compounds, and screening compounds– performed in a new drug discovery process, one of innovation systems for a specific disease. While building compounds is an independent activity, analoging and screening compounds are interdependent activities (Thomke & Kuemmerle, 2002). These three activities are general in the sense that they are productive in many drug discoveries. However, the product that each activity generates is considered value-in-use. Each activity is valuable only when its product can be used for that specific

disease. In this case, the product of each activity is system-specific. Although this case is greatly simplified as the new drug discovery is very complex, it is highly applicable in other innovations such as chip design (Ernst, 2005) and software development (Andersson & Pedersen, 2010).

Under the architecture of system-specific outsourcing, I consider two mechanisms of system-specific outsourcing project modularity and task specificity. As the basic unit is an activity, project modularity means that two or more interdependent activities of a system are integrated into a module. Task specificity means that an independent activity of a system is assigned to a specified task. In a system, modules and tasks are performed independently while each contributes to the same system. Modules and tasks can be separated and outsourced to different providers so that one provider may not be aware of what others are doing.

On the basis of disaggregation and separation, a focal firm is able to capture the most appropriable rents under the architecture of system-specific outsourcing through either project modularity or task specificity (Table 4.2). On the side of capturing value, this architecture supports a clear division of labor between a focal firm and its contract providers responsible for different modules and tasks. A focal firm is able to secure the value of specialization by identifying and locating contract providers who have scientists and technicians with the specific experience, knowledge, and skills. A focal firm is also able to access the specialized and distinct knowledge owned by those contract providers. For example, outsourcing different modules and tasks increases opportunities for a focal firm to learn from and interact with more providers who have knowledge-specific expertise (Elia, Massini & Narula, 2019; McDermott, Mudambi & Parente, 2013). Moreover, a focal

firm can increase its strategic flexibility since each system and activity can be switched quickly from one location to another location (Albertoni et al., 2017).

On the side of reducing costs, a focal firm is also able to mitigate the risks of imitation and technology leakage. Because the architecture is only known to and designed by a focal firm, a contract provider cannot become an effective competitor due to limited knowledge of the overall architecture. In addition, a focal firm can separate independent contract providers responsible for specific modules or tasks in different locations and acts as conduit for information flows between them. This separation allows those contract providers to participate without the need to work as a team or even without the need for communication between each other (Kumar van Fenema, & von Glinow, 2009; Sanchez & Mahoney, 1996; von Hippel, 1990). Besides, a module or a task performed in one location creates the best value only after combining with those products generated at other locations (Gooris & Peeters, 2016; Larsen et al., 2013). That is, the market value of single module and task will be too low to imitate (Fixson & Park, 2008).

Separation also deters a contract provider's progress on learning new things outside a specialized module or task. For instance, when a contract provider starts to search new knowledge, specializing in a specific domain constrains the provider's knowledge search across other domains due to knowledge boundaries as well as organizational boundaries (Carlile, 2004). Moreover, the product of each module and task is specific to a certain system, a contract provider may find it difficult for other use (Pil & Cohen, 2006). Accordingly, the exposure of propriety information to a contract provider is limited in specific domain and the difficulty to learn new things is raised so that technology leakage is reduced. Even though a contract provider's employees leave to another company, their

knowledge and experience about that system-specific product are constrained and would not be easily integrated in their new company (Mayer, Somaya & Williamson, 2012).

Table 4.2: The merits of system-specific outsourcing

Appropriable rents	Dimensions	Merits
Increase value	Human capital availability	- A clear division of labor (Mayer et al., 2012) - Operational efficiency (Contractor et al., 2010; Mukherjee et al., 2013) - Specialized expertise (McDermott et al., 2013) - Relocation flexibility (Albertoni et al., 2017)
Reduce costs	Human capital turnover	- Raise the difficulty of knowledge search (Carlile, 2004) - Raise the difficulty of integration (Larsen et al., 2013) - Raise the difficulty of communication (Gooris & Peeters, 2016) - Applied to the employees (Mayer et al., 2012)

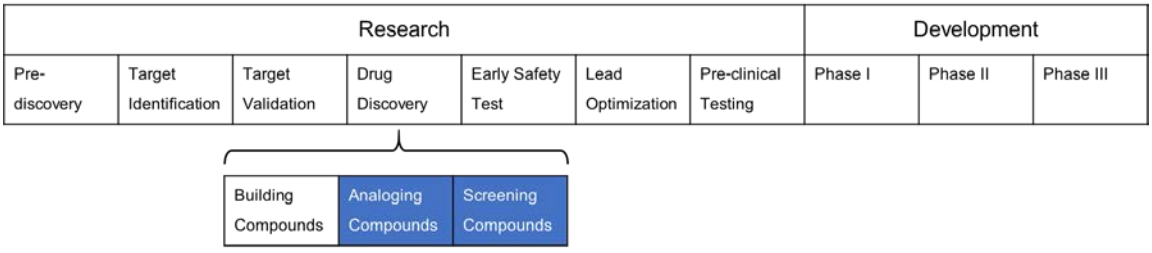
Despite that both mechanisms secure the value of specialization and reduce the technology leakage, each delivers distinct instruments to enhance the appropriable rents of outsourcing innovation. I expound their distinctiveness in the following sections.

4.2.3 Project modularity

Project modularity generates synergy by incorporating two or more interdependent activities of a system into a specific module. As the interdependence between two activities refers to the extent to which the performance of one activity is affected by the performance of another activity (Crowston, 1997), these activities need to be integrated to produce an intended product (or service). Since the overall performance is better through the combined activities than through an individual activity, the integration of two or more interdependent activities achieves synergy (Schilling, 2000). So the performance of outsourcing innovation can be enhanced by integrating the interdependent activities of a system into a module outsourced to an independent contract provider. As shown in Figure 2, for instance,

Thomke and Kuemmerle (2002) argue that integrating analoging and screening compounds into a module in the pharmaceutical R&D process improves the overall R&D performance.

Figure 4.2: Pharmaceutical R&D



By the designing of project modularity, a focal firm also delegates the responsibilities of investment to its contract providers from which it obtains the specialized knowledge. For example, computer companies such as Dell have relied on the East Asian contract providers that are specialized in optical, storage, or vocal modules (Saxenian, 2002). Besides, contract providers will strive for developing knowledge and skills idiosyncratic to their assignments in order to distinguish themselves from other providers and to achieve a better performance (Zirpoli & Becker, 2011). For instance, Kang, Mahoney, and Tan (2009) indicate that contract providers are willing to invest in specialization when they expect to have more positive gains in specialized reputation and knowledge.

As the interdependence between activities also depicts the complexity (Argote, 1982), the designing of project modularity can reduce the risks of technology leakage and IP loss. Since a system creates separate modules to hide complex information by putting different portions of knowledge into each module (Baldwin & Clark, 2015), one contract provider would not know the knowledge of other modules. That is, a focal firm can use project modularity to hide the knowledge and information that might be difficult to protect through the legal system. In addition, a focal firm can shield proprietary information by separating modules across different locations (Gooris & Peeters, 2016). In any case, putting together

the entire system is not only difficult but costly (Larsen et al., 2013; Srikanth & Puranam, 2011). Integration becomes more arduous. Even if a contract provider has intention and abilities to imitate a complete system, it will face much higher challenges and possibly lose its focus on the designate module in which it excels. In this way, the focal firm prevents its contract providers from imitating the whole system.

Even though decomposing a whole system is unfeasible, some might argue that a contract provider can steal a module. For one thing, the product of each module is specific to the system, so a contract provider could find it difficult to use in other systems. For another thing, there may be no market for the single module and, even if there is, the value is relatively low (Fixson & Park, 2008). This mechanism can be further applied to the employees who work for those contract providers and have potential to leak knowledge. Integrated with interdependent activities in a module, firstly, project modularity creates complexity for a contract provider's employees who have the incomplete knowledge of that module (Mayer et al., 2012). For those employees with a portion of knowledge regarding a certain activity of a module, secondly, it is very hard to build up the same module without combining all designate activities (Baldwin & Henkel, 2015).

Table 4.3: Instruments of project modularity for appropriable rents

Appropriable rents	**Impacts**	**Instruments**
Increase value	Synergy	- Interdependence (Crowston, 1997; Schilling, 2000) - Delegate responsibilities to providers (Saxenian, 2002) - Contract providers are willing to invest in specialization (Kang et al., 2009; Zirpoli & Becker, 2011)
Reduce costs	Complexity	- Complexity (Argote, 1982) - Hide complex information within and across modules (Baldwin & Clark, 2015; Gooris & Peeters, 2016) - Each module is specific to the system (Fixson & Park, 2008) - Difficult to combine all activities (Baldwin & Henkel, 2015)

Table 4.3 summaries the instruments by that project modularity increases the appropriable rents of outsourcing cross-border innovation. Overall, the designing of project modularity for an outsourced innovation can be a mechanism to increase the value of specialization based on the availability of human capital. It can also decrease the costs of technology leakage caused by the turnover of human capital and weak IPR protection. Therefore, I propose the following hypotheses:

Hypothesis 2a: The positive impact of human capital availability on the likelihood of outsourcing innovation to a contract provider in a weak IPR country (compared to a contract provider in a strong IPR country) will be strengthened (positively moderated) by a higher level of project modularity.

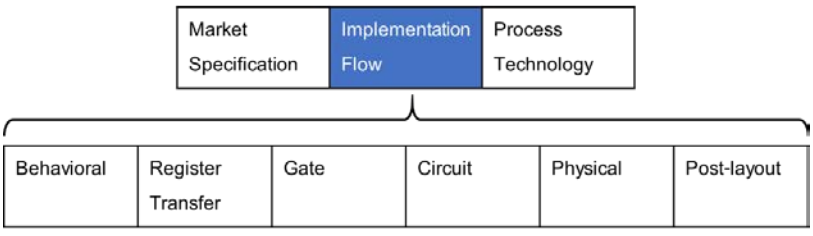
Hypothesis 2b: The negative impact of human capital turnover on the likelihood of outsourcing innovation to a contract provider in a weak IPR country (compared to a contract provider in a strong IPR country) will be lessened (positively moderated) by a higher level of project modularity.

4.2.4 Task specificity

Task specificity creates simplification by specifying an independent activity of a system in a designate task. Not only does task specificity enable a focal firm to allocate some specific, narrow, and independent tasks to foreign contract providers, but also make those contract providers easier to repeat their tasks. This leads the contract providers to have greater competence in production and become specialized to the area in which they own advantages (Levinthal & March, 1993). For example, some pharmaceutical companies outsource narrow, tightly-defined, time-consuming, codifiable, and routinized clinical trial tasks to their contract providers, while these tasks, at the same time, confer those providers' competence, efficiency, and scale that the pharmaceutical companies cannot even compete with (Contractor et al., 2010, 2011; Kapler & Puhala, 2011; Mukherjee et al., 2013).

These days, many industries are characterized by a considerable degree of simplification on the part of contract providers. Each provider is deeply competent in only a narrow task or activity. Take chip design as an example. Chip design, which itself is only one portion of innovation in the semiconductor industry, includes three major design systems – market specification, implementation flow, and process technology. Among these systems can implementation flow be further identified and narrowed in the behavioral, register transfer, gate, circuit, physical, and post-layout level activities (Chang & Tsai, 2002). Each activity can be outsourced to different contract providers of the chip design service for non-recurring engineering (Figure 4.3). Ernst (2005), for instance, indicates that semiconductor companies have outsourced different specific activities of the chip design to contract providers in developing countries, such as Taiwan, India, and Malaysia, so as to lower engineering expenditures. Such outsourcing arrangements take advantage of the very specialized and narrowly tacit knowledge residing in different contract providers spread across locations. When a focal firm makes outsourced arrangements more traceable by designing task specificity, task specificity decreases a contract provider's effort in planning and increases the predictability of business performance so that the contract provider is willing to accept those assignments (Cohendet & Llerena, 2003).

Figure 4.3: IC design



However, a narrowly specified task retards a contract provider's progress on learning and reduces the risk of technology leakage. In the first place, the task assigned to each contract provider is very narrow and only specific to the focal firm's system. Even though an individual contract provider has access to some focal firm's technology, the access is only to a small portion of the total proprietary information. A contract provider is then unable to put the whole innovation together. Since firms learn by starting from the information on hands, the narrow and limited information of each specific task also generates a myopia to hinder a contract provider to look the larger picture and to conduct system-side learning (Levinthal & March, 1993; March, 1988). Along with that, task specificity constrains the provider's creativity and curiosity of exploration (Nelson & Winter, 1982). When a specific task is assigned to a contract provider, this assignment forces that provider to focus on one narrow task and deters that provider from exploring new technology outside the given task. Hence the proclivity for the contract provider to compete with the focal firm is minimal.

Moreover, the tightly specified tasks reduce creativity in employees because task specificity creates simplification which is built upon a small set of interactions. For instance, a specified task engenders myopia and reduces an employee's incentives to change (Amabile & Conti 1999; Levinthal & March, 1993). Recently, Battistelli et al. (2019) propose that a specified task or a routinization of tasks reduces interactivity with colleagues and decreases task-related learning and innovativeness. In addition. In weak IPR countries, talent comes with lower salaries. However, this does not mean that such employees, engineers, or scientists are not curious and willing to explore. The dampening of learning and creativity in a contract provider's employees is something the focal firm

desires – especially in weak IPR countries. There is also an evidence that the deliberate specificity of tasks devolved to foreign contract providers is already under way. For instance, Marcolin, Miroudot and Squicciarini (2016) measure the degree of routinization or specificity of tasks or jobs allocated to different nations under global value chains, showing more mundane and narrower tasks being allocated to riskier emerging nations.

Table 4.4: Instruments of task specificity for appropriable rents

Appropriable rents	Instruments	Impacts
Increase value	Simplification	- Simplified learning (March, 1988) - Make knowledge traceable (Levinthal & March, 1993) - Decrease a contract provider's effort in planning (Cohendet & Llerena, 2003) - Increase the predictability of a contract provider's business performance (Cohendet & Llerena, 2003)
Reduce costs	Myopia	- Myopia (Levinthal & March, 1993) - Access a small portion of information (Contractor et al., 2010, 2011) - Constrain the provider's creativity and curiosity of exploration (Nelson & Winter, 1982) - Applied to the employees: A small set of interactions (Battistelli et al., 2019)

To summarize, Table 4.4 depicts the instruments by that task specificity increases the appropriable rents of outsourcing cross-border innovation. I argue that a focal firm only allows its contract providers access to a limited proprietary information, which slows down their system-wide learning and hinders their creativity and curiosity of exploration. Therefore, a focal firm could capture a larger portion of rents by using task specificity to manage innovation outsourced to contract providers in weak IPR countries. Therefore, I propose the following hypotheses:

Hypothesis 3a: The positive impact of human capital availability on the likelihood of outsourcing innovation to a contract provider in a weak IPR country, compared to a contract provider in a strong IPR country, will be strengthened (positively moderated) by a higher level of task specificity.

Hypothesis 3b: The negative impact of human capital turnover on the likelihood of outsourcing innovation to a contract provider in a weak IPR country, compared to a contract provider in a strong IPR country, will be lessened (positively moderated) by a higher level of task specificity.

4.3 Methodology

4.3.1 Sample

I collected the primary data of offshoring from the ORN survey, including 336 firms that contain the cases of offshore outsourcing in different countries (See Table 2.2 and Figure 2.2). To identify the countries with weak IPR protection, I followed Zhao (2006) by using several data sources from IEF, ICRG, PPI, and the Special 301 reports by USTR. These four sources of data cover legal, political, social, trade, and investment environments, as well as laws, orders, and rights of a regime which affect the IPR protection. Using the sum of the four weighted indices, we identified the weak IPR countries whose IPR values are at or below the mean value. Table 4.5 provides the sample of the weak IPR countries in 1995, 2000, 2005, and 2010 to show the steady changes in the ranking of the weak IPR regimes. Combining the data of the weak IPR countries with the ORN survey, I have 914 cases and provide the generic information of the empirical setting in Table 4.6.

Table 4.5: A list of the weak IPR countries in 1995, 2000, 2005, and 2010

Year 1995	Year 2000	Year 2005	Year 2010
Argentina**	Argentina***	Argentina***	Argentina***
Brazil***	Brazil**	Brazil***	Brazil**
Bulgaria*	Bulgaria	Bulgaria**	--
Chile**	Chile**	Chile**	Chile***
China**	China*	China	China***
Colombia**	Colombia**	Colombia**	Colombia**
Czech Republic	Czech Republic**	--	--
Greece***	Greece***	--	--
Guatemala**	Guatemala***	Guatemala**	Guatemala**
Hungary	Hungary**	--	--
India***	India***	India***	India***
Indonesia**	Indonesia**	Indonesia***	Indonesia***
Israel*	Israel***	Israel***	--
Ireland	--	--	--
Italy**	--	--	--
Kenya	Kenya	Kenya	Kenya
Malaysia	Malaysia***	Malaysia**	Malaysia**
Mexico	Mexico	Mexico**	Mexico**
Philippines**	Philippines**	Philippines***	Philippines**
Poland**	Poland***	Poland**	--
Portugal	Portugal	--	--
Romania**	Romania**	Romania**	Romania**
Russia**	Russia***	Russia***	Russia***
Saudi Arabia***	Saudi Arabia**	Saudi Arabia**	Saudi Arabia
Slovakia	Slovakia	Slovakia**	--
South Africa**	South Africa	South Africa	South Africa
South Korea***	South Korea***	South Korea**	--
Spain	Spain**	--	--
Taiwan**	Taiwan**	Taiwan**	--

*Note: ***Priority watch list of Special 301; **Watch list of Special 301; *Monitoring of Special 301. -- Out of the list.*

Table 4.6: The generic information of cross-border innovation

Entry modes		Captive offshoring		Offshore outsourcing	
Locations		Strong IPR countries	Weak IPR countries	Strong IPR countries	Weak IPR countries
Types of the innovation	Software development	31(3.39%)	44(4.81%)	22(2.41%)	95(10.39%)
	Product development	21(2.30%)	24(2.63%)	9(0.98%)	14(1.53%)
	Engineering	49(5.36%)	46(5.03%)	22(2.41%)	40(4.38%)
	IT	70(7.66%)	77(8.42%)	63(6.89%)	126(13.79%)
	AKS	6(0.66%)	20(2.19%)	8(0.88%)	25(2.74%)
	R&D	34(3.72%)	27(2.95%)	21(2.30%)	20(2.19%)
	Subtotal	211(23.09%)	238(26.04%)	145(15.86%)	320(35.01%)

Note: N=914; Percentage is reported in parentheses; A strong IPR country means its IPR value is above the mean; A weak IPR country means its IPR value is at or below the mean.

4.3.2 Estimation

In this section, I investigate the probability of outsourcing innovation to a contract provider in the weak IPR country instead of that in the strong IPR country. Since I observed the firms of offshoring innovation projects only for those that did outsource offshore, the potential issues about sample selection and endogeneity would exist when I analyze the probability of who and where to outsource. Following Heckman (1979), I conduct the Probit regression to estimate the probability that a focal firm offshored an innovation project by the offshore outsourcing mode instead of the captive offshoring mode in the first-stage estimation (a selection model). This selection model distinguishes offshored projects that undertook the mode of offshore outsourcing from those that undertook neither the mode of offshore outsourcing. In the second-stage estimation, I introduce the inverse Mills ratio, a selection correction term constructed by the results from the first-stage estimation, to control for the potential bias of sample selection in estimating the effects of independent variables and moderating variables on the dependent variable. I also include

all offshoring innovation projects and examined cross-project variances when controlling for the characteristics of a contract provider, a focal firm, and an outsourced project.

4.3.3 Measurement

(1) Selection model

The dependent variable “entry mode” is a binary variable indicating a firm used either the mode of offshore outsourcing or the mode of captive offshoring to conduct its innovation in a host country (Lewin et al., 2009). Specifically, the value of the dependent variable equals 1 if a firm chose the offshore outsourcing mode; otherwise, 0. I then used three items based on the ORN survey about the drivers of offshoring innovation as the instrumental variables. These three items include “enhance capacity for innovation”, “increase organizational flexibility” and “part of a larger global strategy”. While these three items are good predictors of entry mode which firms used to conduct offshore innovation activities, they do not necessarily predict the focal firm’s choice on selecting its contract providers (Lo & Hung, 2015).

(2) Main model

In the main model, the dependent variable “provider selection” is a binary variable indicating whether a firm outsources innovation to a contract provider in a host country with weak IPR protection or to a contract provider in a host country with strong IPR protection. Following previous research, I coded the value of the dependent variable takes 1 if a firm chose to outsource innovation to a contract provider in a country with weak IPR protection; otherwise, 0.

The first independent variable is “human capital availability” used in estimating the value of outsourcing innovation with respect to the availability of human capital from a foreign contract provider perceived by a focal firm. Using the ORN survey data provides the appropriate way to measure the availability of human capital as human capital needs to reflect the dimensions of talent availability, expertise quality, and labor cost (Graf & Mudambi, 2005). I used three items of the ORN survey “talent pool available”, “high level of expertise”, and “low cost of labor” to capture the availability of human capital. According to the ORN survey, three items are measured in a Likert 5-point scale and the scale reliability coefficient is 0.72 (Cronbach's alpha). I then applied the average of these three items to measure the availability of human capital from the observed contract provider in a given country. Simply put, the higher the value, the more available human capital a focal firm perceives to obtain from a foreign contract provider.

The second independent variable is “human capital turnover” used in estimating the costs of outsourcing innovation with respect to the turnover of human capital in a contract provider perceived by a focal firm. Measuring the turnover of human capital requires to reflect the dimensions of employee mobility, expertise selection, and talent retention (Lewin et al., 2009; Mukherjee et al., 2013). I used three items of the ORN survey “high employee turnover”, “increasing difficulty in finding qualified personnel offshore”, and “loss of managerial control” to capture the turnover of human capital. According to the ORN survey, these three items are measured in a Likert 5-point scale and the scale reliability coefficient is 0.71. I also applied the average of these three items to measure the turnover of human capital in a given contract provider. The higher the value of this measure, the more human capital turnover of a foreign contract provider.

Two moderating variables are “project modularity” and “task specificity”. As project modularity refers to the degree to which a designate module integrates two or more interdependent activities of a system to generate synergy, task specificity refers to the degree to which a designate task specifies an independent activity of a system to create simplification. Reflecting this basic difference, I seek to differentiate these two variables between activities which are interdependent versus activities which are independent. To differentiate the outsourcing activities of an innovation from interdependent ones to independent ones, I followed Elia et al. (2019) to use one question from the ORN survey as the conditional item: Does/did this implementation involve one or more discrete tasks or entire processes? This item offers binary results – Yes or No. If the respondent’s answer to this conditional item is “Yes”, the innovation activity outsourced to a contract provider is related to one or more activities, constructing the basic condition of interdependence. On the condition of interdependence, I can measure the value of project modularity which is calculated based on the score of the ORN survey item: Loss of synergy across firm activities. According to Elia et al. (2019), the low value of losing synergy across firm activities means the high project modularity. For the measuring purpose, I reversed the coding of this item to capture the degree to which project modularity generates synergy.

In contrast, if the respondent answered “No” to the conditional item (Does/did this implementation involve one or more discrete tasks or entire processes?), the innovation outsourced to a contract provider would not involve another activity, which is the basic condition of independence. On the condition of independence, I measured the value of task specificity which is calculated based on the another ORN item: The implementation requires personnel with company-specific knowledge involving routines, procedures,

products and services. In line with Marcolin et al. (2016), the measurement of this item is to capture the degree to which task specificity creates simplification. The higher the value of this item, the higher the task specificity.

Several control variables are also included to reflect the characteristics of a contract provider, a focal firm, and an outsourced project. First, I controlled the characteristics of a contract provider including “geographic proximity”, “co-location (with a manufacturing plant)”, “cultural similarity”, and “language similarity” (Gooris & Peeters, 2016; Teagarden, von Glinow & Mellahi, 2018). I also controlled the characteristics of a focal firm such as, “firm experience”, “firm size”, “nationality”, and “industry”. I further controlled the characteristics of an outsourcing project such as “access to local market”, “governance incentive”, and “project type”. Last but not least, I included the calendar years from 1995 to 2010 when a focal firm conducted offshore outsourcing in order to control the possible temporal effects during the observed period.

4.4 Analytical Results

Using the Heckman two-stage model with the Probit estimation, I tested the relationships between the hypothesized effects of variables and provider selection. The descriptive statistics of each variable in the main models and the bivariate correlation between any two variables are listed in Table 4.7.

In the main models, the analysis includes an investigation of the firm’s choice to outsource innovation either to a contract provider in the strong IPR country or to a contract provider in the weak IPR country. Table 4.8 includes the models predicting the firm’s choice between each type of contract providers for an outsourcing innovation activity. The

estimated coefficients represent the probability of outsourcing innovation to a contract provider in the weak IPR country, compared with that in the strong IPR country. In statistics, a positive coefficient of a variable shows that it increases the probability of outsourcing innovation to a contract provider in the weak IPR country compared with that in the strong IPR country while a negative coefficient means that an innovation is more likely outsourced to a contract provider in the strong IPR country than that in the weak IPR country. Each model illustrated in Table 4.8 shows a good explanatory power with a significant Chi-square after the Wald test (Greene, 2000).

4.4.1 The impacts of human capital availability and turnover on outsourcing

According to Model 1 (a null model containing only the control variables) of Table 4.8, the results show that cultural similarity and firm size have significant impacts on the likelihood of outsourcing innovation to a contract provider in the weak IPR country (compared with that in the strong IPR country). Specifically, the negative coefficient of cultural similarity means that the similarity between a contract provider and a focal firm decreases the likelihood of outsourcing innovation to a contract provider in the country with weak IPR protection but increases the likelihood of outsourcing innovation to a contract provider in the country with strong IPR protection (β = -0.79, p-value <0.01). The positive coefficient of firm size means that the scale of a focal firm increases the likelihood of outsourcing innovation to a contract provider in the weak IPR country but decreases the likelihood of outsourcing innovation to a contract provider in the strong IPR country (β = 0.42, p-value <0.01).

Table 4.7: The descriptive statistics of the main model variables

	Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Provider selection	0.69	0.41	1.00														
2	Human capital availability	3.15	1.23	0.13	1.00													
3	Human capital turnover	3.11	1.62	-0.07	-0.02	1.00												
4	Project modularity	2.19	1.29	0.01	0.01	-0.14	1.00											
5	Task specificity	2.35	1.48	0.14	0.13	-0.05	-0.04	1.00										
6	Geographic proximity	2.66	1.42	-0.06	0.05	-0.13	0.13	-0.01	1.00									
7	Co-location	2.41	1.47	-0.05	-0.02	-0.05	0.06	-0.04	0.14	1.00								
8	Cultural similarity	2.80	1.30	-0.05	0.14	-0.14	0.12	0.00	0.07	0.10	1.00							
9	Language similarity	3.03	1.34	-0.07	0.12	-0.09	0.09	0.03	0.08	0.19	0.18	1.00						
10	Firm experience	2.50	0.73	-0.10	-0.02	-0.14	0.02	-0.03	0.05	0.04	0.02	-0.07	1.00					
11	Firm size	7.28	3.11	0.25	0.12	-0.15	0.04	0.04	0.02	0.00	0.02	0.03	0.18	1.00				
12	Access to local market	2.65	1.41	-0.16	-0.07	-0.02	0.12	-0.09	0.18	0.09	0.10	0.17	0.10	-0.14	1.00			
13	Governance incentive	2.30	1.32	0.03	0.10	-0.04	0.02	-0.05	0.05	0.13	0.16	0.13	0.05	0.13	0.09	1.00		
14	Nationality (Ref: US)	0.52	0.50	0.18	0.16	-0.10	0.03	0.15	0.02	0.04	-0.11	0.06	0.07	0.01	0.14	0.17	1.00	
15	Industry (Ref: Software)	0.26	0.44	0.00	0.03	0.12	-0.06	-0.02	-0.04	-0.09	-0.05	-0.07	-0.03	-0.10	0.00	-0.12	0.03	1.00
16	Project type (Ref: IT)	0.41	0.61	0.13	0.16	0.03	-0.01	-0.16	-0.09	0.01	0.00	-0.06	-0.11	-0.09	0.01	-0.03	-0.16	-0.02

Note: Correlations with absolute value greater than 0.15 are significant at $p < 0.05$, and those greater than 0.19 are significant at $p < 0.01$ (two-tailed test).

Table 4.8: Human capital and outsourcing to weak IPR countries

	Model 1	**Model 2**	**Model 3**
Human capital			
Availability		2.37***	3.06***
		(0.35)	(0.79)
Turnover			-0.72**
			(0.30)
Geographic proximity	-0.13	0.09	0.22
	(0.16)	(0.25)	(0.47)
Co-location	0.06	0.25	0.24
	(0.19)	(0.26)	(0.40)
Cultural similarity	-0.79***	-1.12***	-2.11**
	(0.21)	(0.28)	(0.92)
Language similarity	-0.01	-0.08	0.50
	(0.16)	(0.22)	(0.58)
Firm experience	0.39	1.05	1.11*
	(0.65)	(0.97)	(0.67)
Firm size	0.42***	0.58***	-0.07
	(0.11)	(0.14)	(0.29)
Access to local market	-0.26	-0.25	-0.90
	(0.20)	(0.21)	(0.67)
Governance incentive	-0.07	-0.37	-0.01
	(0.19)	(0.25)	0.49)
Nationality	Included	Included	Included
Industry	Included	Included	Included
Project type	Included	Included	Included
Year	Included	Included	Included
Inverse Mills ratio	-1.14***	-1.82	-1.28*
	(0.46)	(1.77)	(0.68)
Constant	3.29***	2.09***	1.49**
	(0.53)	(0.46)	(0.07)
Wald test	297.11***	371.24***	249.05***
Log pseudolikelihood	-104.33	57.89	-30.08

*Note: *p <0.1, **p<0.05, ***p<0.01; Clustered robust standard errors reported in parentheses; A positive (negative) coefficient of a variable shows that it increases (decreases) the probability compared with the reference group (Strong IPR countries).*

Besides, the significant negative coefficient of the inverse Mills ratio (β = -1.14, p-value <0.01) indicates that unobserved characteristics underlying a decision on offshoring influence the choices of the firms that did use the offshore outsourcing mode relative to those using the captive offshoring mode. The negative effect of the inverse Mills ratio also indicates that a firm's intentions to use the mode of offshore outsourcing based on unobserved characteristics decrease the likelihood of outsourcing innovation to a contract provider in the weak IPR country. Thus, it is appropriate to use the Heckman selection model with an inclusion of the inverse Mills ratio, a correction term, for estimations in the main models (Dolton & Makepeace, 1987; Greene, 2000).

According to Model 2 and 3 in Table 4.8, I find supports for the hypotheses related to the impacts of human capital on the choice of outsourcing innovation to a contract provider in the weak IPR country (compared with that in the strong IPR country). First of all, I included the variable “human capital availability” in Model 2 of Table 4.8. In Model 2, the positive coefficient means that the availability of low-cost, high skilled talent increases the likelihood of outsourcing innovation to a contract provider in the country with weak IPR protection (β = 2.37, p-value <0.01). That is said, if a contract provider in the country with weak IPR protection could provide more human capital, it is more likely to be selected by a focal firm. Therefore, Hypothesis 1a is supported. I then introduced the variable “human capital turnover” in Model 3 of Table 4.8. In Model 3, the negative coefficient of human capital turnover indicates that the turnover of talent decreases the likelihood of outsourcing innovation to a contract provider in the country with weak IPR protection (β = -0.72, p-value <0.05). In other words, it is less likely to be selected by a focal firm if a contract provider in the weak IPR country has a high turnover of talent. Hypothesis 1b supported.

I ran additional multinomial logistic regressions with the analysis of marginal effects to conduct additional robustness checks on the first set hypotheses by following Hoetker (2007) and Meyer, van Witteloostuijn, and Beugelsdijk (2017). The estimated coefficients represent the utility of outsourcing innovation to a contract provider in the very strong IPR country (IPR value is above the mean plus one standard deviation), to a contract provider in the strong IPR country (IPR value is above the mean but below the mean plus one standard deviation), or to a contract provider in the weak IPR country (IPR value is at or below the mean). According to the analyses, 1% unit increase in human capital availability leads to 0.125% in the utility of outsourcing innovation to a contract provider in the weak IPR country (β = 0.12, p-value <0.01), compared with 0.077% decrease in the strong IPR country (β = -0.04, p-value <0.01) and 0.036% decrease in the very strong IPR country (β = -0.08, p-value <0.01). By contrast, 1% unit increase in human capital turnover leads to 0.015% decrease in the utility of outsourcing innovation to a contract provider in the weak IPR country (β = -0.02, p-value <0.05), compared with 0.002% increase in the strong IPR country (β = 0.00, p-value <0.1) and 0.021% increase in the very strong IPR country (β = 0.02, p-value <0.05). Taken together, these robustness checks provide significant support for Hypothesis 1a and 1b.

4.4.2 The moderating effects of project modularity

To test Hypothesis 2a and 2b, I introduced the moderating variable “project modularity” to estimate the probability of outsourcing innovation to a contract provider in the country with weak IPR protection. I used the mean centered interaction term between human capital availability and project modularity and the interaction term between human capital

turnover and project modularity in the estimations. The results are listed in Model 4, 5, and 6 of Table 4.9.

Table 4.9: Moderating effects of project modularity

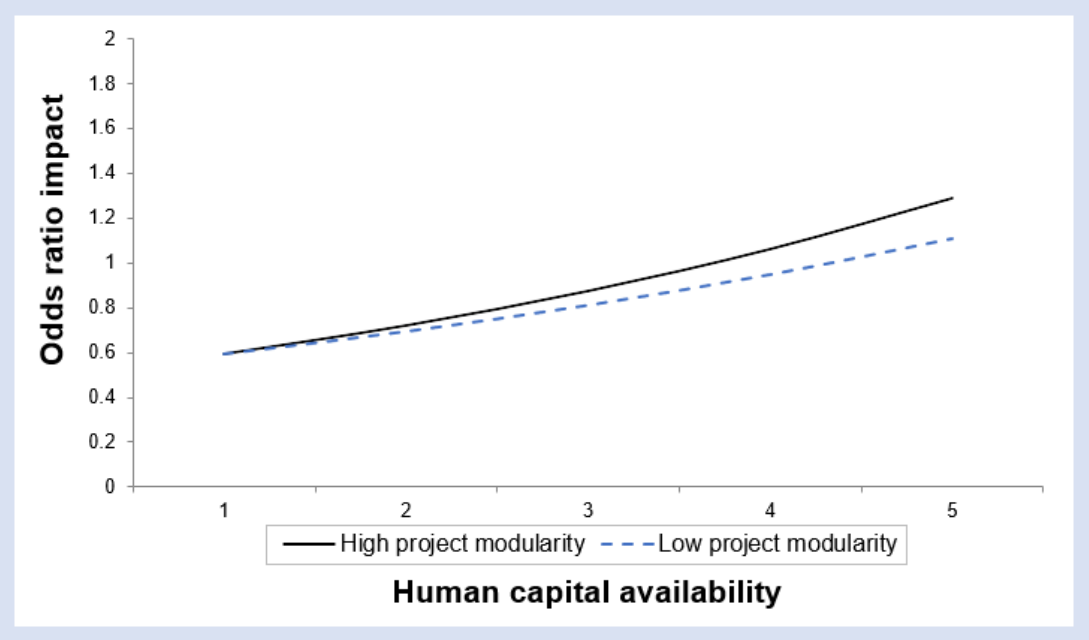
	Model 4	**Model 5**	**Model 6**
Human capital			
Availability	3.58*** (1.11)	3.31*** (0.74)	3.91*** (1.39)
Turnover	-0.66*** (0.23)	-0.45** (0.23)	-0.72** (0.30)
Project modularity	0.98** (0.48)	0.86* (0.49)	0.98* (0.52)
Availability X Project modularity	2.57* (1.50)		2.75** (1.38)
Turnover X Project modularity		0.17** (0.09)	0.25** (0.12)
Geographic proximity	-0.08 (0.37)	-0.24 (0.39)	-0.18 (0.39)
Co-location	-0.02 (0.49)	-0.09 (0.55)	-0.02 (0.51)
Cultural similarity	-2.71*** (0.71)	-2.16*** (0.72)	-2.85*** (0.73)
Language similarity	1.04** (0.50)	0.86 (0.53)	1.16** (0.52)
Firm experience	-3.76*** (0.94)	-3.18*** (1.03)	-4.17*** (1.05)
Firm size	0.80** (0.39)	0.56** (0.22)	0.78** (0.33)
Access to local market	-0.77 (0.85)	-0.85 (0.78)	-0.74 (0.83)
Governance incentive	0.01 (1.00)	-0.01 (0.78)	0.02 (0.96)
Dummies*	Included	Included	Included
Inverse Mills ratio	-0.62* (0.36)	-0.69 (0.42)	-0.55 (0.54)
Constant	0.87** (0.43)	3.59 (4.97)	-0.77 (0.62)
Wald test	319.72***	303.38***	370.57***
Log pseudolikelihood	-25.45	-25.39	-24.56

*Note: *p <0.1, **p<0.05, ***p<0.01; Clustered robust standard errors reported in parentheses; A positive (negative) coefficient of a variable shows that it increases (decreases) the probability compared with the reference group (Strong IPR countries).*

The interaction of human capital availability with project modularity is included Model 4. The results show that the interaction between human capital availability and project modularity is marginal positive (β = 2.57, p-value <0.1). The positive coefficient of the interaction term indicates that the designing of project modularity can increase the main effect of human capital availability on the likelihood of outsourcing innovation to a contract provider in the country with weak IPR protection. This supports Hypothesis 2a. The interaction of human capital turnover with project modularity is then included in Model 5. The results indicate that the interaction of human capital turnover and project modularity is positive (β =0.17, p-value <0.05) and that the designing of project modularity can mitigate the negative impact of human capital turnover on the likelihood of outsourcing innovation to a contract provider in the weak IPR protection country. This supports Hypothesis 2b. Model 6 includes both interaction terms, showing that the reported main effects and moderating effects sustain.

Following Aiken and West (1991) and Hoetker (2007), I plotted the interaction graph, conducted the simple slope analysis, ran the Hausman test, and evaluated the joint effect of the independent variable and moderating variable for robustness checks on the second set hypotheses. Firstly, I defined the high-project-modularity regression by using the value of project modularity above the mean plus one standard deviation and the low-project-modularity regression by using the value of project modularity below the mean minus one standard deviation. Given the estimation of human capital availability on the likelihood of outsourcing innovation to a contract provider in the weak IPR country (in terms of odds ratio), I then drew the interaction graph to illustrate the high-project-modularity and low-project-modularity regressions shown in Figure 4.4.

Figure 4.4: The simple slope of human capital availability with project modularity



In Figure 4.4, the slope of the high-project-modularity regression is steeper than the slope of the low-project-modularity regression. While the slope of the high-project-modularity regression is significantly positive (β = 1.95, p-value < 0.01), the slope of the low-project-modularity regression is also significantly positive (β = 1.57, p-value< 0.01). Despite that, both regressions are significantly different after the Hausman test (χ^2=12.27, p-value< 0.01).

I also evaluated the joint impact of low-cost talent and project modularity for three subgroups (the very strong IPR countries, the strong IPR countries, and the weak IPR countries) in Figure 4.5. Specifically, adding project modularity on human capital availability could lead to a 1.63% drop in the odds of outsourcing innovation to a contract provider in the very strong IPR country and a 1.82% increase in the odds of outsourcing innovation to a contract provider in the weak IPR country. These results are consistent with Hypothesis 2a.

Figure 4.5: The joint effect of human capital availability and project modularity

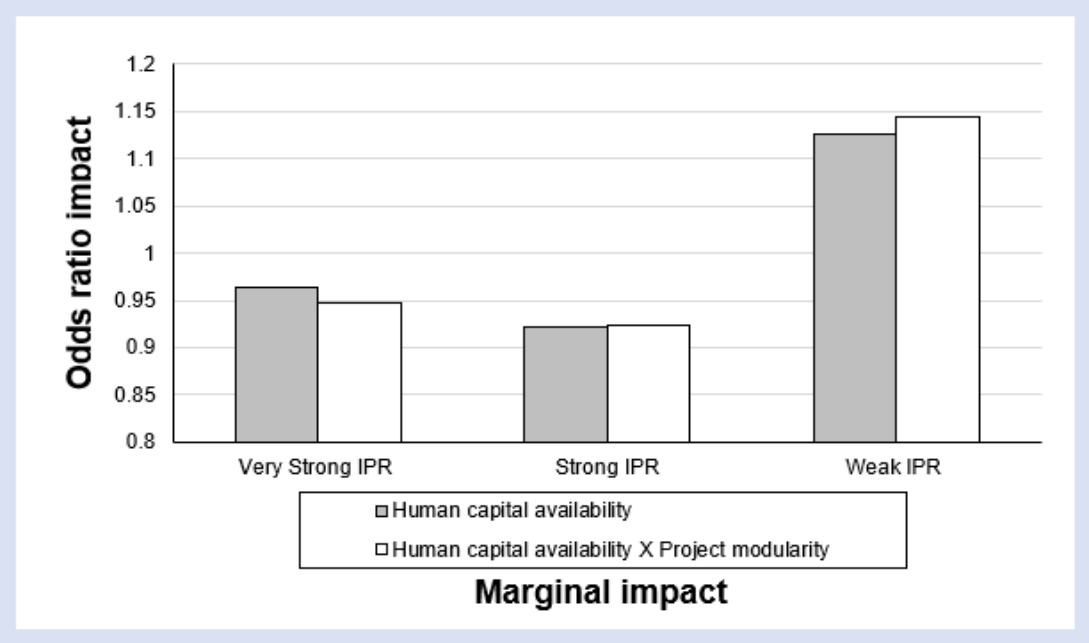
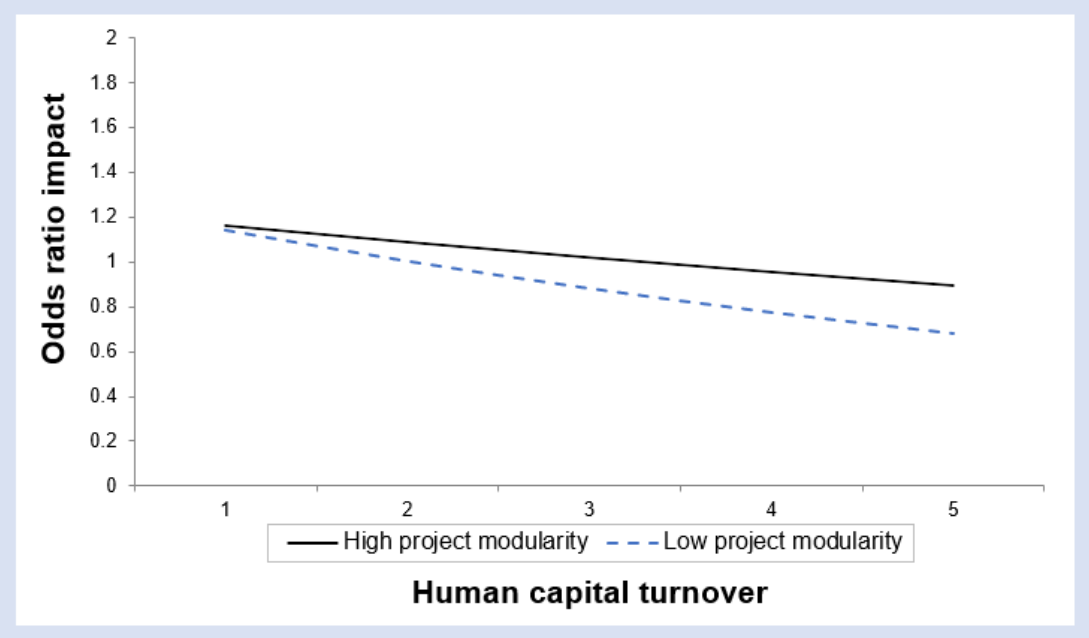


Figure 4.6: The simple slope of human capital turnover with project modularity

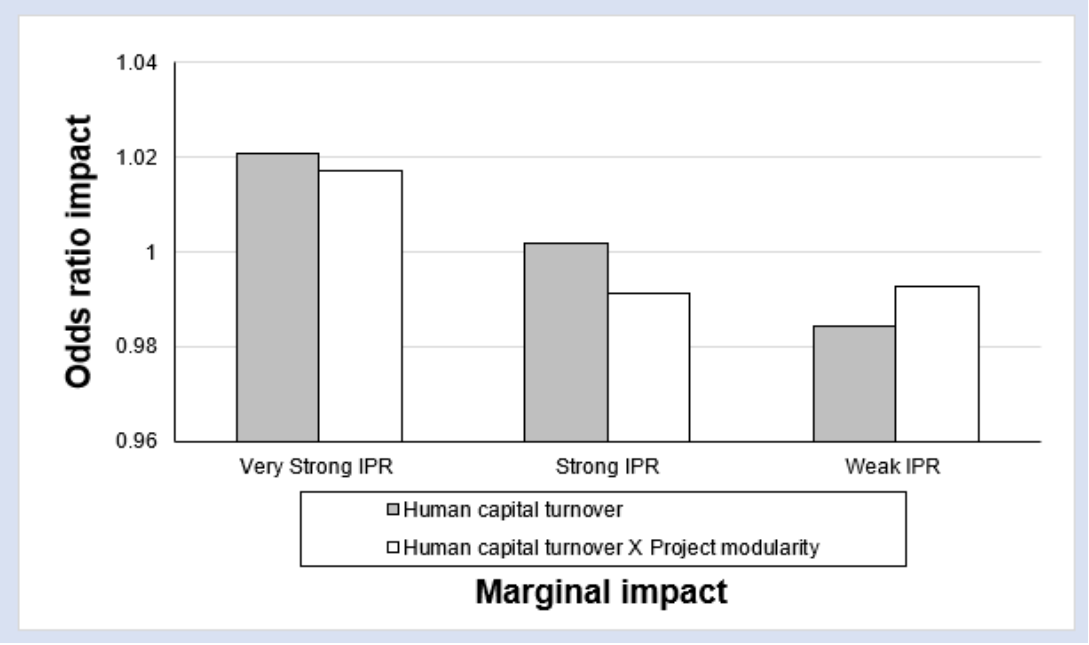


I further conducted robustness tests to check the interaction effect of project modularity on the relationship between the turnover of human capital and the likelihood of outsourcing innovation to a contract provider in the weak IPR country. Figure 4.6 reveals

that the slope of the high-project-modularity regression is flatter than the slope of the low-project-modularity regression. In addition, the slope of the high-project-modularity regression is negative (β = -0.07, p-value < 0.1) and the slope of the low-project-modularity regression is also negative (β = -0.13, p-value < 0.01). In spite of that, the Hausman test shows that both regressions are significantly different (χ^2=19.67, p-value < 0.01).

Figure 4.7 further indicates the joint effect of human capital turnover and project modularity for three subgroups – very strong IPR, strong IPR, and weak IPR countries. Consistent with Hypothesis 2b, the joint effect of adding project modularity on human capital turnover is positive when outsourcing innovation to a contract provider in the weak IPR country. For the calculation of marginal impact, adding project modularity on human capital turnover is associated with a 0.39% drop in the odds of outsourcing innovation to a contract provider in the very strong IPR country while it is about a 0.84% increase in the odds of outsourcing innovation to a contract provider in the weak IPR country.

Figure 4.7: The joint effect of human capital turnover and project modularity



4.4.3 The moderating effects of task specificity

To test Hypothesis 3a and 3b, I introduced another moderating variable “task specificity” into the estimation. I used the mean centered interaction term between human capital availability and task specificity and the interaction term between human capital turnover and task specificity in estimating the probability of outsourcing an innovation activity to a contract provider in the weak IPR country. The results are listed in Model 7, 8, and 9 of Table 4.10. The interaction of human capital availability with task specificity is introduced in Model 7, showing that the interaction between human capital availability and task specificity is significant and positive (β = 2.59, p-value <0.05). Specifically, the positive estimated coefficient indicates that the designing of task specificity can enhance the positive effect of human capital availability on the likelihood of outsourcing innovation to a contract provider in the weak IPR country. Accordingly, Hypothesis 3a is supported.

Then, the interaction of human capital turnover with task specificity is introduced in Model 8, indicating that the interaction between human capital turnover and task specificity is significantly positive (β =0.13, p-value <0.05). The positive estimated coefficient indicates that the designing of task specificity can ease the negative impact of human capital turnover on the likelihood of outsourcing innovation to a contract provider in the weak IPR country. This supports Hypothesis 3b. Model 9 including both interaction terms show that the directions of main effects and moderating effects remain.

Table 4.10: Moderating effects of task specificity

	Model 7	**Model 8**	**Model 9**
Human capital			
Availability	3.95***	4.19***	4.33***
	(0.88)	(1.01)	(0.90)
Turnover	-0.80**	-0.64**	-0.77**
	(0.34)	(0.24)	(0.34)
Task specificity	2.57**	3.48**	3.13**
	(1.27)	(1.71)	(1.54)
Availability X Task specificity	2.59**		2.53**
	(1.15)		(1.26)
Turnover X Task specificity		0.13**	0.13**
		(0.06)	(0.06)
Geographic proximity	0.08	0.24	0.09
	(0.39)	(0.40)	(0.40)
Co-location	0.43	0.36	0.54
	(0.46)	(0.41)	(0.47)
Cultural similarity	-2.48***	-2.36***	-2.70***
	(0.88)	(0.82)	(0.86)
Language similarity	0.60	0.65	0.73
	(0.62)	(0.60)	(0.65)
Firm experience	1.30	0.94	1.25
	(0.89)	(0.95)	(0.93)
Firm size	0.20	0.34	0.36
	(0.44)	(0.47)	(0.47)
Access to local market	-0.63	-0.77	-0.57
	(0.62)	(0.65)	(0.64)
Governance incentive	-0.23	-0.25	-0.35
	(0.54)	(0.44)	(0.53)
Dummies	Included	Included	Included
Inverse Mills ratio	-1.52*	-1.20	-1.45*
	(0.89)	(0.92)	(0.91)
Constant	1.69*	1.35	1.60*
	(0.93)	(0.95)	(0.90)
Wald test	257.95***	224.06***	269.41***
Log pseudolikelihood	-24.54	-24.58	-23.17

*Note: *p <0.1, **p<0.05, ***p<0.01; Clustered robust standard errors reported in parentheses; A positive (negative) coefficient of a variable shows that it increases (decreases) the probability compared with the reference group (Strong IPR countries).*

For robustness checks on the third set hypotheses, I illustrated the interaction plot and conducted the Hausman test to run the simple slope analysis. In the first place, I defined the high-task-specificity regression by using the value of task specificity above the mean

plus one standard deviation and the low-task-specificity regression by using the value of task specificity below the mean minus one standard deviation. Given the estimation of human capital availability on the likelihood of outsourcing innovation to a contract provider in the weak IPR country (in terms of odds ratio), I drew the interaction graph to illustrate two models – the high-task-specificity and low-task-specificity regressions – shown in Figure 4.8.

According to Figure 4.8, the slope of the high-task-specificity regression is steeper than the slope of the low-task-specificity regression. I then calculated the simple slope of the high-task-specificity regression that is significantly positive (β = 2.56, *p*-value < 0.01) and the slope of the low-task-specificity regression that is also significantly positive (β = 1.64, *p*-value < 0.01). Although both slopes are positive, I conducted the Hausman test showing that both regressions are significantly different (χ^2=4.9, *p*-value < 0.05).

Figure 4.8: The simple slope of human capital availability with task specificity

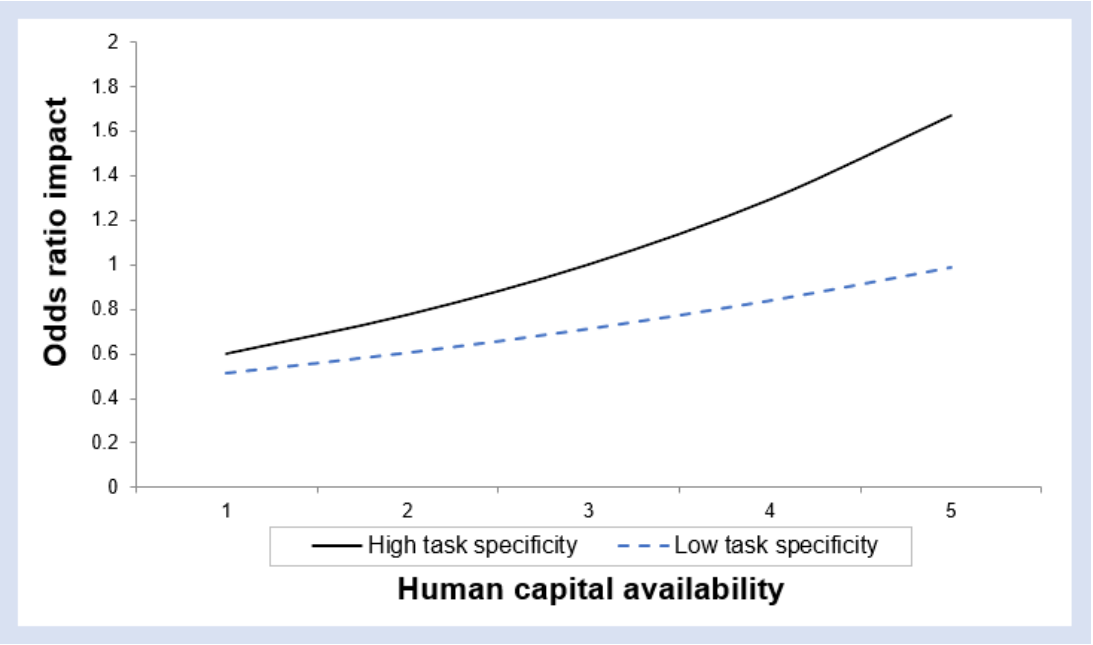
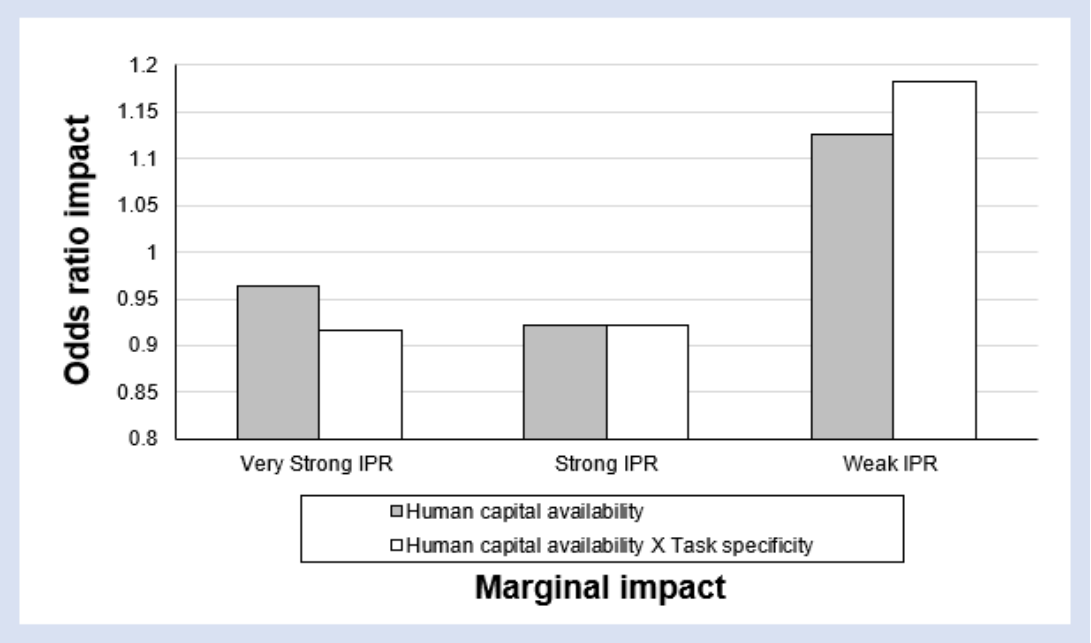


Figure 4.9: The joint effect of human capital availability and task specificity



Moreover, I evaluated the joint effect of human capital availability and task specificity for three subgroups – the very strong IPR countries, the strong IPR countries, and the weak IPR countries (see Figure 4.9). Consistent with Hypothesis 3a, Figure 4.9 shows that the joint effect of adding task specificity on human capital availability is positive when outsourcing innovation to a contract provider in the weak IPR country. Specifically, adding task specificity on human capital availability is associated with a 4.60% drop in the odds of outsourcing innovation to a contract provider in the very strong IPR countries while it is about a 5.77% increase in the odds of outsourcing innovation to a contract provider in the weak IPR country.

On the other hand, I also plotted the interaction graph of human capital turnover and task specificity in Figure 4.10 to illustrate the high-task-specificity and low-task-specificity regressions on estimating the likelihood of outsourcing innovation to a contract provider in the weak IPR country (in terms of odds ratio). Based on Figure 4.10 and calculation, I

had the negative slope of the high-task-specificity regression (β = -0.22, p-value < 0.1) and the significant negative slope of the low-task-specificity regression (β = -0.35, p-value < 0.01). The Hausman test also shows that both regressions are significantly different (χ^2=12.23, p-value < 0.01).

I also evaluated the joint effect of human capital turnover and task specificity for three subgroups – the very strong IPR countries, the strong IPR countries, and the weak IPR countries (Figure 4.11). Consistent with Hypothesis 3b, the joint effect of adding task specificity on human capital turnover is positive when outsourcing innovation to a contract provider in the weak IPR country. To further calculate the marginal impact, adding task specificity on human capital turnover is associated with a 0.26% drop in the odds of outsourcing innovation to a contract provider in the very strong IPR country while it is about a 0.44% increase in the odds of outsourcing innovation to a contract provider in the weak IPR country.

Figure 4.10: The simple slope of human capital turnover with task specificity

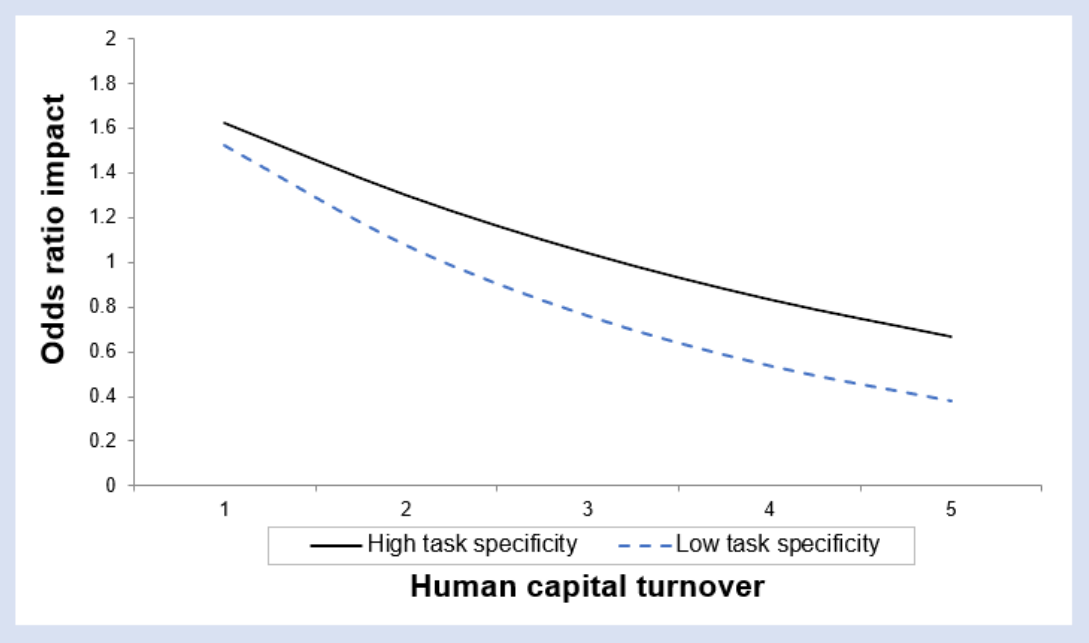
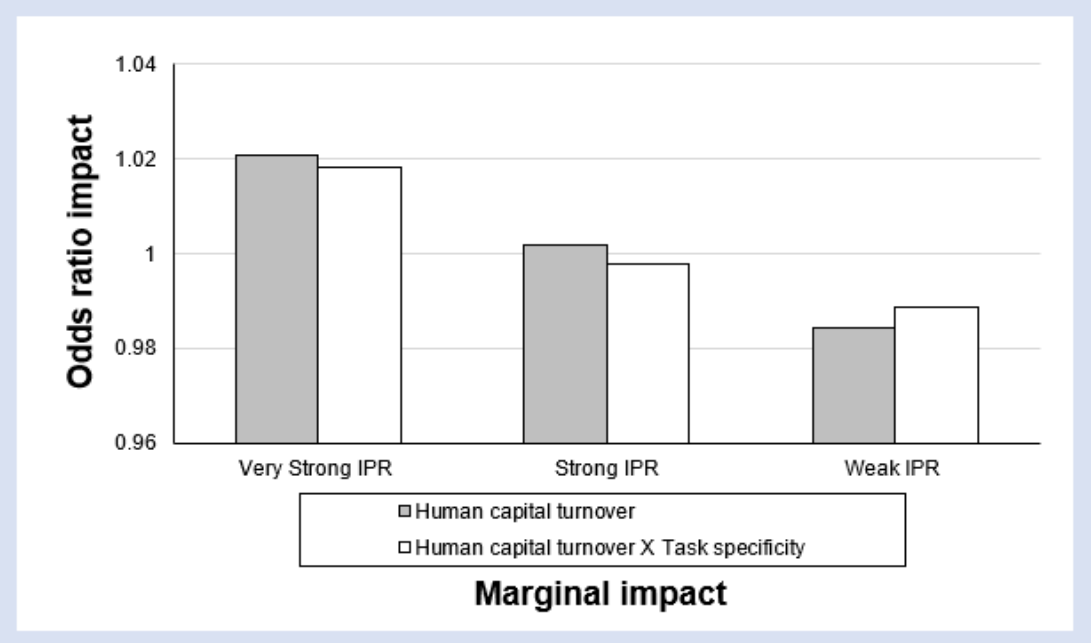


Figure 4.11: The joint effect of human capital turnover with task specificity



5. Expansion, Complexity, and Performance

5.1 Theoretical Background

The expansion of cross-border innovation is an important theme fascinating the scholars of international business, innovation, and strategy (Bartlett & Ghoshal, 1989; Cantwell & Mudambi, 2005; Contractor et al., 2010; Doz & Wilson, 2012). While the traditional literature is focusing on R&D internationalization via foreign subsidiaries (e.g., Penner-Hann & Shaver, 2005; Singh, 2008; Zhao, 2006), an emerging line of research goes beyond that and spots on innovation activities including R&D, product design, and engineering allocated to either foreign subsidiaries or contract providers (e.g., Contractor et al., 2010; Jensen, 2009; Lewin *et al*., 2009; Oslo Manual, 2018). Following this line of research inquiry, I explore the performance implications of expanding cross-border innovation.

Theoretically, expanding cross-border innovation could enhance innovation performance by connecting firms with a wide variety of knowledge sources at globally disperse locations (Doz & Wilson, 2012; Leiponen & Helfat, 2011). As the global economy has become more open and the sources of invention and innovation have become more geographically and organizationally diverse, firms need to create innovative products (or services) by combining multiple knowledge sources and then achieve marketplace success (Teece, 2007, 2014). For example, MacPherson and Pritchard (2003) indicate that Boeing began its expansion with the 737 aircraft to outsource 7 of 19 major parts to foreign suppliers who were in charge of manufacturing, engineering, or designing in early 60s. Boeing then outsourced the major parts of the 747 aircraft to foreign suppliers across 4 countries and led to another success of 747 – a new and first wide-body airplane in early 70s. For the later 777, Boeing continued this trend by outsourcing 12 of 19 major parts to

foreign suppliers across 10 countries. Nowadays, Boeing has pushed this trend further for its most recent jet airliner – the 787 (Hill & Hult, 2017).

Broadly speaking, however, previous studies did not conclusively establish the link between the expansion of cross-border innovation and firm innovativeness but instead yielded mixed results (e.g. Furman et al., 2005; Grimpe & Kaiser, 2010; Mihalache et al., 2012; Nieto & Rodrı´guez, 2011; Singh, 2008). As shown in Table 5.1, some studies have identified positive results. For instance, Penner-Hahn and Shaver (2005) find that Japanese pharmaceutical firms doing international R&D tend to produce more patents than do firms with only domestic R&D. In contrast, Singh (2008) reveals that geographic dispersion of R&D activities does not translate into more valuable innovations. Leiponen and Helfat (2011) indicate that benefits from dispersed R&D do not apply to novel innovation based on the survey data of Finnish companies. Still other studies have found curvilinear relationships between dispersed innovations and firm innovativeness. For example, Mihalache et al. (2012) show that whereas offshoring has important benefits in terms of enhancing innovation, the relocation of primary functions exhibits decreasing returns to scale and eventually dampens innovative outcomes.

Why these mixed findings? In some cases, in-house offshore innovation (i.e. captive offshoring) is the only research focus and offshore outsourcing is not taken into account. Among other cases, the variables associated with time, learning, and strategies are not included in the estimation. Methodologically, it might be that a linear effect is statistically significant while a quadratic test is not incorporated into the estimated function (Table 5.1). Given these mixed findings, there is an opportunity to build up a comprehensive model to bridge the gap.

Table 5.1: Mixed findings of cross-border innovation and firm innovativeness

Effects	Author(s) and year	Performance indicators	Quadratic function	Cubic function
Linear	Penner-Hahn & Shaver (2005)	The count of U.S. drug patents	No	No
	Singh (2008)	The number of forward citations a patent gets	No	No
	Nieto & Rodríguez (2011)	Innovation outputs (Dummies)	No	No
	Bertrand & Mol (2013)	Product innovation (Dummies)	No	No
	Kim (2016)	The number of forward citations	No	No
U-shape	Hsu et al. (2015)	The number of citations	Yes	No
	Steinberg et al. (2017)	The share of its sales from new products over its total sales in the domestic market.	Yes	Yes
Inverted U-shape	Laursen & Salter (2006)	The fraction of the firm's turnover relating to products new to the world market.	Yes	No
	Grimpe & Kaiser (2010)	The share of sales with products new to the market	Yes	No
	Lahiri (2010)	The number of citations	Yes	No
	Chen et al (2012)	The number of citations	Yes	Yes
	Mihalache et al. (2012)	The percentage of revenues over the past three years that is attributable to new products and services.	Yes	Yes
	Belderbos et al (2015)	Productivity	Yes	No
	Hurtado-Torres et al. (2018)	The number of patents	Yes	No

In addition, there is also an opportunity to look at the possible mechanisms which affect the link between the expansion of cross-border innovation and innovation performance. The impact of expanding cross-border innovation on firm innovativeness might be moderated by a number of mechanisms that a firm could adopt. For instance, Penner-Hahn and Shaver (2005) argue that a firm’s absorptive capacity at home is the key to assimilate and integrate technological knowledge coming from abroad. Zhao (2006) shows that the strong internal links between subsidiaries and headquarter are the

mechanisms of integrating knowledge in weak local institutional settings. Similarly, Griffith et al. (2006) discuss the embeddedness of affiliates in local technology and R&D clusters. Singh (2008) considers personnel rotation and cross-regional interpersonal ties as the means of cross-border collaboration and knowledge integration. Lahiri (2010) examines the role of interunit knowledge sharing in integrating knowledge sourcing multiple locations within a MNC. Chen et al. (2012) have pointed out the importance of organizational slack on the transfer of knowledge between a MNC and its subsidiaries. Mihalache et al. (2012) indicate that TMT informational diversity and TMT shared vision would moderate the relation between offshoring innovation and innovation performance. Berry (2014) asserts that MNCs can enable multi-country collaborative innovations through manufacturing integration so as to bring together diverse knowledge to spawn further innovation. Notwithstanding the significant contribution of these studies to enhancing our knowledge of certain mechanisms in managing cross-border innovation from the bottom-up perspective, there is less systematic understanding of how a global strategy influences a firm's cross-border innovation and outcome from the top-down perspective (Teece, 2014).

5.2 Hypothesis Development

5.2.1 Cross-border innovation and firm innovativeness

(1) Direct benefits

The direct benefits of expanding cross-border innovation include access to location-specific advantages, embedded knowledge, and local networks. The direct benefits of expanding cross-border innovation are to reach location-specific advantages after a firm

has conducted cross-border innovation activities. Specifically, the direct benefits include different time zones that may reduce the cycle of innovation development (Carlsson, 2006), different knowledge bases in developed and developing countries that may stimulate the new product development (Cloodt, et al., 2006), and market orientation that could be used to recognize the value of different external needs and trends (Cloodt et al., 2006).

Expanding cross-border innovations also provides firms with more opportunities to access to highly skilled talent, particularly when these human resources may be hard to find within their national borders (Lewin et al., 2009). In this way, firms could reap the benefits of both innovation sourcing and interaction with geographically dispersed actors endowed with complementary knowledge (Berry & Kaul, 2015). Consistent with this argument, some evidence indicate that firms expand innovation across countries to benefit from a greater depth of new technology, more diverse sources of information, and highly qualified personnel (Tallman & Phene, 2007). For example, Lahiri (2010) shows that the greater the distribution of R&D activity, the greater the likelihood that knowledge sourced at individual locations can be used as input into a firm's R&D efforts and activities.

Moreover, firms dispersing their R&D activities globally not only attempt to tap into foreign embedded knowledge but also to build up a learning network which can explore and exploit knowledge on a global scale (Almeida & Phene, 2012; Chen et al., 2012). Moreover, expanding cross-border innovation allows MNCs to tap into leading-edge knowledge by locating affiliates in a close proximity to clusters of excellence in the search for new ideas on novel technologies, products, and processes (Belderbos et al., 2015).

According to the conventional wisdom, expanding cross-border innovation has a linear impact on the innovation performance of a firm. Thus, firm innovativeness is the

function of cross-border innovativeness:

$$y_t = \delta x_t + C \quad (1)$$

Let y_t represent the innovation performance determined by cross-border innovation x_t made in the time period of *t*, while δ is a positive coefficient that captures the direct effects of cross-border innovation and *C* is a constant.

(2) Hidden costs

After a continuous increase in the expansion of cross-border innovation, however, some studies argue that the extra or hidden costs, following from more complexities and difficulties, offset the direct benefits. For instance, Andersson and Pedersen (2010) and Larsen et al. (2013) have asserted that offshoring and outsourcing entail invisible or hidden costs that only become visible when firms start to manage and operate their more complex global value chain configuration. This assertation can be also justified by the fact that firms reach a tipping point where existing processes and structures conflict with the new setup of the global operations as they increase the scale and scope of conducting offshore innovation activities (Massini et al., 2010).

The increasing complexity and difficulty of coordination might push the constantly growing costs of conducting cross-border innovation (Andersson & Pedersen, 2010; Larsen et al., 2013). In addition, expanding cross-border innovation also risks the leakage of a firm's own knowledge to local players in different locations so that the costs of conducting cross-border innovation are increased (Grimpe & Kaiser, 2010; Hennart, 2007; Singh, 2008). Sourcing activities from multiple internal and external providers in different countries, for instance, a firm is likely to face more constraints and intellectual property

concerns (Hennart, 2007). Besides, expanding cross-border innovation brings transaction and agency risks due to incomplete contracts. That is the kind of risk that firms will not even be able to judge whether suppliers are fulfilling contractual obligations and whether suppliers would behave opportunistically (Bunyaratavej et al., 2011). While firms incur the extra overhead of maintaining those dispersed innovations (Bertrand & Mol, 2013; Singh, 2008), the difficulty of coordination has also a negative effect on a firm's innovative performance.

Given the difficulties of coordinating innovation activities across functional, organizational, and geographical borders, it is also hard to integrate knowledge inputs provided by external suppliers into innovation processes (Kogut & Zander, 1992). A high-degree expansion of cross-border innovation can dampen firm innovativeness not only because the geographical dispersions can make the integration of knowledge more difficult but also because innovation requires continuous communication and mutual adjustment between primary functions (Hurtado-Torres et al., 2017; Mihalache et al., 2012). The increasing complexity and difficulty of integrating knowledge might slow down firms' learning so as to hamper the direct benefits of expanding cross-border innovation (Thakur-Wernz & Samant, 2017). As such, the costs of conducting cross-border innovations might exceed the benefits, leading firms to an inefficiency trap (Massini et al. 2010), a transition phase (Asmussen et al. 2016; Chen et al., 2012), or a plateau situation (Thakur-Wernz & Samant, 2017).

Following this line of argument about hidden costs, I write a formula to describe hidden costs. First of all, let h_t represent the hidden costs for expanding cross-border innovation along with complexities z_t produced in the time period of t while z_t

consists of cross-border innovations x_t and x_{t-1} in two time periods *t* and *t -1*. The function of hidden costs is:

$$h_t = \theta \cdot z_t \quad (2)$$

$$z_t = x_{t-1} \cdot x_t \quad (3)$$

$$x_{t-1} = x_t - m \quad (4)$$

where θ is a negative coefficient and *m* is a positive constant.

Combining the functions (2), (3), and (4), then the function of hidden cost could be rewritten as:

$$h_t = \theta \cdot (x_t - m)x_t \quad (5)$$

After the hidden costs are taken into account, the function of cross-border innovation is then modified to state that the relation of innovation performance to the extent of expanding cross-border innovation is curvilinear in the following variables. Specifically, letting y_t represent the innovation performance for expanding cross-border innovation x_t with hidden costs h_t occurred in the time period of *t*. Thus, the function is:

$$y_t = \delta x_t + h_t + C \quad (6)$$

$$y_t = \delta x_t + [\theta(x_t - m)x_t] + C \quad (7)$$

$$y_t = \theta x_t^2 + (\delta - \theta m)x_t + C \quad (8)$$

(3) Accelerated effects

Although the costs of expanding cross-border innovation might exceed the benefits at some point in time, firms could deal with this situation of decreasing returns (Contractor et al., 2010) and simultaneously accumulate experience (Contractor et al., 2003; Li et al., 2004), continue learning (Jensen, 2009; Lu & Beamish, 2004; Lumineau, Frechet & Puthod, 2011) and redirect managerial attention (Grimpe & Kaiser, 2010; Larsen et al., 2013) till

net positive outcomes can be realized. Moreover, increasing complexities allow firms to increase the depth and breadth of knowledge (Damapour, 1996), learn more over time (Stan & Vermulen, 2013), and improve performance (Asmussen et al., 2016; Natividad & Rawley, 2016).

First of all, learning in the international environment tends to be incremental and this should be continued in a cyclical fashion (Johanson & Valhne, 1977). Even when a firm encounters the decreasing returns to expansion which are associated with new complexities at higher levels of global expansion, managers can learn to adjust organizational structures and systems to handle the coordination problems (Li et al., 2004; Lu & Beamish, 2004), to develop the knowledge necessary to operate abroad (Cuervo-Cazurra, 2007), and to discover new possibilities as well as recognize the innovation opportunities (Manning et al., 2008). According to the UNCTAD (2005), this learning process is revealed:

"Enterprises may start by contracting out "commodity" R&D. …….. they may realize the benefits of greater specialization and learn how to manage better the contractual and integration process…….. This process can continue, pushing back the limits of what is acceptable at any given time." (UNCTAD, 2005:170)

Such a learning process is also witnessed at Li et al's (2004) work on US small and medium sized enterprises as well as Jensen's (2009) study on Danish firms while both studies eye new business opportunities as the process has a catalytic effect on the strategic learning. Recent studies also suggest that increasing complexities allow firms to learn more over time and then to improve performance (Asmussen et al., 2016; Stan & Vermulen, 2013). For example, Asmussen et al. (2016) used the case of Nokia and the simulation

model to show that as firms encounter the actual challenges of offshoring, they become better able to understand and learn how to adapt to those challenges and thereby enhance performance.

Second, accumulated experience might also mitigate the negative effects from a continuous increase in the geographic dispersion. Experience is accumulated along with the increase in expansion (Contractor et al., 2003; Li et al., 2004). It might benefit the firm's ability to find suitable contractors, to reduce informational asymmetries, and to better manage and control the expansion process (Grimpe & Kaiser, 2010). So some transaction related costs can be controlled through better contract design and managerial procedures (Lumineau et al., 2011; Stringfellow et al., 2008; Tallman & Phene, 2007). In addition, experience with the growing problems of expanding cross-border innovation activities would drive firms to put consolidation efforts in order to control dispersed units (Chen et al., 2012). Moreover, firms with prior experience are more likely to have accumulated organizational system knowledge and will therefore be comparatively better in estimating the costs associated with complexity (Larsen et al., 2013). As companies accumulate knowledge and experience and get control over managing their cross-border innovation activities, a firm can enter a new phase with positive returns from the increasing expansion.

Third, the decreasing returns to the expansion of cross-border innovation calls for heightened management attention. It is important for managers to know how the negative effects from the increasing scale and scope can be reduced and to find out how the learning effects can be enhanced (Contractor et al., 2010; Thakur-Wernz & Samant, 2017). For instance, Contractor et al. (2010) indicate that firms might be able to find ways to organize their activities in such a way to reduce the costs of complexity and coordination below the

benefits of reconfiguration. More specifically, they suggest that firm can specify up-front a clear division of labor, modularize offshoring activities, and apply modern information technology (e.g. virtual communication) to enhance the efficacy of integration (Contractor et al., 2010). Recently, Stan and Puranam (2017) pointed out that managers can improve the organizational adaption to changes in complexity by focusing and promoting coordination across subunits.

Fourth, new complexities could accelerate and boost innovation. Damapour (1996) argues that new complexities increase the depth of knowledge, diverse the base of knowledge, and add the cross-fertilization of ideas so as to facilitate innovation. Given complexities stemming from high dispersion, managers empirically use the possibilities of connecting and coordinating different R&D initiatives via information and communications technologies (ICT) across remote sources of innovation (Almeida & Phene, 2012; Hsuan & Mahnke, 2011). Natividad and Rawley (2016) also indicate that firms, which have more task complexities, gain benefits from those complexities. As firms gain experience in managing and operating their global network of value chain activities, I argue that the firms might be able to apply more sophisticated techniques and management tools, keeping the benefits of expanding their global networks higher than the costs and accelerating innovation.

Depending upon these arguments, I further create a formula of accelerated effects stemming from new complexities along with the increase in the expansion of cross-border innovation. Firstly, let v_t represent the accelerated effects of adding new complexities for cross-border innovation x_t ,which is denoted and made in the time period of t after complexities z_{t-1} produced in the time period of *t-1*. So I can define the function of

accelerated effects is:

$$v_t = \gamma \cdot x_t \cdot z_{t-1} \quad (9)$$

$$z_{t-1} = x_{t-1} \cdot x_{t-2} \quad (10)$$

$$x_{t-2} = x_t - n \quad (11)$$

Combining the functions (4), (9), (10) and (11), the function of accelerated effects could be rewritten:

$$v_t = \gamma \cdot x_t(x_t - m)(x_t - n) \quad (12)$$

where γ is a positive coefficient, and *n* and *m* are both positive constants.

Then, the function of firm innovativeness can be modified to describe that the relation of innovation performance to the extent of expanding cross-border innovation is sigmoid. More specifically, the function is:

$$y_t = \delta x_t + h_t + v_t + C \quad (13)$$

$$y_t = \delta x_t + h_t + [\gamma x_t(x_t - m)(x_t - n)] + C \quad (14)$$

$$y_t = \gamma x_t^3 - [\gamma(m+n) - \theta]x_t^2 + [m(\gamma n - \theta) + \delta]x_t + C \quad (15)$$

On the whole, I argue that the function of cross-border innovation is consisting of direct benefits, hidden costs, and accelerated effects of expanding cross-border innovation. As such, a nonlinear sigmoid relationship exists between the expansion of cross-border innovation and the innovation performance of a firm. Thus, I propose the following hypothesis.

Hypothesis 1: The relationship between the expansion of cross-border innovation and firm innovativeness is nonlinear and performs an inverted S-shape, with the slope positive at low levels, negative at intermediate levels, and positive at high levels of global expansion.

5.2.2 Global strategy and expanding cross-border innovation

A global strategy affects MNCs to develop and utilize profit-generating assets in more than one country over time (Bartlett and Ghoshal, 1989). It directs and organizes firm resources, activities, and units across functional, organizational and geographical boundaries. For example, firms use a global strategy to direct their attentions to and prioritize their actions on a series of offshoring choices (Massini et al., 2010; Lo & Hung, 2015). It also helps firms recognize opportunities and constraints so as to speed their future learning. For instance, a global strategy affects top management's priority and discretion to recognize which knowledge areas need to be accessed and developed (Larsen et al., 2013; Teece, 2007, 2014).

In addition, a global strategy also enhances the consistency of decisions and actions as well as the alignment of internal and external assets (Bunyaratavej et al., 2011; Lampel & Bhalla, 2011; Larsen et al., 2013). It reinforces the competence of configuration and the capability of orchestration related to efficiency and flexibility in organizing the global network. For example, IBM and several companies have their own strategies to manifest the value of offshoring innovation by exploiting the high-quality low-cost software talent in India (Mihalache et al., 2012). As such, a global strategy lends firms a tool to hold the advantage of orchestration (Contractor et al., 2010; Teece, 2014).

Moreover, a global offshoring strategy is also a top-down approach influencing a firm’s internationalization and expansion. Specifically, a global strategy includes the requisite capabilities and practices for enhancing efficiency in dispersing activities, establishing corporate offshoring resource centers, sharing knowledge transfer, and managing global talent (Massini et al. 2010, Larsen et al., 2013). As a global strategy

adopted by a firm influences its expansion and internationalization, the strategic choice of a MNC is based on its strategy, guiding competence development through internationalization and technology production in a wide range of subsidiaries across selected foreign locations (Almeida & Phene, 2012; Cantwell & Mudambi, 2005; Doz & Wilson, 2012).

More recently, Teece (2014) notes that active development and astute orchestration of tangible and intangible assets through global networks lie at the heart of the rationale for the international enterprise and, together with strategy, determine a firm's innovation potential and longer-run success. Maritan & Lee (2017) also assert that strategy aims to address factors that determine how resource allocations actually are made. Recent research also begins to take issue with the claim that a global strategy is fundamental to offshoring innovation. For example, firms with an international corporate-wide strategy enable them to better manage the offshoring processes and activities (Massini et al., 2010) and the determinants of offshoring R&D are therefore conditioned by firms' offshoring strategy (Martinez-Noya & Garcia-Canal, 2011). All of these assertations underscore the theoretical need to examine the impact of a global strategy on the relation between the expansion of cross-border innovation and firm innovativeness.

Although expanding cross-border innovation is inherently related to direct benefits, hidden costs, and accelerated effects, it is still possible for firms to develop a global strategy as a mechanism to manage the increasing innovation activities across the functional, organizational, and georgical borders. First, a global strategy involves deploying the firm's assets and resources to support market needs and gain advantage over rivals (Maritan & Lee, 2017; Teece, 2014), while recognizing market and technological opportunities and

any constraints imposed by the firm's historical path of evolution (Teece, 2007). Implementing of a global strategy could reinforce the theory of relocating high-value functions, albeit with distinct competencies and capabilities related to efficiency in organizing the global network (Contractor et al., 2010). In this regard, a global strategy plays an important role in orchestrating dispersed innovation activities across functional, organizational, and georgical borders.

Second, a global strategy also helps a firm's learning of capturing the value from geographically dispersed innovations and controlling the risks associated with expansion. For instance, Massini et al. (2010: 367) argue that firms with a corporate-wide strategy guiding offshoring decisions are likely to perceive and understand offshoring differently from those without such a strategy. Firms may execute either an increase in R&D tasks for which performance is less subject to cost reduction but more subject to added value, or dispersed allocation of R&D tasks which may improve performance by offsetting the extra costs related to location-specific risk factors (Contractor et al., 2010). Indeed, firms, like Boeing, IBM, Sapient, and Accenture, leverage the mix of high capabilities and low cost of the Indian software industry to manifest the value of dispersed cross-border innovations (Hill & Hult, 2017; Mihalache et al., 2012). Thus, firms having a global strategy in place can mitigate the impact of the anticipated disadvantages caused by expansion so that the firm innovativeness can be secured.

Third, a global strategy affects managers to prioritize organizational attention to a particular set of critical issues affecting the expansion choices taken by managers (Massini et al., 2010). More specifically, such a strategy directs managers' attention to key success factors and priorities and to coordinate globally dispersed resources and activities, and thus

results in more consistent decisions and superior outcomes (Doz & Wilson, 2012; Larsen et al., 2013).

Accordingly, the introduction of a global strategy could enhance the benefits of expanding cross-border innovation and reduce the costs of complexity and difficulty raised by the expansion. Firms thus get the best of all possible worlds by spreading their foreign operations and outsourcing relationships over a broader area of regions and countries to balance potential gains and risks on the basis of a well-guided strategy (Mukherjee et al., 2013). As such, I assert that the function of firm innovativeness is moderated by a global strategy. Letting y_t represent the innovation performance for dispersed innovations x_t moderated by strategy s_t in the time period of t, the function is:

$$y_t = \delta x_t + \lambda s_t + \rho x_t s_t + C \quad (16)$$

where δ, λ and ρ are positive constants and C is a constant.

Based on these arguments, this study suggests that an implementation of a global strategy enables firms to better manage the coordination and complexity of globally dispersed innovation. Therefore, this study proposes the following hypothesis:

Hypothesis 2: An implementation of a global strategy positively moderates the linear relation between the cross-border innovation and firm innovativeness in such a way that the firm increases the innovative gains attributable to expansion.

5.3 Methodology

5.3.1 Sample

I used the ORN data which explicitly examined whether a respondent company has in place a global strategy. The sample includes 383 firms which are active in different industries: and have conducted innovation activities defined as the allocation of R&D, product design,

and engineering tasks or processes to a location outside the home country from 1995 to 2010.

5.3.2 Estimation

The estimation model used for such a cross-sectional time-series dataset is a panel data model. Panel data models have many advantages on the estimation, such as controlling for unobserved influences, reducing multicollinearity problems, mitigating omitted variable bias, and contributing to enhanced estimation efficiency (Greene, 2000). A generic panel data regression model is written as

$$y_{it} = \alpha_i + \beta' X_{it} + u_{it} \tag{18}$$

$$u_{it} = u_i + o_{it} \tag{19}$$

$$y_{it} = \alpha_i + \beta' X_{it} + o_{it} \tag{20}$$

where y_{it} is the dependent variable, i =1,….,N, t = 1, …,T

α_i is the unknown intercept for each firm.

X_{it} represents factors that affect the dependent variable at period t.

u_i is individual-specific, time-invariant effect.

o_{it} is a time-varying random component.

However, the present dataset has missing years for at least some cross-sectional units in the sample. In such a case, the dataset used in this study constructs an unbalanced panel. One useful panel model to address this issue is a fixed-effects panel model (Wooldridge, 2012). The fixed-effects regression model allows attrition to be correlated with α_i, the unobserved effect from missing data. With the initial sampling, some units are more likely

to drop out of the survey, and this is captured by α_i (Greene, 2000; Wooldridge, 2012). By including firm-specific intercepts in the regression, moreover, a fixed-effects model captures unobserved firm heterogeneity that may not be captured by the control variables. A fixed-effects regression model could be written as Equation (20).

5.3.3 Measurement

Dependent variable The dependent variable is innovation performance to capture firm innovativeness. I used a multi-dimensional construct for measuring innovation performance. The dimensions of the construct are generated from the outcome variables used in prior studies such as Bunyaratavej et al. (2011) and Mihalache et al. (2012). Each of the dimensions has a corresponding item in the Corporate Client Survey. By taking an average across the following three items, this study creates the multi-dimensional measure of innovation performance: (1) better access to new markets, (2) major product innovations, and (3) improved service quality. The Cronbach's α is 0.74, which is higher than the 0.7 threshold typically used for assessing construct reliability (Nunnally & Bernstein, 1994).

Independent variable The variable "global expansion" is to measure the extent of expanding cross-border innovation. I firstly calculated the number of innovation activities, contract providers, and countries to capture functional, organizational, and geographical expansion in the three-dimensional Euclidean space. Because firms that are already experienced with geographic expansion are more likely to engage in further expansion (Lahiri, 2010), prior experience may help firms expand more activities to host countries (Bertrand & Mol, 2013). Then I measured firm experience by counting the time in years

between the launch of the first cross-border innovation activity and the implementation of the observed activity by the focal firm. Consistent with the theoretical arguments (e.g., Muth, 1986), I considered the weight of experience on the degree of expansion by dividing one plus the experience count variable in its natural log form. This measure takes both the expansion and the past experience into account. In formal terms, the formula of a firm i expanding in period *t* is:

$$Global\ expansion_{i,t} = \frac{\sqrt{Activities_i^2 + Providers_i^2 + Locations_i^2}}{1 + ln\,(Experience_{i,t})} \quad (21)$$

where $i = 1,\ldots,N$, $t = 1, \ldots,T$

Moderating variable The moderating variable "global strategy" is a binary variable indicating whether a firm implements a global strategy. The Corporate Client Survey firstly asked the respondent to answer whether the company "has in place an organization-wide strategy for guiding offshoring decisions across all divisions and functions/processes" (Massini et al., 2010). In addition, as a way to verify that a global strategy had been formally implemented, the survey also asked the respondent to indicate whether the company "has the company established an outsourcing center of excellence for facilitating offshoring and outsourcing decisions or supporting implementations across divisions and functions". The responses from these two questions were used to create a dummy variable, taking the value of 1 if a company has a global strategy in place with building a global resource center to implement that strategy; otherwise 0. Subsequently, I created the interaction by multiplying the mean-centered independent variable with the moderating variable to measure the moderating effect of a global strategy on the relation between the expansion of cross-border innovation and innovation performance.

Control variables A set of control variables associated with firm characteristics, location determinants, and industrial factors are included in this study. One of firm characteristics – firm size is controlled. Firm size is a control variable by using the logarithm of the number of employees in the company because the larger firms tend to have economies of scale compared to smaller companies (Nieto & Rodrı´guez, 2011). Moreover, three variables about local resource environment—proximity to local facilities, local human capital and low-cost operation—derived from the surveys used in prior studies are other control variables (Berry, 2014; Lewin et al., 2009). Another control variable related to location is geographical distance which is defined as air miles between the headquarters and offshore locations. This variable is measured by using secondary data from Google distance calculator, and the log value of the total distances between the home and host countries was used in the estimation (Larsen et al., 2013). Last but not least, an industry's rate of offshoring is also controlled in the estimation because offshoring innovations might be a mimetic action of following peers or competitors (Jensen, 2009; Lewin et al., 2009).

5.4 Analytical Results

5.4.1 The test of an inverted S-shape effect

Table 5.2 shows the descriptive statistics of the variables and the correlation coefficients for all of the variables. Table 5.3 provides the results of the fixed-effects regression analysis. In Table 5.3, Model 1 describes the baseline model with only the control variables in estimating innovation performance.

Table 5.2: The descriptive statistics

	Variable	Mean	S.D	1	2	3	4	5	6	7	8
1	Innovation performance	2.43	1.16	1.00							
2	Global expansion	4.78	9.27	0.06	1.00						
3	Global strategy	0.33	0.38	0.10	0.09	1.00					
4	Firm size	6.19	2.90	0.10	0.16	-0.08	0.00				
5	Proximity to local facilities	2.48	1.26	0.13	0.00	0.03	0.12	1.00			
6	Access to talent pool	3.77	0.78	0.10	0.13	0.09	0.02	0.01	1.00		
7	Low-cost operation	3.58	0.88	0.12	0.09	-0.02	0.04	0.05	0.18	1.00	
8	Geographical distance	8.24	1.25	0.00	0.08	0.01	0.05	0.31	0.13	0.05	1.00
9	Industry offshoring rate	0.27	0.13	-0.01	-0.11	-0.18	-0.10	-0.15	-0.02	0.03	0.02

Note: Correlations with absolute value greater than 0.15 are significant at $p < 0.05$, and those greater than 0.19 are significant at $p < 0.01$ (two-tailed test).

Table 5.3: Regression models predicting innovation performance

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	1.379 (1.357)	1.722 (1.093)	1.604 (1.127)	1.537 (1.138)	1.559 (1.156)
Firm size	0.035 (0.043)	0.004 (0.035)	0.010 (0.037)	0.008 (0.037)	0.021 (0.033)
Proximity to local facilities	0.227** (0.093)	0.197** (0.075)	0.196** (0.075)	0.198** (0.076)	0.207*** (0.066)
Access to talent pool	0.260** (0.130)	0.237** (0.114)	0.240** (0.115)	0.249** (0.119)	0.252** (0.103)
Low-cost operation	0.039 (0.129)	0.003 (0.104)	0.005 (0.105)	-0.016 (0.109)	-0.040 (0.095)
Geographical distance	0.014 (0.152)	0.063 (0.123)	0.062 (0.124)	0.057 (0.124)	0.031 (0.108)
Industry offshoring rate	-0.171 (0.391)	-0.164 (0.320)	-0.209 (0.335)	-0.214 (0.348)	-0.238 (0.344)
Global expansion		0.011* (0.006)	0.048** (0.021)	0.145** (0.067)	0.155** (0.070)
Global expansion Squared			-0.001** (0.000)	-0.005* (0.002)	-0.006** (0.003)
Global expansion Cubed				0.001* (0.000)	0.003** (0.001)
Global strategy					0.449 (0.263)
Global expansion X Global strategy					0.131** (0.057)
Adjusted R^2	0.206	0.259	0.298	0.314	0.343
AIC	165.6	167.5	168.1	170.3	172.9
Mean VIFs	1.45	1.50	1.65	1.71	1.83

Note: N=383; *p <0.1, **p<0.05, ***p<0.01. Clustered robust standard errors reported in parentheses.

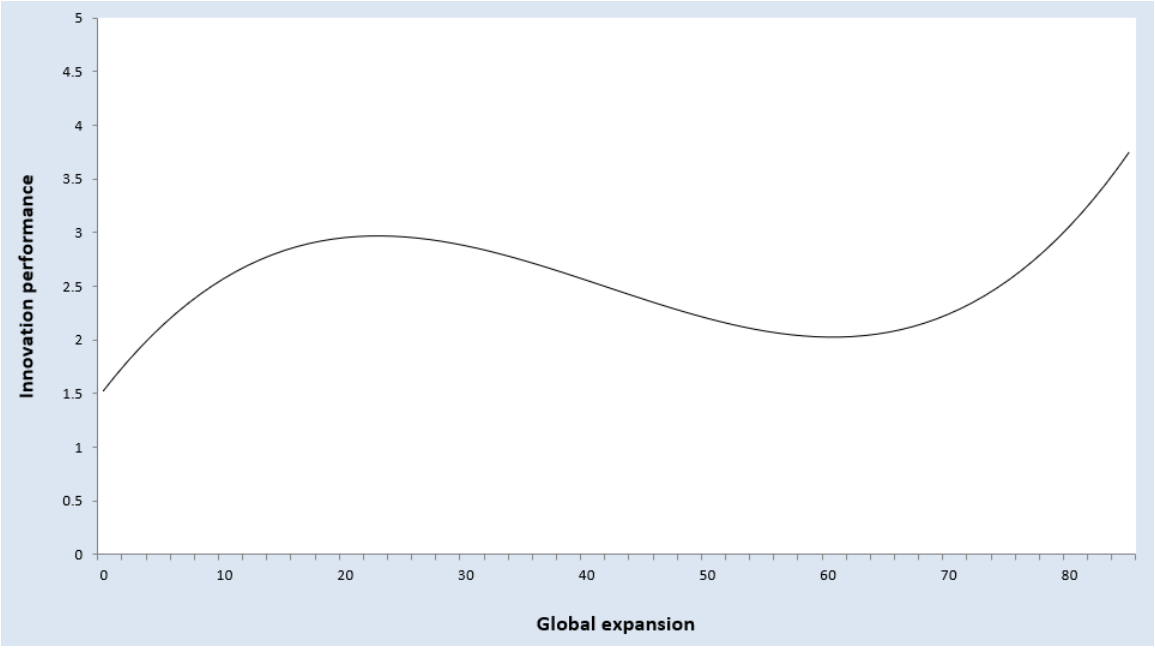
To test the first hypothesis, the variable of global expansion is added to Model 2. The estimated effect of global innovation on innovation performance is positive and significant (β= 0.011; p-value <0.1). This indicates that the more cross-border innovation activities, the higher the firm innovativeness.

To test the inverted S-shape relation between the expansion of cross-border innovation and innovation performance, in addition, the squared term of global expansion is introduced in Model 3 while the squared term and the cubic term of global expansion are incorporated in Model 4. As shown in Model 3 and 4, the inclusion of the squared term and cubic term significantly improved model fit since the adjusted *R* square of both models

increase steadily. A test of the joint significance of the linear, squared, and cubic terms is also significant in all models. According to Model 4, innovation performance is positively related to the linear term of global expansion (β= 0.048; *p*-value <0.05), negatively related to the square term of global expansion (β= -0.005; *p*-value <0.1), and then positively related to the cubic term of global expansion (β= 0.001; *p*-value <0.1).

To further indicate the S-shaped relationship, a simple regression between the expansion of cross-border innovation and innovation performance is performed and illustrated as Figure 5.1. In Figure 5.1, innovation performance first increases as the degree of global expansion increases, then decreases after intermediate levels, and resumes to increase with high levels. This diagram supports the predication of the inverted S-shape relationship between the expansion of cross-border innovation and innovation performance.

Figure 5.1: Fitted curve of innovation performance



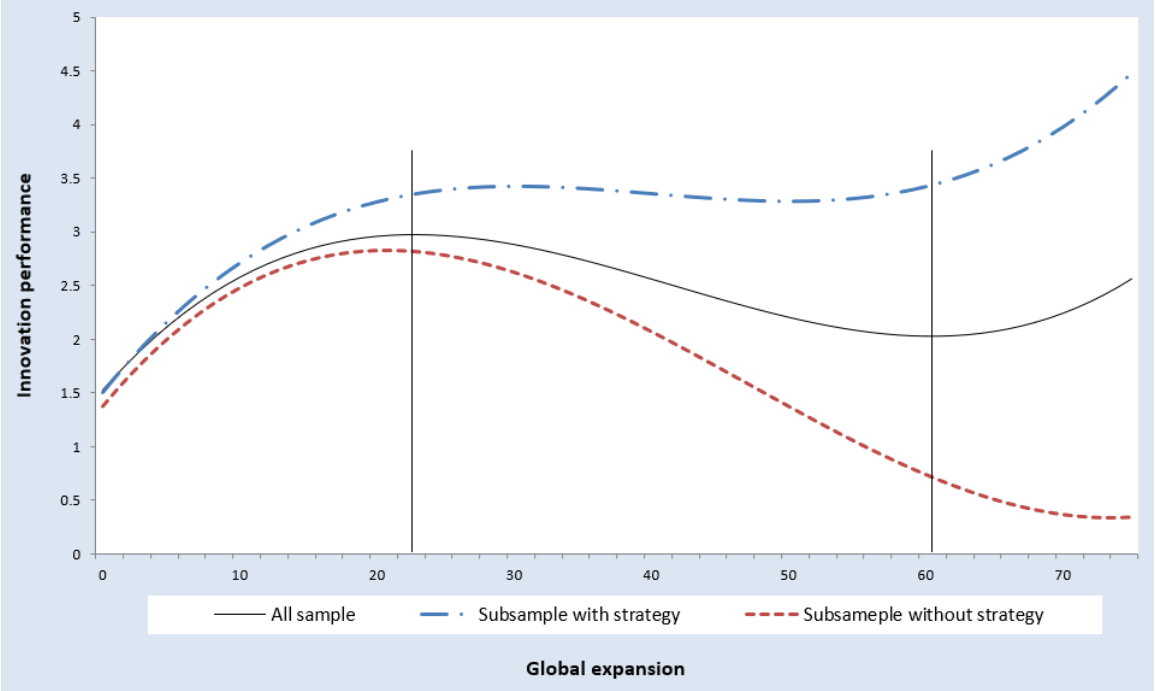
5.4.2 The moderating effect of global strategy

To test the second hypothesis, the interaction term between global expansion and global strategy is introduced in Model 5. After introducing the interaction term to the regression analysis, the main effect of global expansion remains significantly positive (β= 0.155; *p*-value <0.05), while the coefficient of the interaction is also statistically significant and positive (β= 0.131; *p*-value <0.05). Hence, this finding supports Hypothesis 2.

In order to verify the robustness of the results, a simple slope analysis is conducted to test the statistical significance of two regressions (with strategy v.s. without strategy) by following the procedure advanced by Aiken and West (1991). Although for the operations with strategy the slope is significantly positive (β = 2.07, $p < 0.01$) and for the operations without strategy the slope is also significantly positive (β = 1.723, $p< 0.01$), the Hausman test shows that both regressions are significant different (χ^2=4.6, $p < 0.05$).

Figure 5.2 plots the interaction of dispersed innovation with global strategy. Compared with all sample, the subsample with a strategy shifts the threshold beyond which increasing global expansion has a negative effect on innovation performance to the right, shows a flat downward curve after that threshold, and drifts the tipping point above which increasing global expansion has a positive effect on innovation performance to the left. By contrast, the subsample without a strategy, compared with all sample, moves the threshold beyond which increasing global expansion has a negative effect on innovativeness to the left, instills a steep downward curve after that threshold, and shifts the tipping point above which increasing global expansion has a positive effect on innovativeness to the right. These results support Hypothesis 2.

Figure 5.2: The moderating effect of a global strategy



6. Conclusion

6.1 Discussion

6.1.1 Outsource cross-border innovation under uncertainty

In theory, there are several reasons why firms outsource cross-border innovation under uncertainty. First, internalizing innovation activities in subsidiaries may not be desirable or feasible when firms do not have specialized knowledge or capabilities of doing that (Alcácer et al., 2016; Kedia & Mukherjee, 2009; Massini et al., 2010). For example, outsourcing innovation activities to foreign contract providers in the biotech area is pursued by some pharmaceutical companies lacking the biotech capabilities (Kapler & Puhala, 2011). By contrast, some foreign contract providers have gained enough experience and capabilities so that they are capable of performing activities cheaper and better than a focal firm (Currie et al., 2008; Zirpoli & Becker, 2011). Second, small or medium-sized enterprises may not have a subsidiary in a foreign nation (Narula, 2002). Third, internalizing innovation activities in subsidiaries may entail the heavy upfront investment, large sunk costs, and high risks, which a focal firm cannot afford (Gooris & Peeters, 2016; Lewin et al., 2009; Sartor & Beamish, 2014). In these cases, outsourcing becomes the preferred alternative strategy to conduct cross-border innovation activities.

Compared with internalizing, in addition, I argue that outsourcing is an initial option requiring less commitment, conferring higher flexibility, and containing lower loss for firms to make a follow-on investment, abandon the investment, or continue the investment under uncertainty. Moreover, outsourcing is also a growth option offering the opportunities of further expansion. Through the improvement of capability-based, system-based, and network-based learning, a focal firm achieves greater control over the uncertainty and

increases the odds of follow-on actions on its future expansion. Thus, outsourcing cross-border innovation emerges from high uncertainty, and when pursued successfully, firms increase their expansions through learning by outsourcing.

Take a step further. I argue that outsourcing innovation activities to a foreign contract provider in a country with high uncertainty when it provides firms with appropriable rents when the value generated from that provider lies above the costs caused by that provider. Focusing on the access to human capital, previous studies assert that the positive attraction of host-country high-skilled, low-salary talent enhances the appropriable rents of outsourcing cross-border innovation (e.g., Demirbag & Glaister, 2010; Kapler & Puhala, 2011). I echo this stream of research as my findings indicate that the availability of human capital indeed facilitates firms to outsource innovation activities in developing countries with weak IPR protection than in developed countries with strong IPR protection. Even though the costs of outsourcing cross-border innovation in countries with high uncertainty are higher than in countries with low uncertainty, my findings also show that firms are able to design an architecture of system-specific outsourcing to mitigate the costs of outsourcing in developing countries weak IPR protection. Accordingly, the design of system-specific outsourcing could increase the odds for firms to outsource innovation activities in countries with high uncertainty. All of above provide additional explanations of why to outsource cross-border innovation under uncertainty.

6.1.2 Manage cross-border innovation

(1) System-specific outsourcing

In this dissertation, I posit that a focal firm can design the architecture of system-

specific outsourcing to manage cross-border innovation under uncertainty. Under the architecture of system-specific outsourcing, I propose two mechanisms, project modularity and task specificity, which increase quasi rents. As project modularity integrates two or more interdependent activities of a system into a designate module to generate synergy, task specificity specifies an independent activity of a system in a designate task to create simplification.

Building upon the value side research on a clear division of labor (e.g., Mayer et al., 2012), operational efficiency (e.g., Contractor et al., 2010; Mukherjee et al., 2013), specialized expertise (e.g., McDermott et al., 2013), and relocation flexibility (e.g., Albertoni et al., 2017), I propose that project modularity and task specificity help a focal firm capture the value of outsourcing innovation to a contract provider. My findings also provide support with this argument. The empirical results of this dissertation show that both project modularity and task specificity securing the value from the availability of human capital facilitate the likelihood of offshore outsourcing in countries with high uncertainty. Even though the cost side research argues that outsourcing cross-border innovation might be raised by the difficulties of knowledge search (Carlile, 2004), integration (Larsen et al., 2013), and communication (Gooris & Peeters, 2016), my findings indicates that project modularity and task specificity can mitigate the costs of offshore outsourcing, in terms of human capital turnover, a source of (un)intended technology leakage (e.g., Agarwal et al., 2009; Schotter & Teagarden, 2014), and increase the odds of outsourcing in countries with high uncertainty.

Departing from conventional wisdom, I further point out the distinctiveness of project modularity and task specificity (Table 6.1). Both mechanisms offer several distinct

instruments to reduce the costs of offshore outsourcing such as technology leakage. On the one hand, project modularity decreases the leakage by hiding complex information between interdependent activities in a specific module. Because project modularity creates a complicated black box for a contract provider and that provider's employees, they cannot build up the same module without combining all designate activities. On the other hand, task specificity abates the leakage by assigning a narrowly specified and independent task to limit the amount of information exposed to each contract provider. Moreover, the tight specification of each task leads to myopia and decreases a contract provider and its employees' creativity to learn and innovate.

Table 6.1: The comparison of project modularity and task specificity

System-specific outsourcing	**Project Modularity**	**Project Specificity**
Commonality	• Separation • Division of labor • Knowledge-specific expertise • Flexibility of relocation • Efficiency	
Distinctiveness	• Interdependence • Synergy • Hide information	• Independence • Simplification • Limit information

Empirically, I indicate that both project modularity and task specificity augment the value of specialization and mitigate the costs of technology leakage. My findings show that the positive impact of human capital availability on the likelihood of outsourcing innovation to a contract provider in a weak IPR country is strengthened by either greater project modularity or greater task specificity. The negative impact of human capital turnover on the likelihood of outsourcing innovation is then lessened when outsourcing by either greater project modularity or greater task specificity. It is also true that a greater

degree of project modularity and task specificity increases coordination and administration costs in the focal firm (Larsen et al., 2013), and increases knowledge asymmetries across the separated innovation teams (Baldwin & Henkel, 2015). If project modularity and task specificity are carried too far, the overall result may be unsatisfactory or sub-optimal, in terms of creating appropriable rents compared with an internalized development effort (Contractor, 2019). I Tested these two variables on the sample of my study to see what the net effect of greater project modularity and task specificity may be. My findings indeed show that project modularity and task specificity create net benefits. Both mechanisms further augment the value of human capital availability and mitigate the deleterious effect of human capital turnover in countries with high uncertainty. Paying greater heed to such mechanisms would enable more MNCs to outsource more of their innovation activities to emerging nations in order to enjoy the benefits of human capital there.

(2) Global strategy

A global strategy is a corporate strategy for directing and organizing firm resources, activities, and units across functional, organizational and geographical boundaries (e.g., Teece, 2014). It helps firms appropriate the value from expanding cross-border innovation by orchestrating activities between subsidiaries and contract providers across locations. It also aligns a firm’s internal and external assets and its decisions and actions to enhance efficiency and flexibility. Furthermore, it helps firms recognize opportunities and constraints to speed their future learning. As a global strategy guides firms when, what, and how to manage the expansion of cross-border innovation, it lies at the core of cross-border innovation and determines firm innovativeness.

I propose that implementing a global strategy enables a firm to manage the expansion of cross border innovation since the expansion is along with the increase in functional, organizational, and geographical dispersions. Although expanding cross-border innovation might incur the difficulty of continuous communication (e.g., Kotabe et al., 2007), the damage of operational efficiency (e.g., Larsen et al., 2013), the hardship of coordination (e.g., Hurtado-Torres et al., 2018) between offshoring units and actors across locations, a global strategy could help firms lessen such liabilities. Specifically, a global strategy helps firms make the strategic decisions about what sorts of affiliates to build, which specific areas to enter, and which kind of knowledge to manage and integrate. For example, a global strategy leads firms to identify the appropriate offshoring processes and affiliates. It enables firms to assure the quality of communication between offshoring operations and units.

Take Boeing as an example. Boeing has had its own global strategy and built up the Shared Service Group to manage its dispersed affiliates and contract providers so as to utilize them providing innovative products, services, and solutions (Proudford & Hodge, 2016). Novartis provides another example. Based on its strategic plan and global strategy, Novartis designs its NIBR network which is located across the globe to gain access to the world's best scientific talent. Specifically, the institutes of NIBR network are strategically located at Cambridge (US), East Hanover (US), Emeryville (US), La Jolla (US), Horsham (UK), Basel (Switzerland), Siena (Italy), Shanghai (China), and Singapore. This strategy helped Novartis gain more approvals for new molecular entities in both US and Europe than its competitors (Doz & Wilson, 2012).

My findings support this argument. I present that firms having a global strategy in place are better able to manage the expansion of cross-border innovation measured by the

number of offshore activities, contract providers, and locations and then enhance their innovation performance measured by better access to new markets, major product innovations, and improved service quality. As such, it is useful for firms to develop a global strategy as a mechanism to manage cross-border innovation. In this regard, my findings provide support to Teece's (2014) seminal work that promotes the importance of a global strategy in orchestrating assets and activities across functional, geographical and organizational boundaries.

6.1.3 Performance implications of cross-border innovation

Conducting cross-border innovation provides firms with the business, corporate, international, and institutional level benefits. The benefits include access to idiosyncratic resources (e.g., Contractor et al., 2003; Rugman & Verbeke, 2001), new technology (e.g., Belderbos et al., 2015; Grimpe & Kaiser, 2010; Kotabe et al., 2007), and markets and customers (Berry & Kaul, 2015; Sartor & Beamish, 2014; Singh, 2008). Such benefits encourage firms to invest in future opportunities as well as to grow by learning. As mentioned, Apple firstly contracted out IC design and then develops its in-house IC latterly after learning the silicon and software IP from Imagination. My findings of learning by outsourcing in Chapter 3 and cyclical learning in Chapter 5 supports the above assertion.

Although expanding cross-border innovation enhances firm innovation performance the long run, I discuss possible negative and positive impacts of expanding cross-border innovation associated with complexities on firm innovativeness. Despite the costs of managing complexities, I argue that new complexities derived from expansion allow firms to increase the depth and breadth of knowledge, add new ideas, discover new possibilities,

and recognize innovation opportunities. Consistent with Contractor et al. (2003) and Li et al. (2004), in addition, I argue that firms accumulate experience not only from dispersing innovative activities, but also from adapting complexities and difficulties.

Two of the sample companies – Novartis and Boeing provider another supportive evidence. Prior to reorganizing its innovation activities, Novartis had its main US innovation center in East Hanover since 1985. When Novartis identified the difficulty and need of biomedical research, however it quickly switched to Cambridge and built a new global research headquarters in 2002. Take another look at Boeing. As it increasingly dispersed its innovation activities of the 737 and 747 aircrafts, Boeing suffered from the coordination problem and delayed delivery of the first 747. However, Boeing overcame those sufferings, led to another success of the 747, and continued expanding its globally dispersed innovation for the 777 and 787. Thus, some firms indeed are able to respond to the negative impact of complexities while acting on the positive impact of complexities.

6.2 Contribution

This dissertation has several theoretical contributions as well as managerial implications. First of all, I adopt the RO lens to show why outsourcing is a preferred strategy of conducting cross-border innovation. My findings echo the notion that outsourcing is a useful strategic option (e.g., Nieto & Rodríguez, 2011; Rodríguez & Nieto, 2016). I also explore outsourcing as an incremental investment strategy for firms to further expand cross-border innovation. Moreover, I reveal the learning effect of outsourcing cross-border innovation on global expansion. As I bridge the gap between the first initiation of outsourcing and the later expansion of cross-border innovation, I respond to the call to test

the sequential outcomes of offshore outsourcing (e.g., Mukherjee et al., 2013). The adoption of outsourcing has implications for managerial practices. Although several popular arguments and some anecdotal evidence show that the role of outsourcing cross-border innovation is now better understood by managers, I demonstrate how important it is to consider outsourcing as an alternative under uncertainty and when to expand. More specifically, after gaining capability-based, system-based, and network-based learning, managers can pursue further expansion.

Second, I borrow the perspective of appropriable rents to show how firms manage outsourcing cross-border innovation especially under uncertainty. Although the traditional literature asserts that firms are able to internalize the practice of cross-border innovation to substitute the external hazard in countries with high uncertainty (e.g., Alcácer & Zhao, 2012; Berry, 2017; Feinberg & Gupta, 2009; Nandkumar & Srikanth, 2016; Schotter & Teagarden, 2014; Zhao, 2006), this line of literature does not provide an explanation when the firms choose outsourcing as an alternative to conduct cross-border innovation, particularly if they have no subsidiary, avoid risk, or lack specialized knowledge. While the school of internalization does not offer an explanation that firms may prefer outsourcing under uncertainty, I complement this traditional perspective by considering outsourcing an alternative strategy of conducting cross-border innovation. I thus bridge this gap and contribute to a better understanding of the outsourcing strategy.

Third, I focus on two dimensions of human capital – availability and turnover, and simultaneously investigate the value and costs which determine the appropriable rents of outsourcing innovation in countries with high uncertainty (i.e. weak IPR countries). While my findings show that the availability of human capital is an important factor driving firms

to outsource innovation to contract providers in weak IPR countries, I redress the underexplored issue regarding the high turnover of human capital in these countries. The high turnover shrinks the appropriable rents of outsourcing innovation due to the costs caused by technology leakage and IP loss from the departing employees who work for a contract provider and carry the firm's knowledge to local companies or rivals. This becomes a particularly acute problem in high-tech or knowledge-processing sectors involving valuable researchers, scientists, and engineers (e.g., Nandkumar & Srikanth, 2016; Schotter & Teagarden, 2014).

Fourth, I propose the architecture of system-specific outsourcing to address how a firm can capture the appropriable rents in countries with high uncertainty. For one thing, system-specific outsourcing helps firms capture the value of specialization from various independent contract providers (e.g., Zirpoli & Becker, 2011). For another thing, system-specific outsourcing mitigates the costs of outsourcing innovation by minimizing the need for communication between its contract providers and obstructs the knowledge search of each provider (e.g., Gooris & Peeters, 2016). This further increases the appropriable rents of outsourcing innovation for the focal firm. My ideas developed in this study suggest a novel line of inquiry in current and future research on outsourcing innovation in countries with high uncertainty.

Fifth, I introduce two mechanisms – project modularity and task specificity – under the architecture of system-specific outsourcing to address how a firm can capture the most portion of appropriable rents in countries with high uncertainty. While both mechanisms are specific to a certain system, they present several distinct instruments to reduce technology leakage. While project modularity hides complex knowledge and proprietary

information in a specific module, my perspicacity is that project modularity may raise the barriers for a contract provider and its employees to imitate a module and even a system by conferring complexity and deferring learning. While task specificity specifies a task to limit the amount of proprietary information exposed to each contract provider, my insight is that task specificity induces myopia and constrains curiosity of exploration to reduce a contract provider's and its employees' incentives to change. The broader notion that project modularity and task specificity may serve as mechanisms for reducing technology leakage is a worthwhile avenue for research on knowledge sourcing (e.g., Currie et al., 2008; Mayer et al., 2012) and project disaggregation (e.g., Contractor et al., 2010; Kedia & Mukherjee, 2009). By exploring the case of outsourcing innovation in weak IPR countries, I also contribute to a better understanding of what mechanisms can be developed on the theoretical basis of disaggregation. I consider two system-specific outsourcing mechanisms project modularity and task specificity.

Last but not least, I bring in a top-down perspective to manage the expansion of cross-border innovation. As some studies have shown that effect of dispersed innovation on innovative performance might be subject to a number of mechanisms, such as the embeddedness of affiliates (e.g., Griffith et al., 2006), internal links between subsidiaries (e.g., Zhao, 2006), cross-regional interpersonal ties (e.g, Singh, 2008), and interunit knowledge sharing (e.g., Lahiri, 2010), most of those are explored and better understood in the bottom-up perspective. I then provide another lens to expand the knowledge of this line research by taking the top-down perspective, namely a global strategy. As I point out that expanding cross-border innovation may not automatically lead to higher firm innovativeness, a global strategy could direct a firm's attention to orchestrate resources,

activities, and units across locations so as to improve innovation performance. As firms hold equivalent cross-border innovation activities, implementing a global strategy is leading them to higher innovation performance. In other words, firms' different actions toward strategies may further explain the variance of firm innovativeness. I expand the knowledge of this line research by exploring the importance of a global strategy. I also shed some light on the recent literature suggesting that the top-down approach of managing dispersed innovation could exert a greater impact on firm innovativeness and provide some evidence for research arguing for the importance of a global strategy (e.g., Contractor et al., 2010; Maritan & Lee, 2017; Mukherjee et al., 2013; Teece, 2014).

The adoption of a global strategy has implications for managerial practices. Managers must adopt a global strategy to manage their global presence and expansion, when they recognize the magnitude of uncertainty and complexity inevitably influences firm innovation performance. That is, a global strategy is for firms and managers to strategize their cross-border innovation activities.

6.3 Limitation and Suggestion

Regardless of the theoretical contributions and managerial implications, it is crucial to acknowledge that this dissertation has some limitations. I conceptualize the governance modes of cross-border innovation as a dichotomous choice between internalizing (captive offshoring) and outsourcing (offshore outsourcing). I operationalized the governance mode of captive offshoring as a case of a fully own subsidiary or an equity-based investment and the governance mode of offshore outsourcing as a case of an outsourcing contract. Although this dichotomous choice is based on traditional TCE judgement, recent

researchers have proposed that a varied governances are being employed by MNCs that engage in cross-border innovation activities (e.g., Choi & Contractor, 2016; Nieto & Rodríguez, 2011). For instance, Choi and Contractor (2016) propose the spectrum of governance from markets to low-integration non-equity modes, to moderately integrated non-equity modes, to highly integrated non-equity modes, to equity joint ventures, and to hierarchies. As such, future research could explore why and how firms choose different governance modes of cross-border innovation under uncertainty.

The generalizability and the validity of the empirical test may have been affected by the limitations in the design of research. For one thing, I chose chooses the sampling companies from the ORN as the empirical setting. This empirical choice may limit the generalization of the hypotheses. For another thing, the sampling bias might be from choosing offshore outsourcing as an option because it is likely that firms have different option-based choices such as providers and locations in pursuit of cross-border innovation. Besides, the data used to construct valid measures may be limited. Potential measurement errors may also have affected the estimated effects of major covariates derived from the survey data. Future studies should explore the same research issue in other contexts to test the research concept, questions, and framework of this dissertation so as to enhance generalizability and validity. Future studies could also include other variables to measure latent concepts and more control variables to improve these limitations and overcome bias. Future researchers may include the variables of informal institutions in this line of study.

In closing, this dissertation represents one of systematic efforts needed to effectively advance our understanding of cross-border innovation under uncertainty, which becomes an increasingly important topic in strategic management and international business.

7. References

Agarwal, R., Ganco, M. & Ziedonis, R.H. 2009. Reputations for toughness in patent enforcement: Implications for knowledge spillovers via inventor mobility. ***Strategic Management Journal***, 30(13): 1349–1374.

Aiken, L. S., & West, S. G. 1991. ***Multiple Regression: Testing and Interpreting Interactions***. Thousand Oaks: Sage.

Albertoni, F., Elia, S., Massini, S. & Piscitello, L. 2017. The reshoring of business services: Reaction to failure or persistent strategy? ***Journal of World Business***, 52(3): 417–430.

Alcácer, J. & Zhao, M. 2012. Local R&D strategies and multi-location firms: The role of internal linkages. ***Management Science***, 58(4): 734–753.

Alcácer, J., Cantwell, J. & Piscitello, L. 2016. Internationalization in the information age: A new era for places, firms, and international business networks. ***Journal of International Business Studies***, 47(5): 499–512.

Almeida, P. & Phene, A. 2004. Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation. ***Strategic Management Journal***, 8(8–9): 847–864.

Almeida, P., & Phene, A. 2012. Managing knowledge within and outside the multinational corporation. In Andersson, M., Johansson, B., Karlsson, C. and Loof, H. (eds), ***Innovation and Growth: From R&D strategies of innovating firms to economy-wide technological change***. Oxford: Oxford University Press.

Amabile, T.M. & Conti, R. 1999. Changes in the work environment for creativity during downsizing. ***Academy of Management Journal***, 42(6): 630–640.

Andersson, U. & Pedersen, T. 2010. Organizational design mechanisms for the R&D function in a world of offshoring. ***Scandinavian Journal of Management***, 26(4): 431–438.

Angeli, F., & Grimaldi, R. 2010. Leveraging offshoring: The identification of new business opportunities in international settings. ***Industry and Innovation***, 17(4): 393–413.

Argote, L. 1982. Input uncertainty and organizational coordination in hospital emergency units. ***Administrative Science Quarterly***, 27(3): 420–434.

Arikan, A.M., & McGahan, A.M. 2010. The development of capabilities in new firms. ***Strategic Management Journal***, 31(1): 1–18.

Asmussen, C. G., Larsen, M. M., & Pedersen, T. 2016. Organizational adaptation in offshoring: the relative performance of home- and host-based learning strategies. ***Organization Science,*** 27(4): 911–928.

Baldwin, C.Y. & Henkel, J. 2015. Modularity and intellectual property protection. ***Strategic Management Journal***, 36(11): 1637–1655.

Bartlett, C. A., & Ghoshal, S. 1989. ***Managing Across Borders: The Transnational Solution***. Boston: Harvard Business School Press.

Battistelli, A., Odoardi, C., Vandenberghe, C., Di Napoli, G. & Piccione, L. 2019. Information sharing and innovative work behavior: The role of work-based learning, challenging tasks, and organizational commitment. ***Human Resource Development Quarterly***, 1– 21.

Belderbos, R., Lokshin, B., & Sadowski, B. M. 2015. The Returns to Foreign R&D. ***Journal of International Business Studies***, 46(4): 491–504.

Belderbos, R., Tong, T.W., & Wu, S. 2019. Multinational investment and the value of growth options: Alignment of incremental strategy to environmental uncertainty. ***Strategic Management Journal***, 40(1): 127–152.

Berry, H. 2014 Global integration and innovation: Multi-country knowledge generation within MNCs. ***Strategic Management Journal***, 35(6): 869–890.

Berry, H. 2017. Managing valuable knowledge in weak IP protection countries. ***Journal of International Business Studies,*** 48(7): 787–807.

Berry, H., & Kaul, A. 2015. Global sourcing and foreign knowledge seeking. ***Management Science***, 61(5): 1052–1071

Bertrand, O. & Mol, M.J. 2013. The antecedents and innovation effects of domestic and offshore R&D outsourcing: The contingent impact of cognitive distance and absorptive capacity. ***Strategic Management Journal***, 34(6): 751–760.

Bowman, E.H. & Hurry, D. 1993. Strategy through the options lens: An integrated view of resource investments and the incremental-choice process. ***Academy of Management Review***, 18(4): 760–782.

Brouthers, K. D., & Dikova, D. 2010. Acquisitions and real options: The greenfield alternative. ***Journal of Management Studies***, 47(6): 1048–1071.

Brouthers, K.D., Brouthers, L.E., & Werner, S. 2008. Resource based advantages in an international context. ***Journal of Management***, 34(2): 189–217.

Bunyaratavej, K., Doh, J., Hahn, E. D., Lewin, A. Y., & Massini, S. 2011. Conceptual issues in services offshoring research: A multidisciplinary review. ***Group & Organization Management***, 36(1): 70–102.

Cantwell, J., & Kosmopoulou, E. 2002. What determines the internationalisation of corporate technology? In ***Critical Perspectives on Internationalisation***, Havila, V., Forsgren, M. & Håkanson, H. (eds.), Oxford: Pergamon.

Cantwell, J., & Mudambi, R. 2005. MNE competence-creating subsidiary mandates. ***Strategic Management Journal***, 26(12): 1109–1128.

Carlile, P.R. 2004. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. ***Organization Science***, 15(5): 555–568.

Carlsson, B. 2006. Internationalization of innovation systems: A survey of the literature. ***Research Policy***, 35(1): 56–67.

Chang, P.-L. & Tsai, C.-T. 2002. Finding the niche position – Competition strategy of Taiwan's IC design industry. ***Technovation***, 22 (2): 101–111.

Chang, S-J., van Witteloostuijn, A., & Eden, L. 2010. Common method variance in international business research. ***Journal of International Business Studies***, 41(2): 178–184.

Chen, C-J., Huang, Y-F., & Lin, B-W. 2012. How firms innovate through R&D internationalization? ***Research Policy***, 41(9): 1544–1554.

Chi, T., & McGuire, D.J. 1996. Collaborative ventures and value of learning: Integrating the transaction cost and strategic option perspectives on foreign market entry. ***Journal of International Business Studies***, 27(2): 285–308.

Chi, T., & Seth, A. 2009. A dynamic model of the choice of mode for exploiting complementary capabilities. ***Journal of International Business Studies***, 40(3): 365–387.

Chi, T., Li, J., Trigeorgis, L.G., & Tsekrekos, A.E. 2019. Real options theory in international business. ***Journal of International Business Studies***, 50(4), 525–553.

Choi, J. & Contractor, F.J. 2016. Choosing an appropriate alliance governance mode: The role of institutional, cultural and geographical distance in international Research & Development (R&D) collaborations. ***Journal of International Business Studies***, 47(2): 210-232.

Choi, J.J., Ju, M., Kotabe, M., Trigeorgis, L., & Zhang, X.T. 2018. Flexibility as firm value driver: Evidence from offshore outsourcing. ***Global Strategy Journal***, 8(2): 351–376.

Cloodt, M., Hagedoorn, J., & Van Kranenburg, H. 2006. Mergers and acquisitions: Their effect on the innovative performance of companies in high-tech industries. ***Research Policy***, 35(5): 642–654.

Coeurderoy, R. & Murray, G. 2008. Regulatory environments and the location decision: Evidence from the early foreign market entries of new-technology-based firms. ***Journal of International Business Studies***, 39(4): 670–687.

Cohendet, P. & Llerena, P. 2003. Routines and incentives: The role of communities in the firm. ***Industrial and Corporate Change***, 12(2): 771–797.

Contractor, F. J., Kumar, V., Kundu, S. K., & Pedersen T. 2010. Reconceptualizing the firm in a world of outsourcing and offshoring: The organizational and geographical relocation of high-value company functions. ***Journal of Management Studies***, 47(8): 1417–1433.

Contractor, F. J., Kumar, V., Kundu, S.K & Pedersen, T. 2011. Global outsourcing and offshoring – In search of the optimal configuration for a company. In F.J. Contractor,

V. Kumar, S.K. Kundu, & T. Pedersen (Eds), ***Global Outsourcing and Offshoring***, 3–47. Cambridge: Cambridge University Press.

Contractor, F. J., Kundu, S. K., & Hsu, C. 2003. A three stage theory of international expansion: The link between multinationality and performance in the service sector. ***Journal of International Business Studies***, 34(1): 5–18.

Contractor, F. J. 2019. Can a firm find the balance between openness and secrecy? Towards a theory of an optimum level of disclosure. ***Journal of International Business Studies***, 50(2): 261–274.

Cox, J.C., Ross, S.A., & Rubinstein, M. 1979. Option pricing: A simplified approach. ***Journal of Financial Economics***, 7(3): 229–263.

Crowston, K. 1997. A coordination theory approach to organizational process design. ***Organization Science***, 8(2): 157–175.

Cuervo-Cazurra, A. 2007. Sequence of value-added activities in the internationalization of developing country MNEs. ***Journal of International Management***, 13(3): 258–277.

Cummings, J. L. 2004. Work groups, structural diversity, and knowledge sharing in a global organization. ***Management Science***, 50(3): 352–364.

Currie, W.L., Michell, V. & Abanishe, O. 2008. Knowledge process outsourcing in financial services: The vendor perspective. ***European Management Journal***, 26(2), 94-104.

Czarnitzki, D., & Toole, A. A. 2011. Patent protection, market uncertainty, and R&D investment. ***Review of Economics and Statistics***, 93(1): 147–159.

Damanpour, F. 1996. Organizational complexity and innovation: Developing and testing multiple contingency models. ***Management Science***, 42(5): 693–716.

Dankbaar, B. 2007. Global sourcing and innovation: The consequences of losing both organizational and geographical proximity. ***European Planning Studies***, 15(2): 271–288.

Delios, A., Xu, D., & Beamish, P.W. 2008. Within-country product diversification and foreign subsidiary performance. ***Journal of International Business Studies***, 39(4): 706–724.

Demirbag, M. & Glaister, K.W. 2010. Factors determining offshore location choice for R&D projects: A comparative study of developed and emerging regions. ***Journal of Management Studies***, 47(8): 1534–1560.

Di Gregorio, D., Musteen, M., & Thomas, D.E. 2009. Offshore outsourcing as a source of international competitiveness for SMEs. ***Journal of International Business Studies***, 40(6): 969–988.

Doz, Y, L., & Wilson, K., 2012, ***Managing Global Innovation: Frameworks for Integrating Capabilities Around the World. Boston***. MA: Harvard Business School Press.

Dunning, J.H. 1988. ***Explaining International Production***. Unwin Hyman: London and Boston.

Elia, S., Massini, S. & Narula, R. 2019. Disintegration, modularity and entry mode choice: Mirroring technical and organizational architectures in business functions offshoring. ***Journal of Business Research***, 103: 417–431.

Elkjaer, D. & Filmer, S. 2015. ***Trends and Drivers of Workforce Turnover***. New York: Mercer.

Ernst, D. 2005. Complexity and internationalization of innovation: Why is chip design moving to Asia? ***International Journal of Innovation Management***, 9(1): 47–73.

Ernst, D. 2006. Innovation offshoring: Asia's emerging role in global innovation networks. ***East–West Center Special Report***, Number 10. Honolulu: East–West Center.

Feinberg, S. E., & Gupta, A. K. 2004. External knowledge and the assignment of R&D responsibilities to foreign subsidiaries. ***Strategic Management Journal***, 25(8-9): 823–845.

Feinberg, S.E. & Gupta, A.K. 2009. MNC subsidiaries and country risk: Internalization as a safeguard against weak external institutions. ***Academy of Management Journal***, 52(2): 381–399.

Fifarek, B. J., & Veloso, F. M. 2010. Offshoring and the global geography of innovation. ***Journal of Economic Geography***, 10(4): 559–578.

Fisch, J.H. 2008. Investment in new foreign subsidiaries under receding perception of uncertainty. ***Journal of International Business Studies***, 39(3): 370–386.

Fixson, S.K. & Park, J-K. 2008. The power of integrality: Linkages between product architecture, innovation and industry structure. ***Research Policy***, 37(8): 1296–1316.

Folta, T. B., & O'Brien, J. P. 2004. Entry in the presence of dueling options. ***Strategic Management Journal***, 25(2): 121–138.

Furman, J., Kyle, M., Cockburn, I., & Henderson, R. 2005. Public and private spillovers, location & the productivity of pharmaceutical research. ***Annales d'Economie et de Statistique***, 79/80: 165–188.

Gilson, R.J. 1999. The legal infrastructure of high technology industrial districts: Silicon Valley, Route 128, and covenants not to compete. ***New York University Law Review***. 74(3): 575–629.

Ginarte, J. & Park, W. 1997. Determinants of patent rights: A cross national study. ***Research Policy***, 26(3): 283–301.

Gooris, J. & Peeters, C. 2016. Fragmenting global business processes: A protection for proprietary information. ***Journal of International Business Studies***, 47(5): 535–562.

Graf, M. & Mudambi, S.M. 2005. The outsourcing of IT-enabled business processes: A conceptual model of the location decision. ***Journal of International Management***, 11(2): 253–268.

Greene, W. H. 2000. ***Econometric Analysis*.** Upper Saddle River: Prentice-Hall.

Griffith, R., Harrison, R., & Van Reenen, J. 2006. How special is the special relationship? Using the impact of US R&D spillovers on UK firms as a test of technology sourcing. ***American Economic Review***, 96(5): 1859–1875.

Grimpe, C., & Kaiser, U. 2010. Balancing internal and external knowledge acquisition: The gains and pains from R&D outsourcing. ***Journal of Management Studies***, 47(8): 1483–1509.

Hamilton, B. H. & Nickerson, J. A. 2003. Correcting for endogeneity in strategic management research, ***Strategic Organization***, 1: 51–78.

Hätönen, J. 2009. Making the locational choice: A case approach to the development of a theory of offshore outsourcing and internationalization. ***Journal of International Management***, 15(1): 61–76.

Heckman, J. 1979. Sample selection bias as a specification error. ***Economics***, 47(1), 153-161.

Henderson, R., & Cockburn, I. 1996. Scale, scope and spillovers: The determinants of research productivity in drug discovery. ***R&D Journal of Economics***, 27(1): 32–59.

Henisz, W.J., & Delios, A. 2001. Uncertainty, imitation, and plant location: Japanese multinational corporations, 1990–1996. ***Administrative Science Quarterly***, 46(3): 443–475.

Hennart, J. 2007. The theoretical rationale for a multinationality-performance relationship. ***Management International Review***, 47(3): 423–452.

Hill, C. W. L., & Hult, G. T. M. 2017. ***International Business: Competing in the Global Marketplace.*** Eleventh edition. New York, NY: McGraw-Hill Education.

Hoskisson, R.E., Eden, L., Lau, C.M. & Wright, M. 2000. Strategy in emerging economies. ***Academy of Management Journal***, 43(3): 249–267.

Howells, J., Gagliardi, D. & Malik, K. 2008. The growth and management of R&D outsourcing: Evidence from UK pharmaceuticals. ***R&D Management***, 38(2): 205–219.

Hsu, C-W., Lien, Y-C., Chen, H. 2015. R&D internationalization and innovation performance, ***International Business Review***, 24 (2): 187–195.

Hsuan, J. & Mahnke, V. 2011. Outsourcing R&D: A review, model, and research agenda. ***R&D Management***, 41(1): 1–7.

Hurtado-Torres, N.E., Aragón-Correa, J. A., & Ortiz-de-Mandojana, N. (2018). How does R&D internationalization in multinational firms affect their innovative performance? The moderating role of international collaboration in the energy industry. ***International Business Review***, 27 (3): 514–527.

Ipsmiller, E., Brouthers, K. D., & Dikova, D. 2019. 25 Years of real option empirical research in management. ***European Management Review***, 16(1): 55–68.

Ivus, O., Park, W.G. & Saggi, K. 2017. Patent protection and the composition of multinational activity: Evidence from US multinational firms. ***Journal of International Business Studies***, 48(7): 808–836.

Jensen, P. D. Ø. 2009. A learning perspective on the offshoring of advanced services. ***Journal of International Management***, 15(2): 181–193.

Jensen, P. D. Ø., & Pedersen, T. 2011. The economic geography of offshoring: The fit between activities and local context. ***Journal of Management Studies***, 48(2): 352–372.

Jensen, P.D.Ø., Larsen, M. & Pedersen, T. 2013. The organizational design of offshoring: Taking stock and moving forward. ***Journal of International Management***, 19(4): 315–323.

Johanson, J., & Vahlne, J.-E. 1977. The international process of the firm: A model of knowledge development and increasing foreign market commitments. ***Journal of International Business Studies***, 8(1): 23–32.

Kang, M., Mahoney, J. & Tan, D. 2009. Why firms make unilateral investments specific to other firms: The case of OEM suppliers. ***Strategic Management Journal***, 30(2): 117–136.

Kapler, J.K. & Puhala, K.A. 2011. Outsourcing, fragmentation, and integration – The pharmaceutical industry. In F. J. Contractor, V. Kumar, S.K. Kundu, & T. Pedersen (Eds), ***Global Outsourcing and Offshoring***, 137–167. Cambridge: Cambridge University Press.

Kedia, B. L. & Lahiri, S. 2007. International outsourcing of services: A partnership model. ***Journal of International Management***, 13(1): 22–37.

Kedia, B. L., & Mukherjee, D. 2009. Understanding offshoring: A research framework based on disintegration, location and externalization advantages. ***Journal of World Business***, 44(3): 250–261.

Keupp, M.M., Beckenbauer, A. & Gassmann, O. 2009. How managers protect intellectual property rights in China using de facto strategies. ***R&D Management***, 39 (2): 211–224.

Kim, M. 2016. Geographic scope, isolating mechanisms, and value appropriation. ***Strategic Management Journal***, 37(4): 695–713.

King, J. 2004. Today's drug discovery: Unlocking greater potential. ***R&D Directions***, 10(2): 28–36.

Klein, B., Crawford, R.G., & Alchian, A.A. 1978. Vertical integration, appropriable rents, and the competitive contracting process. ***Journal of Law and Economics***, 21 (2): 297–326.

Kogut, B. & Kulatilaka, N. 2001. Capabilities as real options. ***Organization Science***, 12(6): 744–758.

Kogut, B. 1991. Joint ventures and the option to expand and acquire. ***Management Science***, 37(1): 19–33.

Kogut, B., & Zander, U. 1992. Knowledge of the firm: Combinative capabilities and the replication of technology. ***Organization Science,*** 3(3): 383–397.

Kotabe, M., & Mol, M. 2009. Outsourcing and financial profitability: A negative curvilinear relationship. ***Journal of Purchasing and Supply Management***, 15(4): 205–213.

Kotabe, M., Dunlap-Hinkler, D., Parente, R., & Mishra, H. A. 2007. Determinants of cross-national knowledge transfer and its effect on firm innovation. ***Journal of International Business Studies***, 38(2): 259–282.

Kumar, K., van Fenema, P. & von Glinow, M.A. 2009. Offshoring and the global distribution of work: Implications for task interdependence theory and practice. ***Journal of International Business Studies***, 40(4): 642–667.

Lahiri, N. 2010. Geographic distribution of R&D activity: How does it affect innovation quality? ***Academy of Management Journal***, 53(5): 1194–1209.

Lai, E. L.-C., Riezman, R., & Wang, P. 2009. Outsourcing of innovation. ***Economic Theory***, 38(3): 485–515.

Larsen, M. M., Manning, S., & Pedersen, T. 2013. Uncovering the hidden costs of offshoring: The interplay of complexity, organizational design, and experience. ***Strategic Management Journal***, 34(5): 533–552

Leiblein, M.J. 2003. The choice of organizational governance form and performance: Predictions from transaction cost, resource-based, and real options theories. ***Journal of Management***, 29(6): 937–961.

Leiponen, A., & Helfat, C.E. 2011. Location, decentralization, and knowledge sources for innovation. ***Organization Science***, 22(3): 641–658.

Levinthal, D.A. & March, J.G. 1993. The myopia of learning. ***Strategic Management Journal***, 14(Special Issue), 95–112.

Lewin, A. Y., Massini, S., & Peeters, C. 2009. Why are companies offshoring innovation? The emerging global race for talent. ***Journal of International Business Studies***, 40(6): 901–925.

Lewin, A.Y. & Peeters, C. 2006. Offshoring work: business hype or the onset of fundamental transformation?. ***Long Range Plannin***g, 39(3): 221–239.

Li, L., Li, D., & Dalgic, T. (2004). Internationalization process of small and medium-sized enterprises: Toward a hybrid model of experiential learning and planning. ***Management International Review***, 44(1): 93–116.

Li, Y., & Chi, T. 2013. Venture capitalists' decision to withdraw: The role of portfolio configuration from a real options lens. ***Strategic Management Journal***, 34(1): 1351–1366.

Li, Y., James, B.E., Madhavan, R., & Mahoney, J.T. 2007. Real options: Taking stock and looking ahead. ***Advances in Strategic Management***, 24: 31–66.

Lo, Y.-J. & Hung, T.M. 2015. Structure offshoring and returns on offshoring. ***Asia Pacific Journal of Management***, 32(2): 443–479.

Lo, Y.-J. & Hung, T.M. 2020. Offshoring Innovation, Uncertainty, and Strategy. ***Working Paper.***

Lu, J. W., & Beamish, P. W. 2004. International diversification and firm performance: The S-curve hypothesis. ***Academy of Management Journal***, 47(4): 598–609.

Lu, Y., Tsang, E.W.K. & Peng, M.W. 2008. Knowledge management and innovation strategy in the Asia Pacific: Toward an institution-based view. ***Asia Pacific Journal of Management***, 25(3): 361–374.

Lumineau, F., Frechet, M., & Puthod, D. 2011. An organizational learning perspective on contract design. ***Strategic Organization***, 9(1): 8–32.

Luo, Y. 2007. Are joint venture partners more opportunistic in a more volatile environment? ***Strategic Management Journal***, 28(1): 39–60.

MacPherson, A, & Pritchard, D. 2003. The international decentralization of US commercial aircraft production: Implications for US employment and trade. ***Futures***, 35: 221–238.

Mahmood, I. P., & Singh, J. 2003. Technological dynamism in Asia. ***Research Policy***, 32(6): 1031–1054.

Majd, S. & Pindyck, R.S. 1987. Time to build, option value, and investment decisions. ***Journal of Financial Economics***, 18(1): 7–27.

Manning, S., Massini, S., & Lewin, A. Y. 2008. A dynamic perspective on next-generation offshoring: The global sourcing of science and engineering talent. ***Academy of Management Perspectives***, 22(3): 35–54.

March, J.G. 1988. ***Decisions and Organizations***. New York: Blackwell.

Marcolin, L., Miroudot, S. & Squicciarini, M. 2016. Routine jobs, employment and technological innovation in global value chains. ***OECD Science, Technology, and Industry Working Papers***. http://dx.doi.org/10.1787/5jm5dcz2d26j-en

Maritan, C. A., & Lee, G. K. 2017. Resource allocation and strategy. ***Journal of Management***, 43 (8): 2411–2420.

Martínez-Noya, A., & García-Canal, E. 2011. Technological capabilities and the decision to outsource/outsource offshore R&D services. ***International Business Review***, 20(3): 264–277.

Martinez-Noya, A., Garcia-Canal, E. & Guillen, M. F. 2012. International R&D service outsourcing by technology-intensive firms: Whether and where? ***Journal of International Management***, 18(1): 18–37.

Maskell, P., Pedersen, T., Petersen, B., & Dick-Nielsen, J. 2007. Learning paths to offshore outsourcing. ***Industry & Innovation***, 14(3): 239–257.

Massini, S., Perm-Ajchariyawong, N. & Lewin, A.Y. 2010. Role of corporate-wide offshoring strategy on offshoring drivers, risks and performance. ***Industry and Innovation***, 17(4): 337–371.

Mayer, K.J., Somaya, D. & Williamson, I.O. 2012. Firm-specific, industry-specific, and occupational human capital and the sourcing of knowledge work. ***Organization Science***, 23(5): 1311–1329.

McDermott, G., Mudambi, R. & Parente, R. 2013. Strategic modularity and the architecture of multinational firm. ***Global Strategy Journal***, 3(1): 1–7.

McDonald, D.R. & Siegel, D. 1986. The value of waiting to invest. ***Quarterly Journal of Economics***, 101(4): 707–728.

McGrath, R. G., Ferrier, W. J., & Mendelow, A. L. 2004. Real options as engines of choice and heterogeneity. ***Academy of Management Review***, 29: 86–101.

Mihalache, O. R., Jansen, J. J. J. P., Van Den Bosch, F. A. J., & Volberda, H. W. 2012. Offshoring and firm innovation: The moderating role of top management team attributes. ***Strategic Management Journal***, 33(13): 1480–1498.

Miller, K.D. 1993. Industry and country effects on managers' perceptions of environmental uncertainties. ***Journal of International Business Studies***, 24(4): 693-714.

Miller, K.D., & Shapira, Z. 2004. An empirical test of heuristics and biases affecting real option valuation. ***Strategic Management Journal***, 25: 269–284.

Miller, T. & Kim, A.B. 2017. ***Index of Economic Freedom***. The Heritage Foundation: Washington, D.C.

Monaghan, S., Gunnigle, P., & Lavelle, J. 2018. Firm-location dynamics and subnational institutions: Creating a framework for collocation advantages. ***Industry and Innovation***, 25(3): 242–263

Mudambi, R. & Venzin, M. 2010. The strategic nexus of offshoring and outsourcing decisions. ***Journal of Management Studies***, 47(8): 1510–1533.

Mudambi, R., Narula, R. & Santangelo, G.D. 2018. Location, collocation and innovation by multinational enterprises: A research agenda. ***Industry and Innovation***, 25(3): 229–241.

Mukherjee, D., Gaur, A. S., & Datta, A. 2013. Creating value through offshore outsourcing: An integrative framework. ***Journal of International Management***, 19(4): 377–389.

Muth, J. F. 1986. Search theory and the manufacturing progress function. ***Management Science***, 32(8): 938–962.

Myers, S.C. 1977. Determinants of corporate borrowing. ***Journal of Financial Economics***, 5(2): 147–175.

Nandkumar, A. & Srikanth, K. 2016. Right person in the right place: How the host country IPR influences the distribution of inventors in offshore R&D projects of multinational enterprises. ***Strategic Management Journal***, 37(8): 1715–1733.

Narula, R. 2002. R&D collaboration by SMEs: Some analytical issues and evidence. In F.J. Contractor & A. Lorange (Eds.), ***Cooperative Strategies and Alliances*** 543–566. Oxford: Pergamon Press.

Natividad, G. & Rawley, E. 2016. Interdependence and performance: A natural experiment in firm scope. ***Strategy Science***, 1(1):12–31.

Nelson, R. & Winter, S. 1982. ***An Evolutionary Theory of Economic Change***. Cambridge, MA: Harvard University Press.

Nieto, M. J., & Rodrı´guez, A. 2011. Offshoring of R&D: Looking abroad to improve innovation performance. ***Journal of International Business Studies***, 42(3): 345–361.

Nunnally J. C., & Bernstein, I. C. H. 1994. ***Psychometric Theory***. New York: McGraw-Hill.

OECD, 2018. Oslo Manual 2018: The Measurement of Scientific, Technological and Innovation Activities. Paris, French: OECD.

Park, W. 2008. International patent protection: 1960–2005. ***Research Policy***, 37(4): 761–766.

Peng, M.W. & Heath, P.S. 1996. The growth of the firm in planned economies in transition: Institutions, organizations, and strategic choice. ***Academy of Management Review***, 21(2): 492–528.

Penner-Hahn, J., & Shaver, J. M. 2005. Does international research and development increase patent output? An analysis of Japanese pharmaceutical firms. ***Strategic Management Journal***, 26 (2): 121–140.

Pil, F.K. & Cohen, S.K. 2006. Modularity: Implications for imitation, innovation, and sustained competitive advantage. ***Academy of Management Review***, 31(4): 995–1011.

Posen, H.E., Leiblein, M.J., & Chen, J.S. 2018. Toward a behavioral theory of real options: Noisy signals, bias, and learning. ***Strategic Management Journal***, 39(4): 1112–1138.

Proudford, K. L., & Hodge, L. 2016. ***Boeing: The Case for Supplier Diversity***. Ivey Publishing: Ontario.

Quan, X. & Chesbrough, H. 2010. Hierarchical segmentation of R&D Process and intellectual property protection: Evidence from multinational R&D laboratories in China. ***IEEE Transactions in Engineering Management***, 57(1): 9–21.

Reuer, J.J., & Tong, T.W. 2007. How do real options matter? Empirical research on strategic investments and firm performance. ***Advances in Strategic Management***, 24: 145–173.

Rivoli, P. & Salorio, E. 1996. Foreign direct investment and investment under uncertainty. ***Journal of International Business Studies***, 27(2): 335–357.

Rodríguez, A. & Nieto, M.J. 2016. Does R&D offshoring lead to SME growth? Different governance modes and the mediating role of innovation. ***Strategic Management Journal***, 37(8): 1734–1753.

Roza, M., Van den Bosch, F. A. J., & Volberda, H. W. 2011. Offshoring strategy: Motives, functions, locations, and governance modes of small, medium-sized and large firms. ***International Business Review***, 20(3): 314–323.

Rugman, A. M., & Verbeke, A. 2001. Subsidiary-specific advantages in multinational enterprises. ***Strategic Management Journal***, 22 (3): 237-250.

Sanchez, R., & Mahoney, J.T. 1996. Modularity, flexibility, and knowledge management in product and organization design. ***Strategic management journal***, 17(S2), 63–76.

Sartor, M.A. & Beamish P.W. 2014. Offshoring innovation to emerging markets: Organizational control and informal institutional distance. ***Journal of International Business Studies***, 45(9): 1072–1095.

Saxenian, A. 2002. Transnational communities and the evolution of global production networks: The case of Taiwan, China and India. ***Industry and Innovation***, 9(3):183–202.

Schilling, M.A. 2000. Toward a general modular systems theory and its application to interfirm product modularity. ***Academy of Management Review***, 25(2): 312–334.

Schotter, A. & Teagarden, M.B. 2014. Protecting intellectual property in China. ***Sloan Management Review***, Summer: 41–50.

Singh, D. A., & Gaur, A. S. 2013. Governance structure, innovation and internationalization: Evidence from India. ***Journal of International Management***, 19(3): 300–309.

Singh, J. 2005. Collaborative networks as determinants of knowledge diffusion patterns. ***Management Science***, 51(5): 756–770.

Singh, J. 2008. Distributed R&D, cross-regional knowledge integration and quality of innovative output. ***Research Policy***, 37(1): 77–96.

Srikanth, K. & Puranam, P. 2011. Integrating distributed work: Comparing task design, communication, and tacit coordination mechanisms. ***Strategic Management Journal***, 32(8): 849–875.

Stan, M. & Puranam, P. 2017. Organizational adaptation to interdependence shifts: The role of integrator structures. ***Strategic Management Journal,*** 38(5): 1041–1061.

Stan, M. & Vermeulen, F. 2013. Selection at the gate: Difficult cases, spillovers, and organizational learning. ***Organization Science***, 24(3):796–812.

Steinberg, P. J., Procher, V. D., & Urbig, D. 2017. Too much or too little of R&D offshoring: The impact of captive offshoring and contract offshoring on innovation performance. ***Research Policy***, 46(10): 1810–1823.

Sturman, M. C., Walsh, K. & Cheramie, R.A. 2008. The value of human capital specificity versus transferability. ***Journal of Management***, 34(2), 290–316.

Teagarden, M.B., von Glinow, M.A. & Mellahi, K. 2018. Contextualizing international business research: Enhancing rigor and relevance. ***Journal of World Business***, 53(3): 303–306.

Thomke, S. & Kuemmerle, W. 2002. Asset accumulation, interdependence and technological change: Evidence from pharmaceutical drug discovery. ***Strategic Management Journal***, 23(7): 619–635.

Tong, T. W. & Li, S. 2013. The assignment of call option rights between partners in international joint ventures. ***Strategic Management Journal***, 34(10): 1232–1243.

Tong, T. W., Reuer, J. J., & Peng, M. W. 2008. International joint ventures and the value of growth options. ***Academy of Management Journal***, 51(5): 1014–1029.

Trigeorgis, L., & Reuer, J. J. 2017. Real options theory in strategic management. ***Strategic Management Journal***, 38(1): 42–63.

Uhlenbruck, K., Rodriguez, P., Doh, J., & Eden, L. 2006. The impact of corruption on entry strategy: Evidence from telecommunications projects in emerging economies. ***Organization Science***, 17(3): 402–414.

von Hippel, E. 1990. Task partitioning: An innovation process variable. ***Research Policy***, 19(5): 407–418.

Williamson, O.E. 1975. ***Markets and Hierarchies: Analysis and Antitrust Implications***. Free Press: New York.

Williamson, O.E. 1979. Transaction-cost economics: The governance of contractual relations. ***Journal of Law and Economics***, 22: 233–261.

Williamson, O.E. 1985. ***The Economic Institutions of Capitalism***. Free Press: New York.

Yang, Q. & Jiang, C.X. 2007. Location advantages and subsidiaries' R&D activities in emerging economies: Exploring the effect of employee mobility. ***Asia Pacific Journal of Management***, 24(3): 341–358.

Zhang, Y., Li, H., Hitt, M.A., & Cui, G. 2007. R&D intensity and international joint venture performance in an emerging market: Moderating effects of market focus and ownership structure. ***Journal of International Business Studies***, 38(6): 944–960.

Zhao, M. 2006. Conducting R&D in countries with weak intellectual property rights protection. ***Management Science***, 52(8): 1185–1199.

Zirpoli, F. & Becker, M.C. 2011. The limits of design and engineering outsourcing: Performance integration and the unfulfilled promises of modularity. ***R&D Management***, 41(1): 21–43.