REVISITING STRATEGIC MOTIVES, LOCATION CHOICES, AND IMPACTS OF INTERNATIONAL RESEARCH AND DEVELOPMENT

By

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ABSTRACT OF THE DISSERTATION

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Dissertation Advisor: Professor Ajai Gaur

Internationalization of research and development (R&D) by multinational companies is an important topic in the field of international management. Understanding international R&D is a crucial element in understanding globalization, especially in the age of knowledge and information. The purpose of this dissertation is to examine the strategic motives, location choices, and impact of international. In the second chapter, I take stock of the progress in the literature of international R&D by conducting a textual review of existing studies. I find that past studies analyze international R&D primarily from the knowledge-creation and knowledge-exploitation theoretical perspective. I argue that we can advance our understanding of international R&D activities by examining them from other theoretical perspectives. It is also important to analyze different aspects of international R&D, such as regulatory oversight, and the ethical merits of international R&D. For this reason, in this dissertation, I employ and integrate institutional economics, economic theories of offshoring, and behavioral perspective to examine the strategic motives, location choices, and the impacts of international R&D. I develop a theoretical framework and test the arguments in two essays.

In the third chapter, I examine the strategic motive and location choices of international R&D from the perspective of institutions arbitrage. I propose that the R&D

internationalization is also driven by the institutions-arbitraging motives, in which firms seek locations with lax ethical standards to avoid or lower regulatory compliance costs in R&D. The institutions-arbitraging motive encourages firms to seek locations with weak regulatory enforcement to avoid the monitoring of regulatory compliance costs or to avoid potential litigation costs from conducting unethical experiments. I further argue that the likelihood of pharmaceutical firms in selecting locations with lower ethical standards or weaker regulatory enforcement is heterogeneous, depending on the firm's performance relative to the industry average. I find that underperformed firms are more likely to choose locations with low ethical standards or weaker regulatory enforcements than firms with above-average performance.

In the fourth chapter, I examine the domestic impact of international R&D. Based on cost-saving arguments from economic theories as well as the knowledge-augmenting argument from strategic management literature, I propose that the expansion of foreign R&D is associated with the growth of domestic R&D. However, such a positive association is contingent upon the availability of high- and low-discretion slack resources. I argue that because they can provide flexibility for managers to expand innovative activities, high-discretion slack resources strengthen the positive association between foreign R&D and domestic R&D. On the contrary, the accumulation of low-discretion slack resources constraints the selection of R&D projects.

To test my hypotheses, I take advantage of information from clinical trial projects of American-based pharmaceutical firms. My data cover 18 year period from 2000 to 2017. The empirical analyses largely support my arguments.

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First and foremost, I would like to thank my parents for their love and support throughout my life. Thank you both for giving me the strength to reach for the stars and chase my dreams. Thank you for being my first teachers, biggest supporters, and source of inspiration. To them, this dissertation belongs. I also dedicate this dissertation to my wife, Gina, whose words of encouragement and sacrifice has pushed me forward. Her support and companionship throughout my Ph.D. have made this journey easier than it was supposed to be.

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CHAPTER ONE

INTRODUCTION

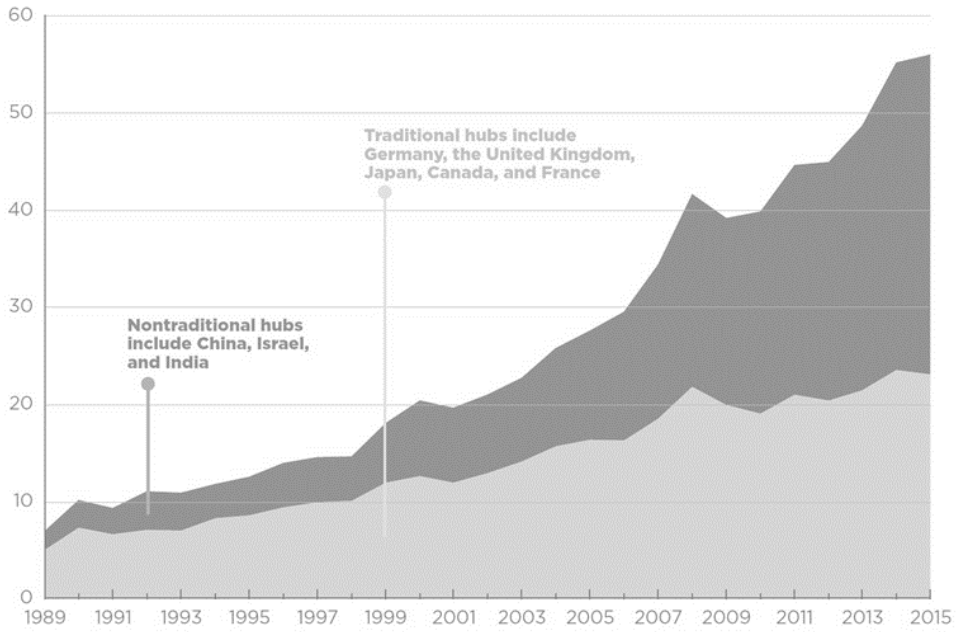
I. BACKGROUND, MOTIVATION, AND OBJECTIVES

Research and development (R&D) activities are an essential component of firms' value creation activities. Past studies have shown that R&D investment can help a firm absorbs external knowledge (Cohen and Levinthal, 1989), develops and renews its technological capability (Helfat, 1997). In short, R&D investment can help a firm gains a competitive advantage in the long run. Before 1980, R&D activities were concentrated mostly in the home country. To the extent that R&D activities took place in foreign countries, the purpose was mostly for local adaptation. For example, European automakers in Mexico performed R&D to re-design the car for tougher roads (Kono & Lynn, 2007). In the background of market liberalization and globalization waves in early 1980, the geographic distribution of R&D activities started to change. In the early days, large multinational companies began to internationalize their R&D functions to "triad" countries. Ford, for example, decided to develop a "global" car by putting together a team of researchers from trans-Atlantic. Procter and Gamble, another American multinational, opened R&D facilities in Japan, Germany, and Belgium in its effort to develop a new product (Kono & Lynn, 2007).

Since 2000, along with the advancement of communication and information technology and the rising of middle-income economies, multinational companies' R&D activities have become even more global. High-tech multinational companies, like IBM, Intel, Siemens, GE, Cisco Systems, Alcatel, have started to locate their R&D labs to emerging economies such as China and India (Kono & Lynn, 2007). Branstetter, Glennon, and Jensen (2019) documented that the overseas R&D expenditure for American multinational companies has increased fourfold within the last two decades.

The location of R&D facilities in the pharmaceutical industry can best illustrate the changing trend of R&D activities' geographical spread. In 2019, the Food and Drug Administration reported that 48% of clinical trials [1] by American pharmaceutical firms were undertaken exclusively outside of the United States. In 2000, the proportion of foreign clinical trials was only 22%. Furthermore, Branstetter *et al.* (2019) documented that the dollar amount of multinational companies' international R&D expenditure undertaken in developing countries has been growing faster than the international R&D expenditure undertaken elsewhere. Figure 1.1 below shows the dollar amount of American multinationals' foreign R&D expenditure. It shows that foreign R&D expenditure in non-traditional locations (mostly developing countries) has increased significantly in the last three decades. These data again confirm the shift in the multinational companies' R&D location preferences.

Figure 1.1. R&D expenditure (in Billion USD) by American multinationals



[1] The stage of product (drug) development process

Source: Branstetter, Glennon, and Jensen (2019)

The upward trend of international R&D, and the dynamics of location preference, has attracted the attention of management scholars. Since early 1990, there have been continuing interests in studying the internationalization of research and development (R&D). There have been at least 77 articles in this topic published in major journals in international business and management. Some authors have studied the location choices of international R&D (e.g., Kuemmerle, 1999a, and 1999b; Niosi & Godin, 1999; Von Zedtwitz & Gassmann, 2002; Veliyath & Sambharya, 2011), the strategic drivers of international R&D (e.g., Cantwell & Mudambi, 2005; Shimizutani & Todo, 2008), the management of international R&D (e.g., Nobel & Birkinshaw, 1998; Phene & Almeida, 2008; Sartor & Beamish, 2014), and the impact of international R&D on firm performance (e.g., Belderbos, Lokshin, & Sadowski, 2015). Taken as a whole, these studies have tried to understand the antecedents, the organization, and the consequences of international R&D.

However, past studies remain unable to fully comprehend the strategic objective, location choices, and the implications of international R&D by multinational companies. For example, the existing theoretical frameworks have established two strategic motives of international R&D, knowledge- and market-seeking motives (Cantwell & Mudambi; 2005; Kuemmerle, 1998a and 1998b; Shimizutani & Todo, 2008). While knowledge-seeking international R&D activities choose a foreign location with immense knowledge endowment, the market-seeking international R&D chooses location with the potential sizable market size. However, not all foreign R&D activities are located in foreign countries that satisfy the knowledge endowment and market potential criteria. In the

pharmaceutical industry, medical experts and scientists have suspected that pharmaceutical firms offshore their R&D activities to developing or least developed countries, not for their local knowledge and market potentials, but for their low level of ethical and regulatory requirements.[2] This accusation hints at the potential institutions-escaping motives as a driver of R&D internationalization. Such an assertion of institutions-escaping motive warrants theoretical and empirical examinations.

Another subject of the unresolved question is on the impact of R&D internationalization on the domestic innovative activities. Branstetter *et al.* (2019) have documented the growing public concern in the United States that international R&D weakens domestic innovative activities. Many pundits and observers share their concern that the offshoring of R&D activities by multinational companies substitute for domestic R&D, and therefore is responsible for the decline of domestic R&D in the United States. The opponents of such a view suggest that international R&D activities have a complementary effect on domestic R&D. Thus domestic and international R&D has a positive association. This concern requires an examination of the nature of the relationship between domestic and international R&D.

Those unresolved discussions of international R&D are the primary motivation of this dissertation. Specifically, this dissertation intends to answer the following questions:

[2] A class-action lawsuit against Pfizer's for allegedly conducting unethical experiments in Nigeria in 1996 provides an illustration that host country knowledge infrastructure and market potentials are not always the main factors that attract multinational R&D activities (Shah, 2003).

1. *How accounting for institutional factors, such as ethical norm and regulatory enforcement, helps us advance our understanding of the strategic motives and location choices of R&D?*
2. *How the expansion of international R&D affects domestic R&D activities? What are the boundary conditions of the relationship between international and domestic R&D?*

I carry out two empirical studies to address the above questions. Also, I perform a review of the literature to understand the current state of studies on international R&D.

II. OVERVIEW OF RESEARCH FRAMEWORK

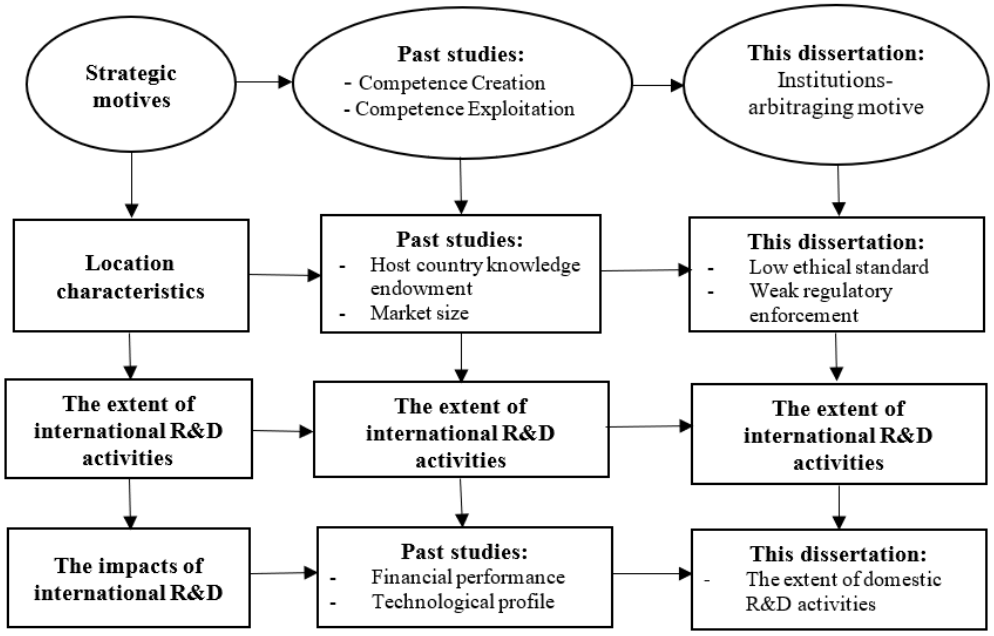
This dissertation aims to build theory and provide evidence on the strategic motives, location choices, and the implication of international R&D. I submit that strategic motives behind R&D internationalization dictate the location choices, and the extent of R&D undertaken in foreign locations. The extent of international R&D activities will then have implications on various aspects of firms' performance and strategy. In this dissertation, I submit institutions-arbitraging as another plausible motive that drives the internationalization of R&D. Such a motive drives firms to locate their R&D in locations with low ethical standards and weak regulatory enforcement. Concerning the implication, the focus of this dissertation is on the relationship between foreign R&D activities affects domestic R&D activities. I examine whether foreign R&D activities complement or substitute domestic R&D. Figure 1.2 presents the overall framework of this dissertation.

Essay 1: The institutions-arbitraging research and development

Why multinational companies internationalize their R&D activities and where they locate their R&D units is a fundamental question in the international business field. The existing

framework of competence-creating and competence-exploiting maintains that multinational companies internationalize their R&D to gain access to (i) local knowledge in foreign locations (Cantwell & Mudambi, 2005; Kuemmerle, 1998a) and (ii) foreign market (Shimizutani & Todo, 2008). These two strategic motives are associated with the locational characteristics that attract foreign R&D units. While knowledge-seeking foreign R&D units are attracted to locations with high knowledge endowment or infrastructure, the market-seeking or knowledge-exploiting R&D are attracted to locations with sizable market size so that multinational company can capitalize on their existing knowledge. This framework views international R&D primarily as a means of cross-border knowledge transfer.

Figure 1.2. Research framework and contribution of this dissertation



However, knowledge creation and exploitation are not the only motives for international R&D. In the medical and pharmaceutical industry, there have been accusations that multinational pharmaceutical firms offshore their clinical trials to

developing countries, not for the access to knowledge infrastructure, but to avoid strict ethical regulations at home. For example, GlaxoSmithKline, Boehringer-Ingelheim, and Gilead offshored their clinical trials to Uganda, Zimbabwe, and Cote-d'Ivoire between 2003 and 2006, despite these countries lack medical workforces and infrastructure and are relatively small in the number of consumers (Weyzig & Schipper, 2008). Later investigation found numerous violations of ethical standards in the clinical trials conducted by multinational companies in these countries. The result of the investigation echoes what has long been suspected by medical experts that multinational pharmaceutical companies use international R&D as a means to avoid regulatory oversights in the home country. These examples hint at the possibility of institutions-escaping or institutions-arbitraging motives behind the internationalization of R&D. I assert that to advance our understanding of motivation and location choices of international R&D, we should account for the institutional factors, such as ethical standards, that govern the conduct of R&D.

In this study, I propose an institutions-arbitraging hypothesis as a plausible driver to explain the strategic motives and the location choices of international R&D. Concerning the strategic drivers, the institutions-arbitraging hypothesis suggests that firms internationalize their R&D to avoid or reduce regulatory-associated costs at home by taking advantage of more lenient R&D regulations in foreign countries. Concerning location choices, this institutions-arbitraging hypothesis suggests that firms may select locations with lower ethical standards or locations with lower quality of government effectiveness in enforcing regulations. Building on the institutions-arbitraging hypothesis,

I empirically examine the impact of ethical norms and regulatory enforcements in host countries on the extent of international R&D projects.

Essay 2: The domestic impact of international R&D

There is growing concern that international R&D weakens domestic R&D activity. In the second empirical study, I address such a question. To better understand the nature of the relationship between domestic and international R&D, I divide international R&D into two types: (i) the cost-reducing, and (ii) the knowledge-augmenting foreign R&D units. These two types of foreign R&D are different in terms of their purpose and location choices. Moreover, the domestic impact of these two types of R&D units should be analyzed from two different theoretical frameworks. The cost-reducing foreign R&D should be evaluated from the lens of economic theory on cost-economizing, while the knowledge-augmenting foreign R&D units should be analyzed from knowledge-based perspectives. These two theoretical perspectives, however, argue for the complementary effect of international R&D. Thus, I submit that international R&D has a complementary effect, not substitution effect, to the domestic R&D. Furthermore, I submit that the relationship between international R&D and domestic R&D is contingent upon the firm's slack resources. I discuss the two different types of slack resources, high-discretion versus low-discretion slack resources, and how they have a different impact on the relationship between international and domestic R&D.

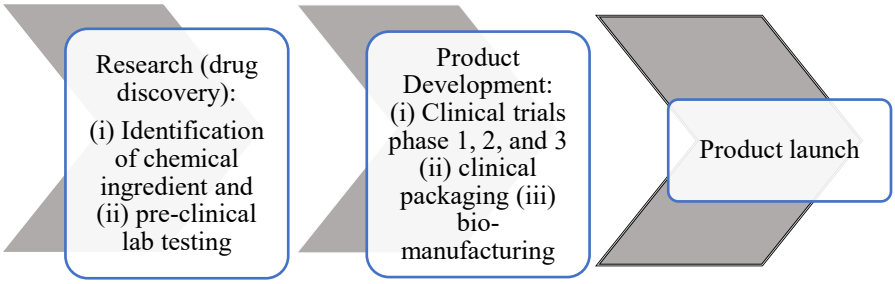
III. EMPIRICAL CONTEXT

The research setting of this dissertation is the pharmaceutical industry, which is one of the most R&D intensive industries. Also, the pharmaceutical industry is one of the most internationalized industries, with firms selling products and perform research and

development across the world. R&D offshoring in the pharmaceutical industry covers a large part of their core activities, such as identification of ingredients and a chemical compound, preclinical testing, clinical trials, clinical packaging, regulatory affairs, and bio-manufacturing (Findlay, 2007). These broad activities can be divided into two categories. The first category is research activity or drug discovery, which consists of the identification of ingredients and pre-clinical testing. Second, the product or drug development consists of clinical trials and clinical packaging, regulatory affairs, and bio-manufacturing. This separation of research and activities makes the pharmaceutical industry the perfect setting for testing my argument.

As this study focus on the internationalization of new product development, thus the main observation is the internationalization or offshoring of clinical trials. The clinical trials (or drug development) primarily involves the testing of chemical compounds discovered in the research stage, on human subjects. These stages are an essential part of drug development and account for approximately 42% of the total R&D expenditure. The clinical trials are costly and can take a long time (Cockburn, 2006). The clinical trials were traditionally done in-house within the home country, but the pharmaceutical firms are increasingly offshoring drug development to CROs, foreign affiliates, and universities or research institutes (Azoulay, 2004). Figure 1.3 below illustrates the flow of research and development activities in typical pharmaceutical firms.

Figure 1.3. Research and development process in the pharmaceutical industry



IV. CONTRIBUTIONS

Theoretical contributions

This dissertation contributes to the development of theories in international R&D in several ways. First, this dissertation advances our understanding of the strategic motives and location choices of international R&D. Using the institutional arbitrage perspective, I suggest that there exists a hidden motive of international R&D, in which some pharmaceutical firms use it as a strategy to avoid home country regulatory oversights, which in turn reduce the costs associated with conducting R&D. The institutions-arbitraging motive influence firms to select locations with lax ethical norms and weak regulatory enforcement. The findings of this study echo the pollution-haven hypothesis, which argues that firms are looking for lax environmental regulations to gain their competitiveness in the market.

Second, this dissertation contributes to a better understanding of the impact of R&D internationalization on domestic R&D activities. This study shows the positive relationship between the expansion of international R&D and the expansion of domestic R&D. This evidence runs counter to a simple, yet widespread, intuition that the multinational companies growing R&D investments in foreign locations substitute for the domestic R&D activities. This evidence also resolves the public debate on the nature of

the relationship between international and domestic R&D. Nevertheless, there exist boundary conditions under which the complementary effect of foreign R&D can change. This study finds that high-discretion slack resources encourage knowledge-augmentation through foreign R&D, whereas the accumulation of low-discretion slacks promotes substituting foreign R&D. These boundary conditions suggest that although we could expect that aggregate domestic R&D activities to increase following an expansion of international R&D, this suggested relationship may not always be appropriate when evaluating individual firms.

Beyond the area of R&D internationalization, this dissertation also contributes to institutions-based view theory. For the institutions-based perspective, this dissertation contributes to examining a condition under which firms are more inclined to engage in institutions-arbitraging strategy. This study suggests that underperformed firms have more pressure to engage in an institutions-arbitraging strategy that can help them reduce costs, albeit unethically. The findings in this study shed light on the firm-level heterogeneity in utilizing the institutions-avoidance strategy.

Managerial implications

This study has important implications for managerial practice. Findings from the second essay show the positive benefit of international R&D on the creation of knowledge activities at home. However, despite its positive benefit, international R&D can bring reputational risks to the firms when it is used to escape ethical oversights. Managers need to realize that engaging in institutions-arbitraging R&D activities, although it can reduce the costs of regulatory compliance and speed up the product development process, can also have a detrimental effect to the firm's reputation. The costs to repair the firm's

reputation may be higher than the cost saved by such a strategy. The result of this study also shows the importance of monitoring international R&D activities. Many multinational companies outsource their product development process to foreign contractors (or known as a contract research organization in the case of the pharmaceutical industry) to lower the total costs of R&D. Managers need to realize that those foreign contractors may adhere to different ethical principles, which could differ from the regulations at home. Monitoring ethical practices of foreign contractors and incentivizing them to adhere to the universally accepted ethical standards are essentials to prevent future reputational damages.

V. ORGANIZATION OF DISSERTATION

The remainder of this dissertation is organized as follows. In chapter two, I review studies about international R&D published in major journals in the international business and management field. In this section, I take stock of what we have known from the literature and then suggest some possible avenues for future studies. In chapter three, I discuss the strategic drivers and location choices of international R&D, particularly in the pharmaceutical industry. I propose institutions-arbitraging as another motive of R&D internationalization. In chapter four, I discuss the relationships between international R&D and domestic R&D and how such a relationship is contingent upon the firm's slack resources. In the final chapter, I conclude and propose future research questions. Taken together, the theoretical frameworks and findings of this dissertation provide some explanations to unresolved questions on the antecedents and the domestic consequences of international R&D.

CHAPTER TWO

THE INTERNATIONAL RESEARCH AND DEVELOPMENT: A REVIEW OF LITERATURE

I. INTRODUCTION

Since early 1990 the number of multinational companies' research and development (R&D) activities conducted overseas have increased significantly. Branstetter, Glennon, and Jensen (2019) show that between 1997 and 2015, the overseas R&D expenditure for American firms has increased fourfold, and the geographic distribution of overseas R&D has also expanded significantly from only a few developed countries to other parts of the world. Kono and Lynn (2007) have shown that the nature of international R&D also changes in the last two decades. In the past, foreign R&D units were directed towards product adaptation activities in the local market. In the automotive industry, for example, foreign R&D activities in the 1970s were directed towards the redesign of cars in dealing with different quality of road infrastructure. In consumer electronics, foreign R&D was directed towards adjusting the product to the power infrastructure in the country (Kono & Lynn, 2007). In the late 1980s and early 1990s, multinational companies started to direct foreign R&D towards the knowledge creation activities as they began to realize the potential human capital and knowledge resources available in different countries. For example, General Motors located some of its R&D activities to South Korea to take advantage of South Korea's strengths in new materials technology. Many telecommunication companies like IBM, Siemens, Alcatel also located their R&D labs in China and India to take advantage of their large pool of engineers and scientists.

In academic publications, international business and innovation management scholars have followed the increasing trend and evolving nature of international R&D by analyzing its various dimensions through different theoretical perspectives. In the analysis of literature, I find that studies of international R&D started in early 1990, which

overlaps the early period of R&D internationalization by multinational companies (Kono & Lynn, 2007). This parallel shows that scholars have been relatively quick in catching up with the trend of international R&D. To continue advancing in the topic of international R&D, we need to identify the current accomplishments as well as the opportunity for future research. In this section, I take stock of our understanding of international R&D by reviewing studies on international R&D published in top international business and management journals. From reviewing abstracts in international business and management journals, I find that past studies have revealed much progress in our understanding of four aspects of international R&D: the strategic factors that motivate and drive the internationalization of R&D, the location choices of foreign R&D, the management, and the implications of international R&D. In general, the literature on international R&D focuses on the knowledge-creation and knowledge-exploitation motives of R&D and how these two motives influence the location choices, the management, and organization, and the impact of international R&D. Nevertheless, given its changing nature, we still need to know more about the evolution of antecedents, organizations, and the implications of international R&D to firms and broader society. I argue that future studies need to pay attention to other motives of international R&D, particularly the possibility of escape-based international R&D. I also argue that future studies should investigate the impacts of international R&D to broader society.

The rest of this literature review is organized as follows. In the next section, I first discuss the methodology of this literature review. I then provide a brief overview of the current state of research in international R&D. After this, I discuss the four primary

topics of international R&D literature and how they connect. Lastly, I conclude with several suggestions on future research opportunities.

II. REVIEW METHODOLOGY

The study of international R&D has been among central topics in international business and innovation literature. This development in academic literature reflects the evolution of internationalization R&D by multinational companies. The internationalization of R&D also reflects the latest trend of knowledge-seeking foreign direct investment (Papanastassiou, Pearce, & Zanfei, 2019). To gain a better understanding of the current state of the topic of R&D internationalization, I conducted a comprehensive analysis of past studies. I relied on Web of Science to search articles published between 1980 to 2019 with the keywords 'international research and development', 'foreign research and development', 'offshore research and development', 'offshore innovation', 'subsidiary research and development, and 'subsidiary innovation'. I analyzed articles in the top ten international business journals according to Gaur and Kumar (2018) and Tüselmann, Sinkovics, and Pishchulov (2016): *Asia Pacific Journal of Management (APJM), Critical Perspective of International Business (CPIB), Global Strategy Journal (GSJ), International Business Review (IBR), Journal of International Business Studies (JIBS), Journal of International Management (JIM), Journal of World Business (JWB), Management and Organizational Review (MOR), Management International Review (MIR),* and *Multinational Business Review (MBR).* I also analyzed articles in other nine top management and innovation journals based on *Financial Times* top 50 journals list: *Academy of Management Journal (AMJ), Academy of Management Review (AMR), Administrative Science Quarterly (ASQ), Journal of Management (JM), Journal of*

Management Studies (JMS), Management Science (MS), Organization Science (OS), Research Policy (RP), and *Strategic Management Journal (SMJ).*

The search in these 19 journals over the 39-period revealed 452 articles. I then systematically review the abstract of all 454 articles to identify whether an article discusses the internationalization of R&D by multinational companies or R&D activities by multinational company's subsidiaries. I exclude the discussion of international R&D cooperation among universities and individual-level international R&D cooperation (e.g., international R&D cooperation among scientists). Of 452 articles, I identify 75 articles on the topics of internationalization of R&D by multinational companies or on the foreign subsidiaries' R&D activities. I then read the 75 articles in detail and made a classification of the articles on four categories: type of study (qualitative vs. quantitative), dependent and independent variables used in the study, and their main findings. Qualitative studies include articles based on case studies or in-depth interviews. Qualitative studies also include theoretical papers without mathematical models or exploratory studies. Quantitative studies include articles that employ empirical methods using numerical data or studies that used mathematical modeling.

Limitations

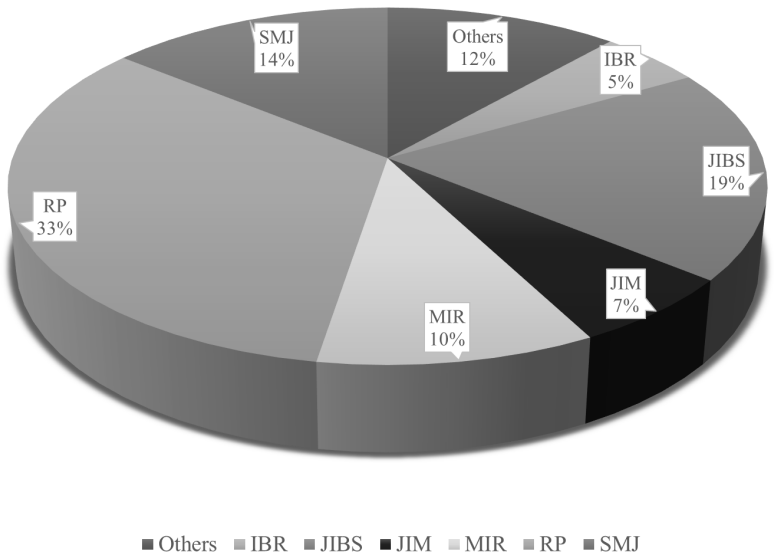
The review process is not without limitations. First, this review methodology focuses only on studies published in 19 academic journals. This methodology excludes many studies of international R&D published outside the chosen journals. This methodology also excludes influential books on international R&D. Second, the search process relies on keywords (e.g., international research and development, foreign research and development, subsidiary research and development). Authors of international R&D

studies in the chosen journals may use different keywords. As a result, some studies on international R&D may not appear in the search results.

III. A BRIEF ASSESSMENT OF INTERNATIONAL R&D

There is an unequal distribution of the articles by journals. Research Policy is the primary outlet for the topics with 26 articles, followed by JIBS with 15 articles and SMJ with 11 articles. For the remaining journals, the distribution in descending order is following: MIR (8), JIM (5), IBR (4), MBR (2), APJM (1), GSJ (1), JMS (1), JWB (1), and MS (2). A noteworthy observation is that three leading journals that published articles in international R&D are specialized in different management sub-fields, RP in the field of innovation policy and management, JIBS in international business, and SMJ in the strategic management field. This finding shows that the topic of international R&D has attracted scholars not only from the international business but also from other sub-fields in management. Figure 2.1 summarizes the distribution of articles by outlet.

Figure 2.1. Share of journals publishing articles on international R&D (1993-2019)



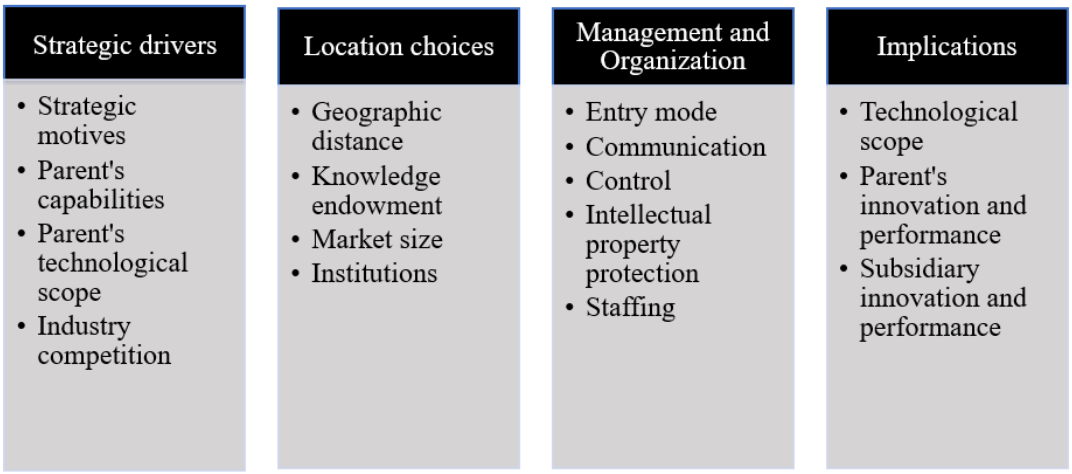
Source: author's analysis based on a literature search

From the abstract analysis, I conclude that the international R&D literature discusses the following areas: the motives and antecedents of R&D internationalization, the impact geographic distance on the location of R&D subsidiaries, the host country characteristics (knowledge endowment, infrastructure, market attractiveness) and how it affects the location choices, the role of host country intellectual property rights protection in attracting international R&D, the entry mode choices of international R&D, the communication problems between parent and R&D subsidiaries, the control and evaluation mechanisms for R&D subsidiaries, as well as the staffing strategy of R&D subsidiaries, the effect of R&D internationalization on firm's performance in the subsidiary and parent level. I grouped those topics into four categories: the strategic drivers, the location choices or locational factors, the management or organization, and the impacts of international R&D. The sub-topic of strategic drivers of international R&D includes articles that discussed the strategic motives of antecedents of R&D internationalization. The group of location choices of international R&D includes articles that discussed the geographic distance, the host country knowledge endowment or infrastructure, the host country market size or attractiveness, and the role of host country intellectual property rights protection in attracting international R&D. The group of management or organization of international R&D consists of articles that discussed the entry mode choices of international R&D, the communication problems between parent and R&D subsidiaries, the control and evaluation mechanisms for R&D subsidiaries, as well as the staffing strategy of R&D subsidiaries. Lastly, the last group of impacts of international R&D includes articles that discussed the effect of R&D internationalization on the technological scope of the parent, parent's innovation, and financial performance,

as well as subsidiaries' innovation and financial performance. Figure 2.2 below summarized the four sub-topics and focus of discussion within each sub-topic.

In terms of distribution, the sub-topic of management and organization of international R&D is the most popular, as it leads with 30 articles. The sub-topics of location choices and strategic drivers of international R&D are in the second and third positions, respectively, each with 18 and 17 articles. The impacts of international R&D are the least popular sub-topic with 12 articles.

Figure 2.2. Classification of sub-topics on studies of international R&D

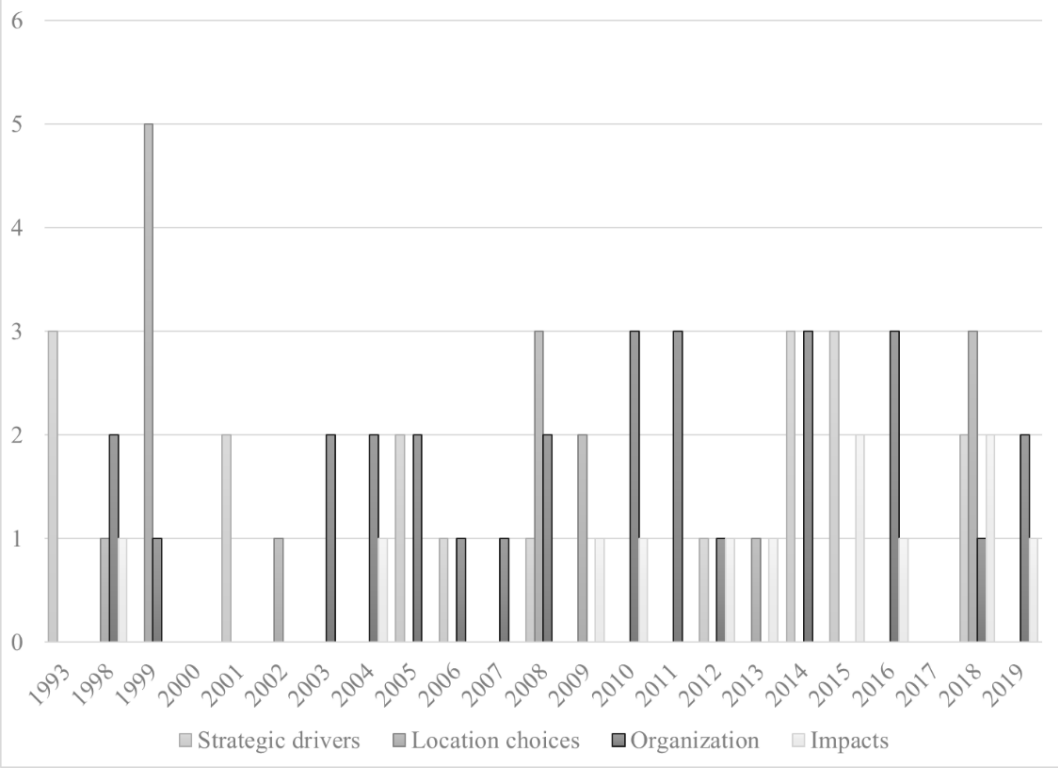


The temporal distribution of articles based on sub-topics shows a relatively even distribution over time. For example, the number of articles discussing the strategic drivers of international R&D is relatively equal over time. The question of location choices of international R&D was the most popular topic in 1999. However, this question still attracts attention from scholars. The sub-topic of management and organization is also distributed relatively equal over time, showing constant interest in this area. Similarly, scholars' interest in the impact of international R&D is relatively constant over time. Figure 2.3 below portrays the distribution of articles by sub-topics over time.

IV. ORGANIZING LITERATURE

I organize the literature on international R&D around the four themes or sub-topics, based on the relationships that the articles analyzed. The first sub-topic on strategic drivers relates to the strategic motives of R&D internationalization and the internal and external factors that increase the likelihood of R&D internationalization by multinational companies. The second sub-topic on location choices relates to locational factors in the host country that attracts R&D investments by foreign firms. The third theme on management and organization of international R&D relates to the discussion on the organizational design, incentives, and structure of foreign R&D subsidiaries. The last theme on the impacts of international R&D relates to how R&D internationalization of the portfolio of foreign R&D affects the organizational performance at various levels (parent vs. subsidiary).

Figure 2.3. Studies of international R&D over time, by sub-topics



Source: author's analysis based on a literature search

Strategic drivers

Early study suggests that the strategic motive of international R&D is market-seeking, and therefore the primary objective of foreign R&D is exploiting the knowledge developed in the home country. Hakanson and Nobel (1993), for example, submitted that foreign R&D is mostly supporting local production, especially in proximate markets. Granstrand, Hakanson, and Sjolander (1993) also argued that foreign R&D units are knowledge-exploiting in nature. Belderbos (2001) found that foreign R&D intensity is positively associated with export intensity, offshored manufacturing intensity, and greenfield experience. Belderbos' (2001) findings support the market-seeking motives of international R&D, as argued by Hakanson and Nobel (1993). Later studies added the knowledge-creation as the second strategic motives of international R&D (Cantwell & Mudambi, 2005; Ambos, 2005). Building on Kuemmerle's findings on the location choice of international R&D (1999a and 1999b), Cantwell and Mudambi (2005) introduce the theoretical framework of competence-creating versus competence-exploiting subsidiaries to distinguish knowledge-seeking and market-seeking R&D units. Based on data from German multinationals, Ambos (2005) found that the knowledge-creation motive is more dominant than the knowledge-exploiting motive. However, Awate, Larsen, and Mudambi (2015) argued that in the context of emerging market multinational companies, investment in foreign R&D is motivated by the need to catch up with technology with industry leaders.

Past studies in this theme also investigate the internal and external factors that encourage (or discourage) investment in foreign R&D. Berry (2006) found that firms with dominant market positions and leading technology are more likely to invest in

foreign R&D. Interestingly, Schubert, Baier, and Rammer (2018) found that firms with low capabilities, not the industry leaders, have a higher likelihood of investing in foreign R&D. Un and Cuervo-Cazurra (2008) found that access to financial capital through the parent encourages investment in subsidiaries' R&D, while access to parent technology and knowledge discourage investment in foreign R&D. With regard to external factors, past studies argue that these two factors encourage investment in foreign R&D: competitive pressures (Berry, 2006), and home country technological capabilities (Granstrand *et al.*, 1993). However, contrary to Granstrand *et al*. (1993), Guellec and De la Potterie (2001) found that home country technological intensity has a negative relationship with the intensity of international R&D. Sambharya and Lee (2014) found that international expansion is a pre-condition to MNCs' international R&D intensity. Extant studies also found that the concern of intellectual property protection is another factor that can discourage the internationalization of R&D (Di Minin & Bianchi, 2011; Perri & Andersson, 2014). Table 2.1 summarizes the extant studies on the strategic drivers of international R&D.

In the discussion of strategic drivers, the literature seems to reach a consensus that internationalization R&D is a pursuit of knowledge in foreign locations. Knowledge exploitation or exploration is undoubtedly a significant motivation behind the internationalization of R&D, but this may not always be the case. Anecdotal evidence in the pharmaceutical industry shows that firms sometimes offshore their R&D projects to a country with low regulatory standards to avoid ethical oversights (Nundy & Gulhati, 2005). Such escape-based R&D internationalization is not discussed in the literature. Therefore, little did we know about other escape motives of R&D internationalization.

Thus, future studies can explore other motives of R&D internationalization beyond knowledge creation and knowledge exploitation.

Furthermore, the extant studies on strategic drivers of international R&D often rely on the rationality assumption. That is, the decision to internationalize and where to locate R&D are based on perfect information, and are made to maximize the benefit, with respect to costs. The literature on international R&D can benefit from studies that incorporate the behavioral aspects of decision making. Challenging the common assumption of rationality in extant studies can help in advancing our understanding of the strategic drivers and location choices of international R&D.

Table 2.1. Publications on the strategic drivers of international R&D

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
1	Hakanson & Nobel (1993)	RP	Qualitative	Motives of international R&D	Not applicable	Four major motives of foreign R&D operation: (1) support to local production (2) market proximity (3) exploitation of foreign R&D (4) political factors
2	Granstrand, Hakanson, & Sjolander (1993)	RP	Qualitative	Not applicable	Not applicable	Increased competition and increased importance of product performance motivate international R&D. Market conditions and production locations remain major locational factors for international R&D. Foreign R&D performance is closely related to home country technological performance
3	Cheng & Bolon (1993)	JIBS	Qualitative	Not applicable	Not applicable	This study calls for more studies to investigate strategic motive and location choices of international R&D
4	Guellec & De la Potterie (2001)	RP	Quantitative	Patent-based indicators of internationalization of R&D	Analysis over time	The increasing trend towards the globalization of R&D by multinational companies in OECD area. The degree of R&D internationalization is higher for small countries and countries with low technological intensity. Geographic distance also encourages R&D cooperation
5	Belderbos (2001)	RP	Quantitative	Overseas R&D by Japanese firms	Firm characteristics	R&D intensity in firm-level, export intensity, overseas manufacturing intensity, and operating experience in greenfield have positive association with overseas R&D intensity
6	Cantwell & Mudambi (2005)	SMJ	Quantitative	Level of subsidiary R&D	MNE-group level characteristics, subsidiary characteristics, and host country characteristics	R&D investment in competence-creating subsidiaries are supply-driven, while R&D investment in competence-exploiting subsidiaries are demand-driven. The R&D of mandated subsidiaries rises with acquisition, but for non-mandated subsidiaries, R&D fall after acquisition. MNEs that grow through acquisitions have more R&D diversity
7	Ambos (2005)	RP	Quantitative	R&D investment in subsidiary	The motivation for R&D investment	German MNCs increasingly invest in resource/knowledge-seeking R&D
8	Berry (2006)	SMJ	Quantitative	R&D investment in subsidiary	Firm's market and technological	Firms with dominant market position and leading technology tend to invest more in R&D in the subsidiaries

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
					position in the industry	
9	Un & Cuervo-Cazurra (2008)	RP	Quantitative	R&D investment	Foreign subsidiary vs. local firms	Better access to and transfer of knowledge and technologies from the MNE and other subsidiaries encourage the subsidiary of a foreign MNE to invest less in R&D relative to a domestic firm. On the other hand, better access to sources of capital through the MNE and other subsidiaries may induce the subsidiary to invest more in R&D. Subsidiaries of foreign MNEs invest less in external R&D than domestic firms.
10	Di Minin & Bianchi (2011)	JIBS	Quantitative and Qualitative	Patent applications of four industry leaders	Locations of R&D	The most critical R&D projects remain homebound—reasons for R&D stickiness: organizational inertia and headquarters centralization of intellectual property.
11	Herstad, Aslesen, & Ebersberger (2014)	RP	Quantitative	Innovation collaboration	Industrial knowledge bases and technological regimes	Behavioral differentiation, derived from knowledge bases and technological regimes, condition the degree of involvement in international R&D collaboration
12	Perri & Andersson (2014)	IBR	Quantitative	Knowledge outflows to local firms, as measured by patent citations by local firms	The external focus in knowledge sourcing	Subsidiaries that extensively draw on external knowledge sources are also more likely to generate knowledge outflows to local firms. However, when the value of the subsidiary's knowledge stock is very high, the knowledge protection restrains reciprocity mechanisms in knowledge exchanges.
13	Sambharya & Lee (2014)	MIR	Quantitative	R&D intensity, patent	International diversification of MNC	The degree of MNCs' international diversification is positively associated with future R&D intensity and patent.
14	Morescalchi, Pammoli, Penner, Petersen, Riccaboni (2015)	RP	Quantitative	Co-inventorship, patent citations, inventor mobility, location of R&D labs	Geographic distance, and constraints imposed by country border	The impact of distance and political constraints on the dependent variables decreased until the mid-90s and increased again

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
15	Awate, Larsen, & Mudambi (2015)	JIBS	Qualitative	Not applicable	Not applicable	While the R&D internationalization of advanced market MNCs can be explained by competence exploitation and competence creation, the R&D internationalization of emerging market MNCs rooted in firms' overall strategy to get on par with industry leaders.
16	Kwon & Park (2018)	RP	Quantitative	R&D investment	Ownership (local vs. foreign), the origin of foreign ownership	Foreign ownership influences R&D investment if the parent is from a G7 country. Foreign subsidiaries whose business is related to that of their parents have higher R&D intensity
17	Schubert, Baier, & Rammer (2018)	JIBS	Quantitative	R&D internationalization decision	Firm capabilities	Firms with low capabilities will internationalize R&D when faced technological uncertainty, while firms with high capabilities concentrate R&D at home base

Location choices

Location choices of international R&D have attracted attention from management scholars. Zander (1998) started to document the increasing dispersion of international R&D. Early studies, however, found that these foreign R&D activities remain concentrated in only five regions known as "triad" (Meyer-Krahmer & Reger, 1999; von Zedtwitz & Gassmann, 2002). Over time, studies found two major locational factors that attract foreign R&D. The first, and often viewed as the traditional factor, is the host country market size (Kuemmerle, 1999a, and 1999b; Niosi & Godin, 1999). The second locational factor is the host country knowledge infrastructure or knowledge stocks (Chung & Yeaple, 2008; Hegde & Hicks, 2008; Kuemmerle, 1999a, and 1999b; Shimizutani & Todo, 2008). Scholars also document that the two major locational factors (market size vs. knowledge stocks) attract a different type of international R&D. Shimizutani and Todo (2008) found that knowledge stocks or knowledge infrastructure attracts the basic research activity (or the R of R&D), the host country market size attracts the product development activities (or the D of R&D). This finding by Shimizutani and Todo (2008) largely echoes the framework of competence-creating vs. competence-exploiting R&D subsidiaries by Cantwell and Mudambi (2005). Hedge and Hicks (2008), on the other hand, found that the host country market size can explain the entry of foreign R&D, but the host country science and engineering capability can explain the intensity of foreign R&D investment.

Other studies argued that knowledge stocks or knowledge infrastructure has become the primary pull factors that attract foreign R&D (Filippaios, Papanastassiou, Pearce, & Rama, 2009; Lewin, Massini, & Peeters, 2009; Veliyath & Sambharya, 2011).

Lewin *et al.* (2009) specifically found that multinational companies are looking for a location with a large pool of science and engineering talents, indicating that the knowledge stocks are associated with human capital. Veliyath and Sambharya (2011) have found that the location choices of international R&D have been broader also to include developing countries. However, the host country innovation capabilities (e.g., technology infrastructure, human capital) remain the most important factor in attracting R&D investments. Given the importance of host country knowledge stocks in attracting R&D, scholars have started to pay attention to institutional factors that shape the knowledge stocks in the host country. Veliyath and Sambharya (2011) have found that host country intellectual property rights protection complements the host country's knowledge infrastructure in attracting R&D investments. Pisani and Ricart (2018) also found that the quality of host country intellectual rights protection is an important consideration for knowledge-seeking foreign R&D. Furthermore, Guimon, Chaminade, Maggi, and Salazar-Elena (2018) argued that innovation policy that encourages linkage between foreign R&D units and local actors is essential to facilitate bi-directional knowledge flows.

With regards to geographic distance, while early studies found that geographic distance is an essential factor (Meyer-Krahmer & Reger, 1999; von Zedtwitz & Gassmann, 2002), a relatively more recent study found that geographic distance is no longer important (Castellani, Jimenez, & Zanfei, 2013). Castellani, Jimenez, and Zanfei (2013) further argued that institutional and cultural distance becomes more important than geographic distance. A similar notion is supported by Joshi and Lahiri (2015), who found an inverted U-shaped relationship between language friction and partner selection

for international R&D. Interestingly, a recent study by Ervits (2018) argued that R&D activities largely remain at the home base, which contradicts the dominant view of the nature of global innovation. Table 2.2 summarizes the extant studies on the location choices of international R&D.

Following the competence-creating vs. competence-exploiting framework, the theme of location choices predominantly views that multinational companies respond primarily to knowledge-related locational factors. The knowledge stocks and infrastructure are undoubtedly significant drivers, but the multinational company also responds to variations in other locational factors when deciding to internationalize their R&D activities. One important locational factor is the institutions or regulations that govern R&D activities, which also vary across locations. The institutional factors are often missed in the discussion as past studies focused almost exclusively on the intellectual property rights institutions. Little did we know about other dimensions of institutional quality and how they affect the decision of R&D internationalization. For example, regulations governing the rights of human participants have a significant effect on the costs of R&D in the pharmaceutical industry. In other industries, regulations on data privacy may also limit the new product development process. These regulations may motivate the internationalization (or re-location) of R&D. Thus, future studies can account for the effect of broader aspects of institutional variations on various decisions of R&D internationalization.

Table 2.2. Publications on the location choices of international R&D

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
1	Zander (1998)	RP	Quantitative	Geographical location, as well as dispersion of R&D	Analysis over time (longitudinal)	There is an increasing dispersion of foreign R&D locations. However, there is a duplication of capabilities within individual technologies
2	Meyer-Krahmer & Reger (1999)	RP	Qualitative	Not applicable	Not applicable	The internationalization of R&D is still characterized by "triadization", involving companies from U.S., European Union, and Japan. The location choice of R&D internationalization has shifted towards locations that offer technology, market size, and integration with value chains. However, the location of international R&D is concentrated in a few areas and center of excellence
3	Zander (1999)	RP	Quantitative	Geographical dispersion of R&D	Not applicable	Cluster analysis suggests significant differences in the geographical dispersion of technological capabilities, implying different approaches to the upgrading of competitive advantage
4	Kuemmerle (1999a)	JIBS	Quantitative	R&D investment in host country	Locational factors	Relative market size and relative strength of the host country's science base determined whether FDI in R&D is carried out in the host country
5	Kuemmerle (1999b)	RP	Quantitative	Location characteristics, motives, and mode of entry of foreign R&D	Analysis over time	The investment in foreign R&D has risen significantly for the last 40 years. The motive has shifted from knowledge exploitation to knowledge creation in host countries. New R&D labs are typically located near universities, while in the past, R&D sites were located near the manufacturing site or to market. Greenfield is the dominant entry mode for international R&D.
6	Niosi & Godin (1999)	RP	Qualitative	Location characteristics and organizational structure of foreign R&D	Not applicable	The main motivation of Canadian firms' internationalization of R&D is market-seeking. The secondary motive is to get access to skilled personnel and foreign technology. Canadian firms also choose a friendly socio-political environment. Canadian firms' international R&D units are autonomous.
7	von Zedtwitz & Gassmann (2002)	RP	Quantitative	Four archetypes of R&D internationalization	Locations of R&D	Research activity is concentrated in only five regions in the world, while development activities are more globally dispersed
8	Chung & Yeaple (2008)	SMJ	Quantitative	Knowledge sourcing in foreign locations by US firms	Patent stocks to measure technical activity	Country-industry with larger knowledge stocks and greater technical similarity to the United States are more attractive as a location for knowledge sourcing

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
9	Hegde & Hicks (2008)	RP	Quantitative	Foreign R&D intensity by US firms	Host country characteristics: market size, science and engineering capability	Market size primarily predicts the entry of US R&D activity, while science and engineering capability largely explains the R&D intensity post-entry
10	Shimizutani & Todo (2008)	RP	Quantitative	Nature, extent, and location choice of Japanese firms' foreign R&D	Foreign advanced knowledge, host country market size	Basic research is associated with the host country's advanced knowledge; development/product design is associated with host country market size
11	Lewin, Massini, & Peeters (2009)	JIBS	Quantitative	Offshored innovation by US multinationals	Availability of highly skilled science and engineering talent in the host country vs. home	Availability of highly skilled science and engineering talent in the host country is associated with a greater likelihood of offshored innovation activities by US multinational companies
12	Filippaios, Papanastassiou, Pearce, & Rama (2009)	RP	Quantitative	R&D internationalization	Scientific heterogeneity in host countries, and demand conditions	Overseas R&D can undertake genuine knowledge creation activity by capitalizing scientific heterogeneity and demand conditions in the host country
13	Veliyath & Sambharya (2011)	MIR	Quantitative	R&D investments by multinational companies	Host country knowledge infrastructure, IPR protection	The location choices of international R&D have been broader also to include developing countries. However, the host country innovation capabilities (e.g., technology infrastructure, human capital) remain the most important factor in attracting R&D investments.
14	Pisani & Ricart (2018)	MIR	Quantitative	Likelihood of knowledge-augmenting R&D	Formal institutions (strength of R&D) and informal institutions (culture)	The strength of intellectual property protection and cultural differences increase the likelihood of knowledge-augmenting R&D.
15	Guimon, Chaminade, Maggi, & Salazar-Elena (2018)	JIM	Qualitative	Not applicable	Not applicable	it is critical to complement national innovation policy with the establishment of linkage between foreign actors and local actors that hold absorptive capacity.
16	Ervits (2018)	MBR	Qualitative	Not applicable	Not applicable	Innovative activities by major MNEs remain at home base, which contradicts the nature of global innovation

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
17	Castellani, Jimenez, Zanfei (2013)	JIBS	Quantitative	R&D investment	Geographic distance, institutional distance, specialized knowledge cluster	Geographic distance has a relatively low impact on international R&D, but institutional distance matters. Specialized technology cluster attracts international R&D
18	Joshi & Lahiri (2015)	JIBS	Quantitative	Cross-border R&D alliance formation	Language friction index	An inverted U-shape relationship between partners' language friction index and the cross-border R&D formation.

Management and organization of international R&D

The theme of management and organization is the most popular topic in international R&D literature. Early studies in this theme focused on the entry modes and the communication pattern between the R&D unit and other units within the network of the multinational company. Penner-Hahn (1998) found a sequence of entry modes for international R&D. However, multinational companies with substantial resources and capabilities can omit some parts of the entry sequence. A more recent study by Li and Xie (2016), found that the use of joint venture is reduced when the scope of R&D subsidiaries is limited to only research-oriented ones.

With regards to communication, Nobel and Birkinshaw (1998) found that local and international adaptors (or competence-exploiting units) focus their communication within the internal corporate network, while international creators (or competence-creating units) have strong communication network internally as well as externally. Asakawa and Lehrer (2003) found that the regional office can act as an efficient mediator in the communication between headquarters and local R&D subsidiaries. While other studies focus on formal communication, Hansen and Lovas (2004) focused on informal communication between headquarters and R&D subsidiaries, as well as among R&D subsidiaries. Hansen and Lovas (2004) found that informal relations can have a stronger effect on knowledge transfers than formal communication. Furthermore, they found that informal communication can overcome the negative effect of geographic distance on the extent of knowledge transfer. Fisch (2003) created a model that can minimize communication costs.

Another topic of interest is the integration of R&D subsidiaries and between R&D subsidiaries and headquarter. Gassmann and von Zedtwitz (1999) found that R&D subsidiaries enjoy decentralized decision making, but there is a trend of increased integration among them, although in a few cases, there is tighter coordination and the re-centralization of decision making. Asakawa and Som (2008) focused on the integration of subsidiaries with their host market and argued that it is vital for the R&D subsidiaries to understand the local conventional wisdom. Other studies pointed out the importance of integration between subsidiaries and the local environment. Phene and Almeida (2008), as well as Berry (2014), found that integration with the local environment further enhances the subsidiary's innovative capabilities. Un and Rodriguez (2018) further argued that integration with local markets, primarily through collaboration with customers and competitors, complements the subsidiary's existing knowledge. Earlier studies argued that the key factors to enhance integration with local markets or with headquarters are strategic mandate (Manolopoulos, Papanastassious, & Pearce, 2005) and the subsidiary's ability to process knowledge (Ambos and Schlegelmilch, 2006).

Despite the importance of integration with local markets, studies also argue for the need of knowledge protection mechanisms in local markets. Zhao (2006), in her seminal paper, argued that firms could protect the outcome of international R&D when the outcome was used only internally. In other words, a strong linkage between R&D subsidiaries and headquarters can prevent knowledge leakage. De Faria and Sofka (2010) found that multinational companies prefer a broad knowledge protection strategy in a host country with fewer knowledge-sharing opportunities. Driffield, Love, and Menghinello (2010) found that the knowledge leakage does not originate from codified

knowledge but the productivity of foreign R&D subsidiaries. Sofka, Shehu, and de Faria (2014) found that both competence-creating and competence-exploiting mandates increase the knowledge protection intensity, but the existence of technological clusters in the host country reduces such intensity.

The literature in the area of management of foreign R&D also discusses the control mechanisms. Ambos and Schlegelmilch (2007) argued that control mechanisms depend on R&D mandates (competence-creating vs. competence-exploiting). Sartor and Beamish (2014) submit that the type of organizational control over foreign R&D units depends on the informal institutional uncertainty. Lastly, Manolopoulos, Soderquist, and Pearce (2011) found that control and coordination mechanisms depend on the characteristics of the subsidiary, such as age, size, and role.

Lastly, the literature on the management of international R&D also discusses the staffing strategy of foreign R&D units. Sapouna, Manolopoulos, and Dimitratos (2016) found that employees in locally integrated R&D subsidiaries and those in internationally independent R&D units are more likely to take an international assignment in other R&D units. On the other hand, employees in the R&D lab support are less likely to take an international assignment. More recently, Nuruzzaman, Gaur, and Sambharya (2019) found that international experience of top managers can enhance knowledge transfer for competence-exploiting R&D units, while industry experience of top managers can enhance the local knowledge creation of competence-creating R&D subsidiaries. Table 2.3 summarizes the extant studies on the management and organization of international R&D.

In the area of management and organizations, the literature of international R&D can benefit from more studies on the organizational culture of R&D units, and how culture differences (both at national- and organizational-level) affect the outcome of international R&D. Specifically, future studies could investigate whether cultural differences at the national level enhance or diminish the mutual learning in international R&D alliance. Existing studies view cultural differences more as a barrier in international R&D, and thus multinational companies tend to avoid a location with a large cultural gap. However, the impact of cultural differences on the outcome of international R&D activities is relatively unknown. On the one hand, one could argue that cultural differences can create barriers in the knowledge transfer process. On the other hand, one could argue that cultural differences expand the knowledge boundary and therefore increases the potential outcome of cross-border knowledge creation activities. Literature in international R&D could also benefit from studies investigating conditions that can minimize the problems associated with cultural differences in cross-border R&D activities.

Table 2.3. Publications on the organization of international R&D

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
1	Nobel and Birkinshaw (1998)	SMJ	Quantitative	Communication and control mechanisms for foreign R&D units	Not applicable	Local and international adaptors focus their communication on their internal corporate network, while international creators have strong internally and externally oriented network of relationships
2	Penner-Hahn (1998)	SMJ	Quantitative	Mode and sequence of entry for international research activities	Firm capabilities	There is a sequence to the mode of entry for foreign R&D. Firm capabilities may cause a firm to omit parts of the sequence of mode.
3	Gassmann & von Zedtwitz (1999)	RP	Quantitative	Dispersion of R&D unit, and the degree of cooperation between individual R&D units	Not applicable	The stronger orientation of R&D activities towards international markets and knowledge centers. There is an increased integration of decentralized units. Tighter coordination and recentralization of R&D activities at fewer know-how centers
4	Fisch (2003)	RP	Quantitative	Problems of international communications among R&D labs in different locations	Pattern	Communication-economic network model can identify the dispersion of R&D activities across spaces that can minimize the communication problems among R&D labs
5	Asakawa & Lehrer (2003)	JWB	Quantitative	Knowledge application at the global level	Knowledge generation at the local level (host country), regional offices	Regional offices act as regional innovations relays that mediates the relationship between local knowledge generation and the knowledge application at the global level
6	Oxley & Sampson (2004)	SMJ	Quantitative	Scope of international R&D activities	Relationship between a firm and its strategic alliance partners	When the partner is firm's competitor in the end product, a smaller scope of international R&D alliance can better protect technology
7	Hansen & Lovas (2004)	SMJ	Quantitative	The different pattern of cross-border technology transfers	Formal organizational structure, informal relations, geographic distance, and	Informal relations have a stronger effect on knowledge transfers than formal structure. There is a negative relationship between geographic distance and the extent of cross-border knowledge transfer, but informal relations can overcome such negative effects.

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
					relatedness of subsidiaries' competencies	
8	Manolopoulos, Papanastassious, & Pearce (2005)	IBR	Quantitative	The network of technology generation	Subsidiary size, strategic types of subsidiaries	Different strategic types of subsidiaries source technology differently. Larger subsidiaries get access to wider sources of technology
9	Ambos & Schlegelmilch (2006)	IBR	Quantitative	Headquarters' ability to benefit from reverse knowledge transfer	Subsidiary capabilities	Subsidiary's contexts and capabilities to process knowledge influence the efficiency of MNC knowledge integrating institutions
10	Zhao (2006)	MS	Quantitative	Self-citation of patents	IPR protection in the host country	Weak IPR protections are associated with more self-citation patents, indicating that firms protect knowledge creation in foreign subsidiaries through internal linkages
11	Ambos & Schlegelmilch (2007)	SMJ	Quantitative	Control mechanisms to manage foreign R&D	R&D mandate and interdependence	R&D mandates and interdependence affect the type of control mechanism in foreign R&D
12	Asakawa & Som (2008)	APJM	Qualitative	Not applicable	Not applicable	Multinational companies should combine conventional wisdom in managing R&D with the unique capabilities they learn in China and India.
13	Phene & Almeida (2008)	JIBS	Quantitative	Subsidiary innovation	Internal and external sources of knowledge, subsidiary capabilities	Knowledge absorbed from the host country is useful to subsidiary innovation. Furthermore, sourcing and combinative capabilities of subsidiary have a positive impact on subsidiary innovation
14	Marin & Bell (2010)	RP	Quantitative	Subsidiary's innovative activities	Integration to the local economy, and relationship with headquarter	The most innovative subsidiaries were those that enjoy integration to both the local economy and their global cooperation

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
15	de Faria & Sofka (2010)	RP	Quantitative	Broad formal knowledge protection strategy in the host country (patenting, secrecy, lead time, complex design)	Host country characteristics	Firms prefer broad knowledge protection strategy in a host country with fewer knowledge-sharing opportunity, but narrow knowledge protection strategy in a host country with greater knowledge sharing opportunity
16	Driffield, Love, Menghinello (2010)	JIBS	Quantitative	Nature of intra-firm technological flows	R&D investment by a foreign subsidiary, and investment in capital	Spillovers from MNE subsidiaries to local firms do not originate from codified knowledge associated with subsidiary R&D, but rather from the productivity of subsidiaries
17	Manolopoulos, Soderquist, & Pearce (2011)	JIM	Quantitative	Coordination pattern in decentralized foreign R&D	foreign R&D lab characteristics	Laboratory related characteristics (roles, age, size) are the main determinants of foreign R&D labs coordination mechanisms and instruments
18	Kappen (2011)	RP	Quantitative	Subsidiary's patenting activity	Competence-creating overlaps as a result of the acquisition in host countries	Competence-creating overlaps in foreign R&D initially have a retrogressive effect on subsidiary technological evolution, but over time become positive.
19	Keupp, Palmie, & Gassmann (2011)	MIR	Quantitative	R&D subsidiary performance	Asset transfer from parent to a subsidiary, R&D subsidiary mandate, operational autonomy	Asset transfer from parent to a subsidiary, R&D subsidiary mandate, and operational autonomy has a positive effect on the performance of R&D subsidiaries
20	Najafi-Tafani, Giroud, & Sinkovics (2012)	MIR	Quantitative	Knowledge transfer from subsidiary to the parent	Subsidiary characteristics	Subsidiary willingness and socialization mechanism enhance subsidiary's reverse knowledge transfer
21	Sartor & Beamish (2014)	JIBS	Quantitative	Organizational control over R&D subsidiary	Three types of informal institutions	MNC organizational control over offshored R&D subsidiary is contingent upon the type of informal institutional uncertainty

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
22	Sofka, Shehu, de Faria (2014)	RP	Quantitative	Knowledge protection in subsidiary	Competence-creating and competence-exploiting subsidiary	Competence-creating and competence-exploiting mandate increase knowledge protection intensity. Technological cluster in the host country reduces the knowledge protection intensity
23	Berry (2014)	SMJ	Quantitative	Worldwide R&D activities and patents of MNC	Manufacturing integration across subsidiaries	Manufacturing integration can enable multicounty collaborative innovations, and that these innovations will bring together diverse knowledge
24	Hakanson & Kappen (2016)	IBR	Quantitative	The volatility of foreign R&D labs	Mergers and acquisition activity	The negative effect of mergers and acquisitions on the survival of R&D in the acquired unit is not immediate, but lagged
25	Sapouna, Manolopoulos, & Dimitratos (2016)	MIR	Quantitative	R&D international assignment	R&D employees' role	Employees in R&D lab support are not likely to take the international assignment, but employees in locally integrated R&D and internationally independent R&D labs are likely to assume the international assignment
26	Li & Xie (2016)	MIR	Quantitative	The choice of equity joint venture in international R&D	Scope of R&D activities and the types of JV partners	Multinational companies can reduce the use of equity joint venture when the scope of R&D is limited to research-oriented ones, and when academic institutions are chosen as local partners. Large cultural distance also moderates such effect
27	Un & Rodriguez (2018)	JIM	Quantitative	Performance	Local vs. foreign ownership, R&D collaboration partners	Subsidiaries benefit more from R&D collaborations with customers and competitors, whose deeper knowledge of local conditions complement subsidiaries' knowledge
28	Lagerstrom, Schweizer, Jakobsson (2019)	MBR	Qualitative	Not applicable	Not applicable	Describe four phases in the evolution of R&D capabilities in subsidiaries
29	Liu (2019)	JIM	Qualitative	Not applicable	Not applicable	The process of R&D recentralization and moves toward a transnational emphasis
30	Nuruzzaman, Gaur, & Sambharya (2018)	GSJ	Quantitative	Foreign subsidiaries' innovation	Top manager characteristics, subsidiary R&D	Managers' industry experience enhances the positive effect of subsidiary R&D on innovations

Implications of international R&D

Past studies have examined the impact of international R&D on various organizational outcomes. First, past studies are interested in how R&D investment in subsidiary-level affects subsidiary performance. Kuemmerle (1998) have found that the size of foreign R&D labs has inverted U-shaped relationships with subsidiary performance. Manolopoulos, Dimitratos, Young, and Liouskas (2009), on the other hand, found a positive linear relationship between foreign R&D investment and the performance of R&D subsidiaries.

Extant studies also investigated the impact of international R&D on the performance of the parent company. Penner-Hahn and Shaver (2005) found the positive impact of foreign R&D on the performance of the firm (parent-level), but this positive relationship occurs only when the company has existing research capabilities. Blomkvist, Kappen, and Zander (2010) found that the internationalization of R&D has accelerated the speed of entry into new technology, although this is not a general development. Mihalache, Jansen, Van den Bosch, and Volberda (2012) found an inverted U-shaped relationship between offshored innovation on the new product introduction, and top management characteristics moderate such a relationship. Belderbos, Lokshin, and Sadowski (2015), as well as Driffield, Love, Yang (2016), found that the international R&D activities complement the positive effect of domestic R&D on the productivity of the firm. Furthermore, Scalera, Perri, and Hannigan (2018) found that the internationalization of R&D has a positive effect on the parent's technological scope. Rosenbusch, Gusenbaur, Hatak, Fink, and Meyer (2019) further confirm the positive

effect of international R&D on innovation performance, but such a relationship is moderated by host country institutional environment and cultural differences.

Past studies also found that international R&D activities influence the organizational structure of the multinational company. Mudambi and Navarra (2004) found that the subsidiary's contribution to R&D or innovative activities is positively associated with the subsidiary's bargaining power vis-à-vis headquarters. Similarly, Foley and Kerr (2013) found that the American multinational companies increase their investment in a host country following an increase of the share of patenting of the ethnicity associated with the host country. Baier, Rammer, and Schubert (2015) found that international R&D has a positive effect on the organizational adaptability of the multinational company. Table 2.4 summarizes the extant studies on the implications of international R&D.

From past studies, we have known how international R&D influences financial performance and the trajectory of the firm's technological development and innovativeness. However, we have a limited understanding of the impact of international R&D on domestic R&D activities. For example, we know little about the nature of the relationship between foreign R&D and domestic R&D. Do foreign R&D activities complement or substitute domestic R&D? This question may have an implication on whether international R&D activities cause job loss or job creation at home. The field can also benefit from the study on the social impact of international R&D. For example, we know little about whether consumers in the host and home country receive a net benefit from the international R&D activities.

Table 2.4. Publications on the impacts of international R&D

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
1	Kuemmerle (1998)	RP	Quantitative	Performance of foreign R&D labs (contribution of R&D sites to sales)	The size of foreign R&D laboratories	There is a concave relationship between foreign R&D laboratory size and performance. But there is a linear relationship between firm learning and laboratory performance
2	Mudambi & Navarra (2004)	JIBS	Quantitative	Foreign subsidiary's bargaining power	Intra-MNC knowledge flows	Subsidiaries with greater contributions to intra-MNC knowledge flows have greater bargaining power
3	Penner-Hahn & Shaver (2005)	SMJ	Quantitative	Patent output	International R&D activities, R&D capabilities	Firms benefit from international R&D activities only when they have existing research capabilities
4	Manolopoulos, Dimitratos, Young, & Liouskas (2009)	MIR	Quantitative	Subsidiary performance	Internal (from a parent) vs. local technology sourcing in the host country	Internal technology sourcing has a positive impact on subsidiary performance. Contrary to expectations, local technology sourcing in the host country harms subsidiary performance
5	Blomkvist, Kappen, & Zander (2010)	JIBS	Quantitative	Subsidiary's patenting activity	Analysis over time	There is evidence of accelerated entry into new technology, but this is not a general development.
6	Mihalache, Jansen, Van den Bosch, Volberda (2012)	SMJ	Quantitative	Introduction of new product	Offshoring of high value-added business function (including R&D)	Offshoring of R&D has an inverted U-shape relationship with the introduction of a new product, moderated by top management team characteristics
7	Foley & Kerr (2013)	MS	Quantitative	Operations of foreign affiliations of US multinationals	Patent applications of US multinationals	Increase in the share of a patent of a particular ethnicity is associated with an increase in the share of firm affiliate in countries related to that ethnicity
8	Baier, Rammer, Schubert (2015)	JIM	Quantitative	Organizational structure adaptability	Innovation (R&D) offshoring	Inverted u-shape effect of innovation offshoring on the effectiveness of organizational adaptability
9	Belderbos, Lokshin, Sadowski (2015)	JIBS	Quantitative	Firms productivity	Foreign R&D investment	Foreign and domestic R&D exhibit complementarity in their effects on productivity, but roles of domestic and foreign R&D depend on the relative position of the home country

No	Authors	Journals	Type	Dependent Variable	Independent Variable	Main Findings
10	Driffield, Love, Yang (2016)	RP	Quantitative	Parent innovative performance	Technological capability of foreign affiliates	Enhanced parent productivity as a result of foreign affiliates performance
11	Scalera, Perri, & Hannigan (2018)	JIBS	Quantitative	Technological scope of firm innovations	Domestic and international knowledge connectedness	Both domestic and international knowledge connectedness positively affect the technological scope of the firms, but the effects are different
12	Rosenbusch, Gusenbaur, Hatak, Fink, & Meyer (2019)	JMS	Quantitative	Innovation performance	International R&D	Differences in the institutional environment and culture moderate a positive association between innovation offshoring and innovation performance, but such a relationship.

V. CONCLUSION AND RESEARCH OPPORTUNITIES

In this article, I take stock on the development of literature on international R&D. The objective of this review is to help in identifying common ground among existing studies. Despite the methodological limitations in identifying the relevant literature, I found that the study of international R&D has progressed vastly in the last 30 years. The existing studies have helped to advance our understanding of strategic drivers, location choices, management and organization, and the implications of international R&D.

In general, the literature has reached some consensus in certain areas. In the theme of strategic drivers, the literature submits that the internationalization of R&D by multinational companies is driven by two strategic motives: the knowledge-creation and the knowledge-exploitation motives. Following these two strategic drivers, the literature in the theme of location choice found that multinational companies respond to knowledge infrastructure and market size in the host country when deciding the location for international R&D. Literature in the management and organization of international R&D has found that the changing role of R&D subsidiaries, from knowledge implementor to knowledge creator, has changed the organizational architecture of R&D units within multinational companies. The emergence of the center of excellence with decentralized authority within the multinational company has replaced the centralized R&D in the subsidiary headquarter. Past studies have also found that the ability to create knowledge increases the bargaining power of a subsidiary vis-à-vis headquarters. In the sub-topic of the implications of international R&D, past studies have found that internationalization of R&D changes the trajectory of a firm's technological development and positively influences a firm's financial performance, both in the parent- and subsidiary-level.

Given the dynamics of R&D globalization, there remains an avenue for further studies. I argue that future studies need to challenge the dominant view that international R&D is solely knowledge-creation or knowledge-augmentation activities. Future studies need to account for external factors that drive the internationalization of R&D. For example, given the complexity of regulatory oversights that govern R&D activities, future studies need to move beyond the intellectual property rights protections and national innovation policy in examining the strategic drivers and the location choices of international R&D. To advance what we already know, future studies can analyze the international R&D from institutional economics or neo-institutional theory to evaluate the strategic drivers and location choices of international R&D. Another important avenue for future study is the evaluation of ethical merits of international R&D. Research and development activities that involve human participants are often constrained by ethical requirements, which vary across national boundaries. Studies in medical field has long suspected international R&D as a means for firms to escape home country ethical requirements. Future studies can evaluate how ethical requirements at home affect the motivation and the location choices of international R&D and what are firm-level characteristics that influence the likelihood to use international R&D as an escape strategy.

The literature could also benefit from more studies on the relationship between cultural differences (both at the national and organizational level) and the organization of R&D subsidiaries. Extant studies in international management have evaluated the influence of cultural distance on entry mode choices of cross-border expansion. Future studies on international R&D can benefit from evaluating the effect of cultural distance

on the entry mode, the organizational structure, and the performance evaluation of international R&D.

On the area of impacts, extant studies have focused solely on how international impacts the performance and technological capability of focal firms. International R&D activities, however, may also have implications on external stakeholders. Thus, the literature could benefit from studies that account for the impact of international R&D on broader society. For example, future studies could investigate whether R&D internationalization leads to job creation (or job loss) at home and host countries. Another interesting area is to investigate the impact of R&D internationalization on consumer welfare, both at the host and home countries.

CHAPTER THREE

THE INSTITUTIONS-ARBITRAGING RESEARCH AND DEVELOPMENT

I. INTRODUCTION

There is a continuing interest to study international research and development (R&D) of multinational companies. Extant studies have analyzed the international R&D primarily from the knowledge-based perspective. In general, past studies view that international R&D is an instrument to seek knowledge available in foreign locations or to exploit knowledge created at home in foreign locations (Ambos, 2005; Cantwell & Mudambi, 2005; Kuemmerle, 1999a and 1999b; Shimizutani & Todo, 2008). On the premise that international R&D facilitates knowledge creation or knowledge augmentation, past studies also find that it has a positive impact on the performance of the firm. Penner-Hahn and Shaver (2005) found the positive impact of foreign R&D on the performance of the firm (parent-level), but this positive relationship occurs only when the company has existing research capabilities. Blomkvist, Kappen, and Zander (2010) found that the internationalization of R&D has accelerated the speed of entry into new technology. Mihalache, Jansen, Van den Bosch, and Volberda (2012) found an inverted U-shaped relationship between offshored innovation on the new product introduction, and top management characteristics moderate such a relationship. Belderbos, Lokshin, and Sadowski (2015) found that international R&D activities complement the positive effect of domestic R&D on the productivity of the firm. Furthermore, Scalera, Perri, and Hannigan (2018) found that the internationalization of R&D has a positive effect on the parent's technological scope.

However, the framework of knowledge-creation and knowledge exploitation implicitly assume that the strategic decision and location choices of R&D are made in the absence of institutional or regulatory considerations. Consequently, the analysis of

international R&D from a knowledge-based perspective often overlooked the impact of cross-country variation of regulatory requirements on the motives and location choices of international R&D. Studies in other fields have hinted at the importance of accounting for institutional factors to explain the motives and location choices of R&D by multinational companies. For example, scholars in the medical field have expressed concern over the lack of the ethical and regulatory merits of R&D activities undertaken in foreign locations (Glickman *et al.*, 2009; Nundy & Gulhati, 2005). In the past, there have been formal attempts to investigate numerous potential violations of ethical standards in the clinical research conducted by multinational pharmaceutical companies in developing countries. An example is Roche that was found to use political prisoners in China as guinea pigs for new drug development (Schrempf-Stirling, 2014). American- and British-based pharmaceutical firms have also been found to conduct unethical clinical trials in India (Lloyd-Roberts, 2012). This anecdotal evidence indicated that knowledge creation and knowledge augmentation are not the only motives behind the internationalization of R&D. There exists another plausible motive of R&D internationalization that is not explained by the existing theoretical framework.

The purpose of this study is to present an analysis of international R&D from the institutions-based perspective. Understanding the role of institutional factors in R&D, however, requires the shift of analysis from basic research (or the R of R&D) to the development process (or the D of R&D). While the regulations that oversee the basic research (or the knowledge discovery process) are not profound, the regulatory oversights that govern the product development process (or the D of R&D) are intense, especially regulations on the ethical standards. These regulatory requirements for the product

development process can have significant cost implications. For example, in the pharmaceutical industry, the regulatory-associated costs for the product development process could contribute up to 40% of total R&D (Glickman *et al.*, 2009; Nundy & Gulhati, 2005). Given the significant impact of regulatory requirements on the costs of new product development, managers may account for the geographic variation of the institutional factors when deciding on the location choices of international R&D.

In this study, I argue that there exists a dark side of international R&D as it can be exploited to facilitate the institutions-arbitraging strategy that allows firms to avoid or reduce regulatory-associated costs by taking advantage of locations with more lenient institutional requirements. Specifically, I argue that institutions-arbitraging strategy motivates firms to select locations with lower ethical standards or lower quality of government effectiveness in enforcing regulations. Two conditions allow for the institutions-arbitraging strategy in international R&D. First, there are discrepancies in the ethical and regulatory standards or the level of regulatory enforcement across locations. As a result, the regulatory-associated costs of R&D vary across countries. Second, the international R&D undertaken in foreign countries are admissible in the home country, and no compliance audit is taken to evaluate the ethical merits of foreign R&D. The United States Food and Drugs Administration (US FDA), for example, accepts the clinical trials undertaken by American pharmaceutical firms in foreign locations. US FDA conducted quality assurance on the submission of results from international clinical trials, but on the average, US FDA audits only 0.7% of total international clinical trials (Ayalew, 2013). Moreover, the US FDA audits only assess whether submissions are

complete, informative, internally consistent, and not obviously invalid. No audit is conducted to assess the ethical merits of foreign clinical trials (Zarin *et al.*, 2011).

I further examine the boundary condition of institutions-arbitraging international R&D. I argue that firms with performance below industry-average are more likely to engage in institutions-arbitraging international R&D than firms with performance above industry-average. The reason is that low performance increases the necessity to avoid regulatory-associated costs. Thus, performance below industry-average can further strengthen the negative relationship between the host country's ethical standards and the number of international R&D, as well as between the host country's regulatory enforcement and the number of international R&D. To develop my arguments, I primarily draw from the behavioral economics literature, specifically from the performance feedback model (Cyert & March, 1963; Greve, 1998).

To test these propositions, I examine the location choices of drug development projects undertaken by the 200 US-based pharmaceutical firms. I link the quality of the host country's ethical standards and the government's effectiveness in enforcing regulations with the number of drug development projects undertaken in that country. Data on drug development are drawn from clinicaltrials.gov. I found that the low ethical standard in the host country is associated with more drug development activities by US pharmaceutical firms. Moreover, I also find that weaker regulatory enforcements in host countries are associated with a greater number of drug development projects. These findings suggest that pharmaceutical firms select R&D locations to help them arbitrage regulatory domains and enforcements in their effort to reduce the cost of regulatory compliance. The use of location for clinical trials/drug development projects offers a

novel approach to study the internationalization of R&D, which in the past relies on the location of inventors.

This study has important theoretical, managerial, and policy implications. For the theory development, this study contributes to the literature on the internationalization of R&D by accounting for the cross-country differences in regulatory oversights that govern the applied R&D process. This study specifically accounts for the variation of ethical standards in R&D and the regulatory enforcement across locations to explain the strategic motives and location choices of R&D. In so doing, I push the boundary of what is known by submitting the institutions-arbitrage as another strategic motive that can explain the location choices of R&D. Second, this study serves a call to evaluate the international R&D from other theoretical perspectives, for instance, from the viewpoint of ethics or social responsibility. Extant studies on international R&D often neglect ethical and responsibility issues. The absence of ethical considerations in the literature of international R&D is unfortunate because ethical requirements are important considerations in the R&D practices. Professional associations have tried to set up ethical standards in conducting research in their respective fields. Ethical standards are especially important in the area that involves research or experiments in humans and animals. Third, this study integrates the performance feedback model into the institution-arbitraging hypothesis. Specifically, I argue that the likelihood to engage in institutions-arbitraging strategy is contingent upon the firm's performance relative to the industry average.

For managers, this study is a reminder of the importance of monitoring international R&D activities. Many multinational companies outsource their product

development process to foreign contractors to lower the total costs of R&D. Managers of a multinational company need to realize that those foreign contractors adhere to a set of ethical principles that may be different from the ethical regulations at home. Monitoring ethical practices of foreign contractors and incentivizing them to adhere to a higher standard of ethics are essentials to prevent future reputational damages.

For policymakers, this study provides evidence that R&D offshoring can be used by multinational companies to avoid policy or regulations. This type of international R&D can motivate the race to the bottom behavior in which host country government, especially in developing countries, lower down their ethical regulations or enforcements to attract more international R&D activities. Such a policy to lower down the ethical regulations can have a negative social impact on the host countries. Institutions-arbitraging R&D activities that avoid ethical standards can be harmful to consumers in host countries, as shown by unethical practices of clinical trials in developing countries. For policymakers in countries that set high standards of ethical practices, this study indicates that the differences in institutional quality across the world can undermine the objectives of rules and regulations imposed by the government. Thus, international coordination to establish sets of standards to promote responsible research and innovation is necessary.

II. THEORETICAL BACKGROUND

Knowledge-based perspective on international R&D

Research and development are the key drivers of competitive advantage for firms (Teece, 1986; Schumpeter, 1942). A firm that never invests in R&D would have internal limitations in developing technology (Helfat, 1997), and constraints in absorbing external

technology (Cohen & Levinthal, 1989). In the past, most of the R&D activity was done at headquarters, primarily to protect the appropriability of R&D outcomes (Di Minin & Bianchi, 2011; Patel & Pavitt, 1991). As a result, R&D activity was less globalized than other activities by the firm, such as manufacturing. In the late 80s/early 90s, the pattern has started to change; many multinational companies have started to internationalize (and decentralize) their R&D to foreign locations (Kono & Lynn, 2007). According to Kono and Lynn (2007), there are two generations of international R&D. The first generation of international R&D is a response to local demand in foreign locations. This purpose implies that firms conduct R&D in foreign locations primarily as a mechanism to modify their existing product, which was invented or designed at home to meet the local consumers' needs and tastes. Hence, the first generation of international R&D is market-seeking oriented, intending to exploit core competency at home to satisfy the host country consumers or host country regulations (Mansfield & Romeo, 1980; Shimizutani & Todo, 2008). Following this logic, one could argue that the internationalization of R&D in the pharmaceutical industry is driven by the motive to gain regulatory approval necessary for market access in the host country.

The second generation of international R&D, however, has a different objective. It aims to tap into unique knowledge or knowledge infrastructure available in foreign locations (Kono & Lynn, 2007; Kuemmerle, 1999b; Zander, 1999). This type of R&D has emerged from the need for firms to expand their R&D bases. Knowledge developed overseas are then brought back to the home country. The two generations of international R&D also differ from each other in terms of knowledge flows. While the first-generation

international R&D facilitates unidirectional knowledge flows from the home to the host country, the second-generation establish the bi-directional flow of knowledge.

Kono and Lynn's (2007) notion on the first and second generation of international R&D echoes the concept of competence-exploiting vs. competence-creating foreign subsidiaries (Cantwell & Mudambi, 2005). The competence-exploiting foreign subsidiary, whose role is to exploit home knowledge in foreign locations, is reflective of the typical first-generation international R&D. The competence-creating foreign subsidiary, on the other hand, is the "center of excellence" that engage in knowledge-generating activities by internalizing unique knowledge available in foreign locations (Frost *et al.*, 2002). A study by Berry (2006) has shown that competence-creating international R&D help firms to build their technological and market positions. The existence of a competence-creating R&D lab also shows the reverse flow of knowledge from subsidiary to headquarter (Frost & Zhou, 2005). Hence the competence-creating subsidiaries reflect the second generation of international R&D.

International R&D, as a knowledge-generating activity, has been a dominant view in the literature. Many studies have used the competence-creating framework to examine the location choice of international R&D. Shimizutani and Todo (2008) found for firms that engage in basic R&D, the availability of advanced knowledge in a foreign country can motivate the internationalization of R&D. Similarly, Demirbag and Glaister (2010) found that the host country's science and engineering talent pool is an essential factor for R&D location for multinational firms.

In addition to competence-creation and competence-exploitation motive, past studies also pointed out cost-reduction as a motive of R&D internationalization. The

underlying argument is that the vast growth of highly skilled science and engineering talent in developing countries where the standard of living is relatively lower than that in developed countries enable the multinational companies to cut the costs of R&D activities. Chung and Yeaple (2008), for instance, found that firms from the United States are attracted to locations with the technical similarity to the US so that firms can reduce their fixed R&D costs while simultaneously taking advantage of the knowledge available in foreign locations. Another empirical evidence by Lewin, Massini, and Peeters (2009) shows that the offshoring of innovation activities is driven by the need to access low-cost science and engineering talent outside the home country. This finding emphasizes the cost reduction motive behind the internationalization of R&D.

Furthermore, the knowledge-creating R&D activities are also attracted to the host country's national innovation systems. Filippaios, Papanastassiou, Pearce, and Rama (2009) found that multinational companies are attracted to scientific heterogeneity in foreign locations. Guimon, Chaminade, Maggi, and Salazar-Elena (2018) found that national innovation policy, such as industry and university collaboration and government supports in basic absorptive capacity for industry, can help to attract R&D investments. Another aspect of the national innovation system is intellectual property rights protections. Pisani and Ricart (2018) found that the strength of intellectual property rights protection increases the attractiveness of host country knowledge infrastructure.

Institutions-based perspective

Institutions are humanly devised constraints that structure human interactions; they include formal rules as well as informal norms of behavior and conventions (North, 1990). Institutions can be both supportive and detrimental to organizations (Boddewyn &

Brewer, 1994; Popli, Akbar, Kumar, & Gaur, 2017; Gaur, Ma, & Ding, 2018). On the one hand, strong institutions promote market efficiency by providing useful information and enforcing property rights (North, 1990). On the other hand, institutions can be developed independent of the efficiency logic and being detrimental to organizations. Thus, institutions vary not by their benefits or costs to organizations.

Furthermore, institutions also vary by time and space, and this creates an opportunity for organizations to arbitrage institutions across a political boundary. Globalization relaxes the local institutional constraints and enables firms to arbitrage across institutional boundaries. Siegel (2005) found that foreign firms issued bonds in the United States as a mechanism to rent US securities laws. Similarly, firms from developing countries can cross-list their stock in foreign markets to voluntarily subjecting themselves to higher disclosure standards and stronger enforcements (Coffee, 2002). These studies focused on how firms from developing countries can borrow better institutions from advanced countries.

The strategy to arbitrage the institutional environment, however, is not an exclusive domain to firms from developing countries. Li and Zhou (2017) found that many American firms offshore their manufacturing to developing countries to borrow lower environmental standards in these countries. By arbitraging environmental standards, firms can conceal their regulatory non-compliance and, at the same time, cut their costs. I argue that arbitraging institutions can provide plausible explanations for the R&D internationalization by US pharmaceutical firms. In this study, I focus on two aspects of institutions, ethical standards, and government effectiveness in enforcing regulations.

Ethics and responsibility in international business

Ethics, the accepted principles of right or wrong that govern the conduct of a person or organization, are an important element of institutions. Ethical issues frequently arise in international business because the accepted principles of business conduct often vary across nations. These variations of ethical standards across countries create the opportunities for multinational companies to arbitrage a higher ethical requirement in one location for a lower ethical standard in another location. Past studies on ethical issues in international business have pointed out the issue of pollution (Low & Yeats, 1992), corruption (Cuervo-Cazurra, 2016; Luo, 2006), and child labor and poor working conditions (Narula, 2019) by multinational companies. These past studies argue for the possibility that multinational companies can engage in unethical practices to take advantage of low standards of various regulations.

This study tries to scrutinize international R&D activities from the lens of ethics and corporate responsibility. Extant studies on international R&D often neglect the ethical and responsibility issues, perhaps because the potential ethical violations in international R&D activities are less visible than the ethical violations in labor and environmental practices. The absence of ethical considerations in the literature of international R&D is unfortunate because ethical requirements are important considerations in the R&D practices. Professional associations have tried to set up ethical standards in conducting research in their respective fields. Ethical standards are especially important in the area that involves research or experiments in humans and animals. For this reason, R&D in the pharmaceutical industry is restricted by various regulations, which directly affect the cost of doing R&D. I argue that the institutions-

arbitraging motive encourages pharmaceutical firms to locate their R&D activities in locations with lax ethical requirements.

Performance feedback model

According to the behavioral theory of the firm, comparisons of realized performance (or goal variables, in a generic term) with aspiration levels determine organizational actions (Cyert & March, 1963). Aspiration levels are constructed from sources such as an organization's experience, or historical aspirations, and its observation of other organizations, or social aspirations (Cyert & March, 1963; Greve, 1998). Social aspirations theory argues that managers form reference groups of other organizations that they view as similar to theirs (Lant & Baum, 1995; Porac, Thomas, & Baden-Fuller, 1989). Organizations, or managers, display greater awareness of the behaviors of organizations in these reference groups and a greater likelihood of imitating them (Baum & Haveman, 1997; Fiegenbaum & Thomas,1995; Porac, Thomas, Wilson, Paton, & Kanfer, 1995).

This theory further argues that when an organization falls below the aspiration level of performance, decision-makers initiate a problemistic search for actions that may produce outcomes above the aspiration level (Cyert & March, 1963). As long as a specific problem is not solved, an organization will continue to search for a satisfying answer as the declared goal. The general prediction is that the greater the gap between realized performance and performance aspiration, the greater the likelihood of firm to engage in risk-taking activities, such as the creation of new products with unknown demand (Greve, 1998), the search of new technologies (Chen, 2008; Greve, 2003), acquisition and divestment (Desai, 2016), and the foreign expansion to the distant

territory. Problemistic searches can also encourage unethical behavior, such as financial misrepresentation (Harris & Bromiley, 2007). More recent research by Xu, Zhou, and Du (2019) argues and find that performance below aspirations level can trigger a deviant risk-taking behavior, such as bribery. This evidence shows that underperformance can also trigger the cost-cutting strategies that may be unethical. Extending this argument to institutions-based view, I argue that underperformed firms are more likely to engage in institutions-arbitraging strategy by locating R&D in locations with low ethical standards or weak regulatory enforcement.

Research setting

The research setting of this study is the pharmaceutical industry, which is one of the most R&D intensive industries. Also, the pharmaceutical industry is one of the most internationalized industries, with firms selling products and perform research and development across the world. R&D is the most important source of competitive advantage in the pharmaceutical industry (Henderson and Cockburn, 1994; Piachaud, 2004; Dierickx and Cool, 1989).

The pharmaceutical industry is at the forefront of R&D globalization. Until the 1980s, the big pharmaceutical firms performed all the operations in-house in their home country (Cockburn, 2004). During this time, the industry had a period of high growth due to numerous scientific breakthroughs. However, for the last three decades, the industry is facing many challenges due to rising costs accompanied by longer development time, oncoming patent expirations of many blockbuster drugs, fewer replacement drugs, changing technology, and higher litigation costs (John, 2006; Hall & Reynders, 2000). To overcome these challenges, pharmaceutical firms are increasingly developing new drugs

in foreign locations. R&D offshoring in the pharmaceutical industry covers a large part of their core activities, such as identification of ingredients and a chemical compound, preclinical testing, clinical trials, clinical packaging, regulatory affairs, and bio-manufacturing (Findlay, 2007). In 1996, 83.96% of clinical research by the American pharmaceutical firms was conducted in North America. In 2006, the percentage of clinical trials by American firms in North America dropped to 63.18%.[3] In 2020, recent data available at clinicaltrials.gov[4] shows that 49% of clinical trials by American pharmaceutical firms are undertaken exclusively outside the United States, and only 34% of clinical trials are undertaken exclusively in the United States. Moreover, the location preference for international R&D by American multinational companies also shifted from Canada, Western Europe, and Japan to China, India, Southeast Asia, and Eastern Europe, especially the former Soviet Union (Glickman *et al.*, 2009). This shift of location choice of clinical trials to emerging economies in Asia and Eastern Europe is consistent with the general trend of international R&D by American companies across various industries (Branstetter, Glennon, & Johnson, 2019).

Pharmaceutical R&D activities consist of two phases. The first phase is the basic research or the drug discovery process, which aims to find the formulation of a chemical compound or the drug candidate. The second phase is the drug development process or known as clinical trials, in which the resulting chemical compound from phase one is tested in animal and human subjects. The clinical trials are costly and can take a long time (Cockburn, 2006), and were traditionally done in-house within the home country.

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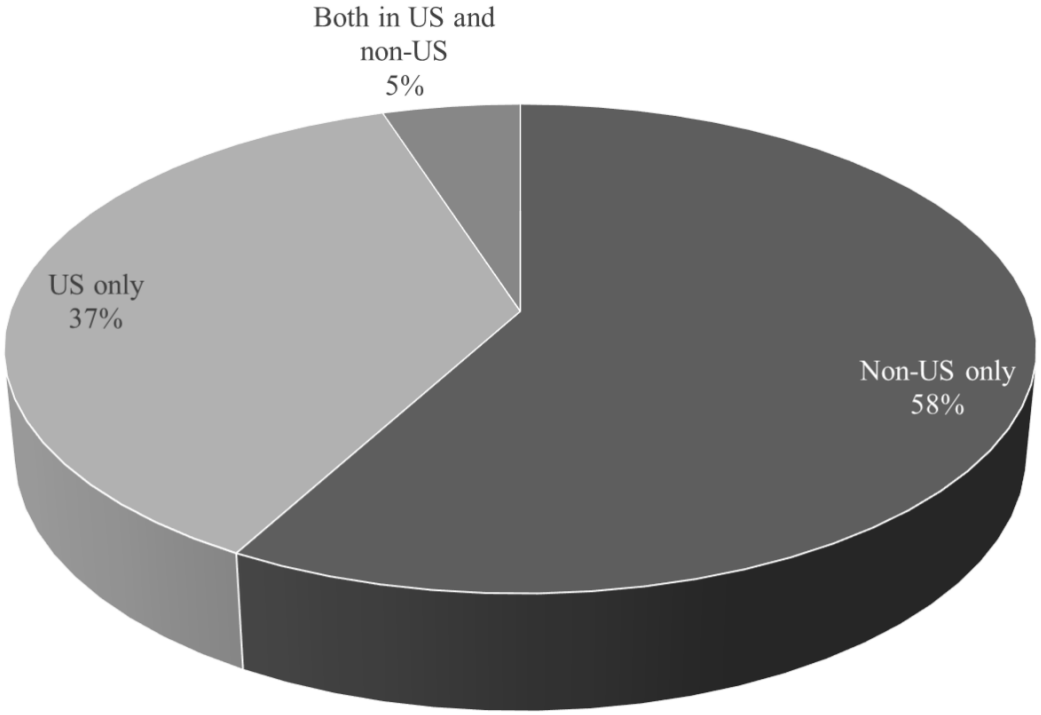
[3] Ayalew K. FDA perspective on international clinical trials. U.S. Food & Drug Administration. https://www.fda.gov/downloads/drugs/newsevents/ucm441250.pdf

[4] https://clinicaltrials.gov/ct2/resources/trends#LocationsOfRegisteredStudies

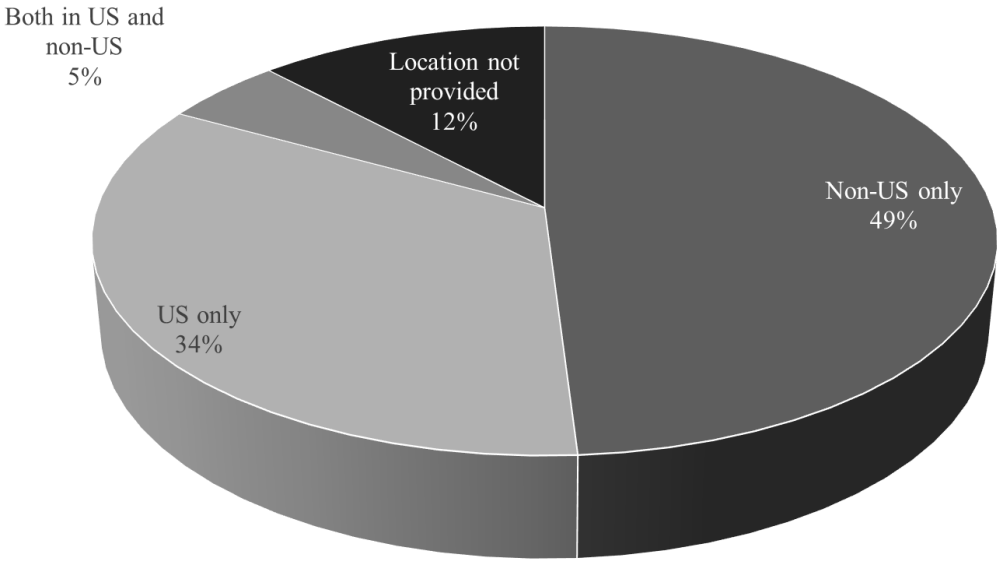
However, the pharmaceutical firms are increasingly offshoring drug development to clinical research organizations (CROs), foreign affiliates, and universities or research institutes (Azoulay, 2004). As of April 2019, data shows that 57% of clinical trials in the recruiting stages took place exclusively outside the US, and 5% took place in both the US and foreign locations (see Figure 3.1). Furthermore, if we look at the registered clinical trials, 48% of registered clinical trials are undertaken outside the US, 5% are in both the US and foreign countries, and 34% are performed exclusively in the US (see Figure 3.2).

Figure 3.1. Distribution of recruiting clinical trials by locations



Source: clinicaltrials.gov (as of April 4th, 2019). From total 50,038 recruiting studies

Figure 3.2. Distribution of registered clinical trials by locations



Source: clinicaltrials.gov (as of April 4th, 2019). From total 302,226 registered studies

In addition to knowledge-exploiting and knowledge-creating arguments, experts argue for other pharmaceutical industry-specific motives that can explain the offshoring of pharmaceutical R&D to developing countries. First, the proponent of R&D internationalization in the pharmaceutical industry argues that the offshoring of clinical trials is motivated by the need to study and test drugs for tropical diseases (e.g., malaria, dengue, leprosy, chagas, ebola, cholera, etc.). The assumption is that clinical trials for tropical diseases are more suitable to be undertaken in tropical countries, which happen to be developing countries (Nundy & Gulhati, 2005). Data, however, show that tropical diseases clinical trials are only 1% of total clinical trials (Nundy & Gulhati, 2005), which is far below the proportion of international clinical trials. Second, offshoring clinical trials allow pharmaceutical companies to recruit a large pool of treatment naïve patients (or patients who have never undergone treatments), which are available in developing

countries due to low coverage of immunization (Yang, Chen, & Bennet, 2018). Clinical trials for treatment naïve patients allow better identification of drug candidates.

A critical aspect of this international clinical trial is that the Food and Drug Administration (FDA) considers them as admissible evidence for the drug efficacy and drug safety procedure. The admissibility of international clinical trials to the FDA enables pharmaceutical firms to arbitrage regulatory requirements across the border, as I will elaborate in detail in the hypotheses section.

Boundary conditions

Before establishing my argument, I need to clarify boundaries. First, the use of institutional arbitrage as a theoretical framework assumes that ethical considerations and regulations have a significant impact on the process of research and development. This assumption may be valid in the case of applied research or product development but may not be applicable for basic research (i.e., knowledge discovery). Second, the context of R&D in this study is limited to clinical trials in the pharmaceutical industry and does not include the drug discovery process. The regulatory constraints for the drug development process are different from the drug development process. The regulatory oversights in the drug discovery process are minimal because it does not involve human subjects. The drug development process, on the other hand, is subject to various ethical standards and regulations, as it involves the safety and efficacy testing in animal and human subjects.

III. HYPOTHESES DEVELOPMENT

Pharmaceutical firms R&D and ethical standards

Across various industries, applied R&D is subject to regulations. The most important regulations that govern the applied R&D is the ethical standards of conducting

experiments on human subjects. In the pharmaceutical industry, the ethical standards on conducting experiments on human subjects have been the major issue in the drug development process (Friedman, Furberg, DeMets, 2010). Important debates in establishing ethical standards in drug development include the physician's obligations to patient vs. societal goods, the use of placebos, participants' confidentiality, data sharing, informed consent, and publication bias. Emanuel, Wendler, and Grady (2000) list seven criteria of ethical standards in drug development: (i) social vs. scientific value (ii) scientific validity (iii) fair subject selection (iv) independent review (v) informed consents (vi) respects for potential and enrolled subjects. These ethical principles, in general, aim to reduce health hazards for participants of clinical trials or end consumers. However, some of these principles, although well-intended, conflict with the firm's pursuit of efficiency, and thus raise the costs of drug development.

Health professions, over the years, have attempted to establish universal guidelines of ethical principles when pharmaceutical firms conduct clinical trials. For example, the World Medical Association issued ethical guidelines in clinical trials in 1964, through the Declaration of Helsinki. This guideline has been revised in 1975, 1983, 1989, and 1996. Another example is ethical guidelines prepared by the Council for International Organizations of Medical Sciences (CIOMS), in collaboration with the World Health Organization. The international ethical guideline by CIOMS-WHO was first proposed in 1982 and revised in 1993. The objective of these guidelines is to protect patients' rights. The requirement of informed consent, for example, intends to let the potential participants understand the risks and benefits of the clinical trials before they enroll in clinical trials. This requirement also allows participants to evaluate the purpose

of a clinical trial and whether it is consistent with their values or preference (Emanuel *et al.,* 2000) and thus help potential participants make an informed decision.

These international ethical principles, nevertheless, only provide the guideline. Eventually, it is the national government that has discretionary power whether to translate these guidelines into laws, which results in disparities in ethical standards around the world. Advanced countries, like the United States, adopt and enforce relatively strong ethical standards for drug development. For pharmaceutical firms, adhering these ethical guidelines can increase the credibility of R&D outcomes and prevent the potential reputational and monetary damages resulting from a violation of ethical issues. These regulatory oversights, however, increases the complexity of conducting clinical trials in the United States, and place more significant burdens for the pharmaceutical firms in terms of regulatory compliance, documentation, and training (Glickman *et al.*, 2009). As a result, stricter regulatory compliance makes it more expensive to perform clinical trials in the United States. While in developing countries, the ethical standards for drug development are relatively behind. Lower standards of health care in developing countries also allow ethically problematic study designs that would not be allowed in advanced countries. Shah (2003) has warned the possibility of developing countries with less stringent ethical standards being chosen by pharmaceutical companies as locations of clinical trials to avoid ethical and regulatory requirements. In another study, Zhang *et al.* (2009) reported that 90% of published clinical trials in China did not report the ethical review, and only 18% of clinical trials in China adequately discussed the informed consent of participants.

Such differences in ethical standards across countries create an arbitrage opportunity for pharmaceutical firms from advanced countries. I argue that pharmaceutical firms can take advantage of institutional differences by offshoring a portion of phase III clinical trials to countries with lower ethical standards so that they can avoid the regulatory requirements imposed by the authority in home countries. Avoiding ethical requirements means that pharmaceutical firms can reduce the costs associated with regulations and costs of the documentation requirement. For example, by avoiding informed consent, pharmaceutical firms can reduce the costs of recruitment because uninformed patients are willing to participate without being paid. This strategy, however, does not eliminate the costs of regulatory compliance, but rather it allows firms to conceal their non-compliance, and thus reduce the costs at least partially. Another motive for pharmaceutical firms to locate portions of applied R&D in countries with low ethical standards is the shortened time for product development. For example, by avoiding the informed consent requirement, pharmaceutical firms can accelerate the patients' recruitment because uninformed patients are more willing to participate than uninformed patients. Conducting the unethical R&D, however, may risk the outcomes of R&D being invalidated by the home country's regulatory body. The absence of audits on ethical standards of foreign clinical trials, however, reduces the risk of clinical trial invalidation by home country government. In the US, for example, FDA audits only 0.7% of all foreign clinical trials (Ayalew, 2013). FDA also assumes that the ethical merits of offshored clinical trials are evaluated by the host country's regulatory body (Pierik, 2015). From the perspective of the FDA, a relocated trial falls within the jurisdiction of

the host country, and it makes sense to assume that the host country should determine its ethical requirements (Pierik, 2015).

A well-documented example of a firm that arbitrage ethical standards in the medical study is the controversy of Roche's CellCept controversy that conducts a clinical trial in China for its new product by using organs taken from executed prisoners (Schrempf-Stirling, 2014). This practice is considered unethical in countries with strong human rights protection, but it does not violate China's ethical standards and regulations. As a result, Roche can avoid the legal sanction of such ethical standars violations. BBC[5] also reported that patients from low caste groups in India were being placed in drug trials without their informed consent. Tarjun Prajapati, whose father was a victim of international clinical trials, said in an interview (Lloyd-Roberts, 2012):

> *"I went to the market to buy Fondaparinux[6] but couldn't. I was told they were only available from the hospital and only then did I realize he was on a trial drug. I feel very bad that my dad died because of those medicines."*

Hence, I submit that a host country with lower ethical standards can attract more institutions-arbitraging pharmaceutical R&D.

> *Hypothesis 1: The ethical standard in a foreign country is inversely associated with the number of the applied R&D projects undertaken by the pharmaceutical firms in that country*

Pharmaceutical firms R&D and government effectiveness in enforcing regulations

Another critical component that comprises the formal institutions is the government effectiveness in enforcing regulations. As a general conception, government effectiveness refers to whether the public administration does well what it is supposed to do, whether

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[5] Source: https://www.bbc.com/news/magazine-20136654

[6] A drug candidate for heart disease. BBC report can be found in https://www.bbc.com/news/magazine-20136654

the actions and procedures of the public organizations and its members help achieve the objectives, and in the end, whether it achieves its objective (Garcia-Sanchez, Cuadrado-Ballesteros, & Frias-Aceituno, 2013). In this context, I refer to government effectiveness as to whether the public administration enforces the regulations so that those regulations achieve their objectives. Ineffective government means that regulations are not monitored well, and the regulatory enforcements are weak so that the objectives of the regulations are not satisfied.

Extant studies have found that an ineffective government distorts the market by creating an inconsistent external environment and thus has detrimental effects on the performance of the firm (Shleifer & Vishny, 1993). On the other hand, government effectiveness attracts foreign investment as it helps generate firms' confidence in the regulations and therefore improves business climates (Globerman and Shapiro (2003). Getz and Volkema (2001) have found that government effectiveness in enforcing regulations have a positive impact on firm performance as it can reduce regulatory uncertainty and create a healthy business climate. These studies, in general, pointed out that government ineffectiveness is harmful to the firms' efficiency logic.

The absence of government effectiveness in enforcing regulations, on the other hand, can reduce the firm's compliance with regulatory requirements. The lack of government effectiveness in enforcing regulations reduce the firm's expected loss when it does not comply with regulations. Hibbs and Piculescu (2010) model firm behavior under different levels of regulations enforcement and find that firms may perceive the tax as not "worth paying" when the government does not enforce the regulations effectively.

In this study, I argue that firms take advantage of cross-border variation in government effectiveness in enforcing regulations when they select the location for applied R&D. In countries with an ineffective government, rules and regulations are often not monitored. The absence of monitoring and enforcement by the government can have two implications. First, in the absence of regulatory monitoring, the chances of firms getting caught when violating the ethical requirements of R&D is reduced. Second, in countries with weak regulatory enforcements, firms face lower legal sanctions, such as litigation costs, associated with violating the ethical standards. Hence, from firms' perspective, operating in the environment with weaker regulatory enforcements is similar to operating in the institutional environment characterized by the low ethical standards or regulatory demands, as both environments reduce the regulatory burden for the firms. Again, the opportunity to avoid strict regulatory enforcements at the home country through locating R&D in countries with weak regulatory enforcements exists because home country regulatory bodies do not evaluate the ethical and regulatory merits of R&D projects undertaken outside their jurisdictions.

In the context of institutions-arbitraging international R&D, the harmonization of ethical standards around the world incentivizes the firms to locate their institutions-arbitraging R&D in countries with weak regulatory enforcements. The World Health Organization (WHO) has sought to harmonize the ethical standards in clinical trials around the world by influencing the national governments to adopt the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Good Clinical Practice (ICH-GCP). I argue that the WHO efforts to converge the ethical standards in clinical trials around the world do not

limit the arbitrage opportunity for R&D activities so long as the national government's ability to monitor and enforce regulations varies across the border. Therefore, pharmaceutical firms from advanced countries can still undermine the internationally adopted ethical standards in the drug development process by locating clinical trials in countries with an ineffective government.

Annelies Den Boer, of the Dutch non-profit Wemos Foundation, has shown concern on the possibility of pharmaceutical firms taking advantage of a lack of regulatory control in host countries to avoid the regulatory requirements in pharmaceutical R&D (Hirschler, 2011).[7]

> *"It's very difficult to check if companies do indeed abide by International Conference on Harmonization of Clinical Trials because governments in countries where these trials take place do not exercise a lot of control."*

Furthermore, the institutional deficiency caused by the absence of regulatory enforcement also opens the possibility for large firms to utilize their capability in a political strategy to get the preferential treatments and escape from the written regulatory requirements. Extant studies have suggested that a firm's capability to encounter ineffective government, or even corrupt practices can be beneficial as it can help firm influencing the regulations (Oliver and Holzinger, 2008; Uhlenbruck et al., 2006). In the context of the pharmaceutical industry, the ineffectiveness of the government in enforcing regulations can be beneficial for large pharmaceutical firms as they can easily escape from the *de jure* regulatory requirements. Hence, I argue the negative association between host country regulatory enforcement and the number of international R&D in the pharmaceutical industry.

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[7] Source: https://www.reuters.com/article/us-pharmaceuticals-trials/special-report-big-pharmas-global-guinea-pigs-idUSTRE7450SV20110506

Hypothesis 2: The host country government effectiveness in enforcing regulations is inversely associated with the number of the applied R&D undertaken by the pharmaceutical firms in that country

Moderating effect of performance aspirations

Furthermore, the likelihood of engaging in institutions-arbitraging R&D may differ across pharmaceutical firms. Firms generally do not want to engage in institutions-arbitraging strategy, as it may be considered as illegal or unethical. Legality and morality remain important behavioral considerations for most firms (Cuervo-Cazurra, 2006; Jeong & Weiner, 2012). However, certain circumstances may drive managers to unethical behavior. When the firm's performance falls below the reference group, managers start to feel the pressures and therefore look for a solution that can improve performance until it reaches the aspiration level. Facing the pressures to improve performance, managers may look for a short-term solution that can increase the chance of achieving favorable business outcomes, even though such solutions can cause negative consequences to other firms or society (Harris & Bromiley, 2007; Xu *et al.*, 2019).

In the pharmaceutical industry, the performance of the firm relative to the social group is often defined by the ability (or speed) to introduce new drugs (Findlay, 2007; Shah, 2003). Therefore, the short-term solution to low performance is to engage in cost-cutting strategies, such as institutions-arbitraging product development. Avoiding the ethical standards or the regulatory enforcements of ethical standards can help underperformed firms to speed up the process of patients' recruitment and hence increase the speed-to-market of a new drug. Extant studies have shown that conducting clinical trials in developing countries, where ethical standards are lower and regulatory enforcement are weaker, can cut the total costs of applied R&D by 40% (Glickman *et al.*,

2009; Findlay, 2007). Thus, institutions-arbitraging strategy by selecting R&D locations with weak ethical standards or regulatory enforcement can be a short-term cost-saving mechanism for firms with low performance. Hence, I argue that underperformed firms have a greater inclination towards locating R&D in countries with low ethical standards or weak regulatory enforcements.

> *Hypothesis 3a: The inverse relationship between ethical standard in the host country and the number of the applied R&D projects is greater in firms with performance below social aspirations level*

> *Hypothesis 3a: The inverse relationship between regulatory enforcement in the host country and the number of the applied R&D projects is greater in firms with performance below social aspirations level*

IV. EMPIRICAL DESIGN

To test my propositions, I use data on locations of clinical trials of the US-based pharmaceutical firms. Clinical trials are an essential part of R&D in the pharmaceutical industry and account for approximately 42% of the total R&D expenditure. The use of data of companies from one country (in this case, the United States) implies that the effect of home country variables become constants. Therefore, my empirical test combines data in the level of the host country, firm, and drug development project. This approach allows me to examine the impact of host country-level characteristics on the number of clinical trials undertaken by pharmaceutical firms in various locations.

Sampling method, primary data sources, and dependent variables

I randomly select 200 US-based pharmaceutical firms from the list of firms in the pharmaceutical industry provided by Mergent Horizon. Out of 200 samples, 14 firms do not have firm-level data. Thus, the final sample consists of data from 186 pharmaceutical firms. I then collect phase 3 clinical trial data (including the locations) from

clinicaltrials.gov. I look for clinical trials in the period between 2000 to 2017. Clinicaltrials.gov allows me to collect information on the (i) starting date of clinical trials (ii) location of clinical trials and (iii) type of diseases. From the location information, I identify a set of probable clinical trial locations outside the United States. This set of probable location consists of 78 countries. Then, I construct a time-varying firm-country dyadic dependent variable that measures the number of drug development (phase 3 clinical trials) undertaken by a pharmaceutical firm in every country within the set of probable locations. I assign the value 0 when the firm does not have a drug development project in a particular location. After eliminating missing values, the final dataset consists of 93,740 firm-country-year observations.

Main explanatory variables

The first primary explanatory variable is the host country's ethical standard. I use the perception of ethical business behavior to proxy for the host country's ethical standard. The perception of ethical business behavior ranges from 1-7 (best). A low score of this index implies that ethical standards in doing business are at a low level. This data is drawn from the World Economic Forum. The second primary explanatory variable is government effectiveness in enforcing regulations. I use the index of government effectiveness by the World Governance Indicators as a proxy. This variable captures the perception of government credibility in formulating and implementing policy as well as public service. This index ranges from -2.5 to 2.5 (best). A low score in this index reflects the government’s failure to deliver basic public service as well as to implement national policy.

The moderating variable is the performance relative to social aspirations. I create a binary variable to identify firms with performance below social aspirations. The value of 1 is assigned to a firm if its return on equity is lower than the industry average return on equity minus one standard deviation, and 0 is the firm's return on equity is greater than or equal to industry average return on equity minus one standard deviation.

Control variables

Treatment naïve patients. One alternative explanation for the hypothesis is that developing countries, which happen to have weak ethical standards and inefficient regulatory enforcements, have a large pool of treatment naïve patients (Yang *et al.*, 2018). Clinical trials on the treatment of naïve patients can help scientists better to identify the effect of drug candidates on the disease. To account for the pool of treatment naïve patients in the host country, I control for the immunization/vaccination coverage rate in the main model. The host country average vaccination rate is measured as the vaccination coverage rate across six disease areas (BCG, DTP1, DTP3, Hepatitis B3, MCV1, Polio 3). This data is drawn from the World Health Organization database.

Host country knowledge endowment. Past studies have pointed out that one motive of R&D internationalization is knowledge-creating (Cantwell & Mudambi, 2005; Shimizutani & Todo, 2008). This type of R&D is attracted to host country knowledge potential. As a proxy for knowledge potential, I use the number of patent applications in the host country. Data for patent applications in the host countries are drawn from the World Bank development indicators.

Host country market potential. Another type of international R&D is knowledge-exploiting, which aims to localize the product as a market penetration effort (Kuemmerle,

1999a; Shimizutani & Todo, 2008). This market-seeking R&D is attracted to host country market potential. I use the total health expenditure per capita as a proxy for the market potential. Data for health expenditure per capita is drawn from the World Health Organization database.

Mimicking the location choice of a non-profit organization. To account for the possibility that pharmaceutical firms mimicking the location choices of non-profit organizations (e.g., hospitals, universities, government agencies), I control for the number of non-industry clinical trials in the host country. These data are available at clinicaltrials.gov.

Other country-level control variables. Country-level control variables can be divided into three categories, economic characteristics, the national innovation system, and the market regulations. Proxies for economic characteristics include (i) foreign direct investment inflows as a ratio to GDP and (ii) annual growth of GDP. Data for both proxies are drawn from the World Bank Development Indicators. Proxy for the national innovation system is the intellectual property rights protection, which measures the quality of IPR in the host country. The range of IPR protection indicator is -2.5 to 2.5 (best). This indicator is drawn from the World Governance Indicators. Proxies for the market regulation are (i) the quality of business-friendly regulation and (ii) the effect of taxation rate on the incentive to invest. The quality of business-friendly regulations is a perceptual measure that rates the quality of regulations on firms and markets. The effect of the taxation rate on the incentive to invest is also a perceptual measure that rates the effect of taxation. These two indicators range from 2.5 to 2.5 (best). Data for the

perception of business-friendly regulations and the effect of taxation on the incentive to invest are drawn from the World Governance Indicators.

Firm-level control variables. I include various firm-level control variables. First is the R&D intensity, measured as the log of R&D expenditure as a ratio of total assets. Firms with high R&D intensity is expected to have more international R&D. Second, I include the percentage of foreign sales to total sales. This variable reflects the international orientation of the firm. The expectation is that firms with a higher proportion of foreign sales are more likely to internationalize their R&D to meet with local regulatory requirements. I also include the firm size, measured by the log of total assets. Bigger firms are more likely to internationalize their R&D activities. Fourth, I include the current ratio to control for the liquidity level of the firm. Firms with higher liquidity ratios have greater financial capability to internationalize their R&D activities. I also include the debt-to-equity ratio to measure the risk gearing of the firm. Firms with a high debt-to-equity ratio have higher financial risks that can affect the likelihood of R&D internationalization. Lastly, I include cashflows per share to measure the earnings potential. Firms with high cashflows per share are expected to have greater financial capability to internationalize their R&D. These firm-level variables are drawn from Mergent Horizon. In the main model, I add the year fixed effect to control for the unobserved time variance variable.

Methods

Equation (3.1) shows the econometric model to test the hypotheses:

$$RND_{i\text{-}j,t} = \beta_0 + \beta_1 ET_{j,t} + \beta_2 GE_{j,t} + \beta_3 PBS_{i,j,t-1} + \beta_4 ET_{j,t} * PBS_{i,j,t-1} + \beta_5 GE_{j,t} * PBS_{i,j,t-1} + \gamma \sum CL_{j,t} + \delta \sum FL_{i,t} + \mu_t + v_t \quad \text{(Eq. 3.1)}$$

Where $RND_{i\text{-}j,t}$ denotes the number of clinical trials or applied R&D undertaken by firm i in country j at time t. $ET_{j,t}$ denotes the perceived ethical business behavior in country j at time t. $GE_{j,t}$ denotes the score of perception of government effectiveness in enforcing regulations in country j at time t. $PBS_{i,j,t\text{-}1}$ denotes the binary measure of the firm with performance below social aspirations (1 if performance last year falls below the social aspirations level, and 0 otherwise). $CL_{j,t}$ denotes the time-varying country-level control variables. $FL_{i,t}$ denotes the time-varying firm-level variable. μ_t denotes the time fixed effect, and v_t denotes the residual.

The dependent variable in this model is a count variable (as it measures the number of international R&D projects in the host country), with excessive zero counts. These excessive zero counts can be generated by a separate process that prevents some firms from experiencing the event being counted. In this case, I argue that the zero counts come from two processes. First, zero counts as the result of the decision-making process by the firm. For example, firm i do not choose country j as a location for a clinical trial because the locational factors of country j are not attractive for firm i. The second process is the zero count as the result of the firm not having sufficient resources to offshore its clinical trials in any foreign location. The advantage of using zero-inflated negative binomial regression is that it allows for additional over-dispersion via a splitting process in which the probability of a zero outcome is modeled by logistic regression, and the continuous outcome is modeled using a negative binomial error structure. The second process of zero counts (firms not having enough resources to offshore drug development) is modeled through the logistic regression. I use the current ratio and log total assets as

independent variables as these two variables can capture the variation of the firm's resources and capabilities to offshore the drug development.

V. RESULTS

Descriptive Statistics and Correlation Matrix

Table 3.1 reports the descriptive statistics for the variables used, showing some interesting findings. The average count of international R&D from a firm in a particular location is 0.05, which is low because of excessive zero counts. Among the firm-location dyadic in my analysis, the highest count of international R&D is 24.

Table 3.1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Count of international R&D	80,127	0.05	0.47	0.00	24.00
Ethical behavior	80,127	4.46	1.06	2.79	6.78
Government effectiveness	80,127	0.59	0.90	-1.00	2.44
Patent application in million	80,127	0.02	0.09	0.00	1.10
Healthcare expenditure per	80,127	1.86	1.68	0.00	6.81
Business friendly regulations	80,127	0.62	0.83	-1.30	2.23
IPR score	80,127	4.15	1.20	1.96	6.48
Effect of tax on investment	80,127	3.67	0.83	1.86	5.99
FDI inflows per GDP	80,127	0.04	0.09	-0.55	1.46
Annual GDP per capita growth (%)	80,127	3.17	3.76	-14.81	25.56
Non industry clinical trials	80,127	71.46	131.40	0.00	859.00
Average immunization coverage (%)	80,127	0.92	0.08	0.46	0.99
Performance below social aspiration	80,127	0.85	0.36	0.00	1.00
R&D intensity	80,127	3.07	1.49	0.01	8.70
Percentage of foreign sales	80,127	0.06	0.19	0.00	1.00
Log total assets	80,127	3.93	2.38	-6.91	13.06
Current ratio	80,127	6.53	9.81	0.00	172.42
Debt-to-equity ratio	80,127	1.47	9.41	0.00	195.07
Earnings per share ($1000)	80,127	-0.27	5.03	-162.18	0.19

Table 3.2 provides the correlation matrix. The two main explanatory variables (ethical standards and government effectiveness in enforcing regulations) have a high correlation coefficient of 0.87. The measure of ethical standards and government effectiveness in enforcing regulations also have a high correlation coefficient with many other country-level variables. Thus, multicollinearity could be an issue. To address the multicollinearity issue, I construct the residual values of ethical standards and government effectiveness in enforcing regulations that reflect the proportions of ethical standards and regulatory enforcement unexplained by the GDP per capita or income level. More details on this procedure are discussed in robustness checks.

Table 3.2 Correlation matrix

No	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	International R&D	1.00																	
(2)	Ethical behavior	0.05	1.00																
(3)	Government effectiveness	0.06	0.87	1.00															
(4)	Patent application in million	0.00	0.03	0.05	1.00														
(5)	Healthcare expenditure per capita	0.07	0.75	0.81	-0.01	1.00													
(6)	Business friendly regulations	0.07	0.80	0.94	-0.04	0.78	1.00												
(7)	IPR score	0.06	0.92	0.89	0.07	0.78	0.82	1.00											
(8)	Effect of tax on investment	-0.01	0.50	0.35	0.03	0.25	0.33	0.43	1.00										
(9)	FDI inflows per GDP	-0.02	0.16	0.14	-0.07	0.18	0.17	0.15	0.25	1.00									
(10)	Annual GDP per capita growth in	-0.04	-0.16	-0.26	0.09	-0.33	-0.27	-0.20	0.19	0.11	1.00								
(11)	Non-industry clinical trials	0.11	0.27	0.33	0.44	0.37	0.28	0.35	-0.02	-0.11	-0.11	1.00							
(12)	Average immunization coverage	0.00	-0.03	0.08	0.12	-0.01	0.08	0.01	-0.12	0.06	-0.01	-0.01	1.00						
(13)	Performance below social aspirations	-0.09	-0.01	0.00	0.01	0.03	0.00	0.02	0.00	0.00	-0.02	0.04	0.00	1.00					
(14)	R&D intensity	0.23	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.00	-0.21	1.00				
(15)	Percentage of foreign sales	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.18	0.19	1.00			
(16)	Log total assets	0.20	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	-0.22	0.82	0.21	1.00		
(17)	Current ratio	-0.02	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	-0.04	-0.11	-0.09	-0.02	1.00	
(18)	Debt-to-equity ratio	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.05	1.00
(19)	Earnings per share	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.07	0.03	0.01	0.04	0.02	0.01

Note: correlation coefficient above |0.3| is significant at a 90% level of confidence

Table 3.3 presents the result for the baseline hypotheses. Column 1 presents the results of baseline model when only control variables are included. The following control variables are statistically significant at 95%: patent applications (β = -0.677; p = 0.037), score of business-friendly regulations (β = 1.126; p = 0.000), IPR score (β = -0.178; p = 0.001), effect of tax on investment (β = -0.454; p = 0.000), FDI inflows per GDP (β = -2.129; p = 0.000), non-industry clinical trials (β = 0.003; p = 0.000), average immunization coverage rate (β = -0.010; p = 0.010), performance below aspirations (β = -0.571; p = 0.000), R&D intensity (β = 0.799; p = 0.000), total assets (β = -0.143; p = 0.000).

In column 2, I add the score of ethical behavior as an additional explanatory variable to the baseline model. The coefficient of ethical behavior is negative (β = -0.176; p = 0.017). The p-value indicates a 1.7% probability that the true relationship between ethical behavior and the number of pharmaceutical R&D in the host country is not negative. In this model, the healthcare expenditure per capita is now statistically significant at 95% confidence level (β = 0.042; p = 0.049). The coefficients and statistical power of the remaining control variables are qualitatively similar. In column 3, I add the score of government effectiveness in enforcing regulations as an additional explanatory variable to the baseline model in column 1. The coefficient of government effectiveness in enforcing regulations is negative (β = -0.325; p = 0.005). The p-value indicates a 0.5% probability that the true relationship between government effectiveness in enforcing regulations and the number of pharmaceutical R&D in the host country is not negative. Again, the coefficients and statistical power of the remaining control variables are qualitatively similar.

Table 3.3 Baseline results from zero-inflated negative binomial regression

DV: International R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior				-0.176	(0.074)	0.017				-0.136	(0.074)	0.071
Government effectiveness							-0.325	(0.115)	0.005	-0.278	(0.118)	0.018
Patent application in million	-0.677	(0.325)	0.037	-0.686	(0.325)	0.035	-0.546	(0.327)	0.095	-0.573	(0.328)	0.081
Healthcare expenditure per capita	0.042	(0.029)	0.149	0.058	(0.029)	0.049	0.057	(0.029)	0.051	0.068	(0.029)	0.023
Business friendly regulations	1.126	(0.073)	0.000	1.151	(0.074)	0.000	1.329	(0.103)	0.000	1.319	(0.103)	0.000
IPR score	-0.178	(0.052)	0.001	-0.064	(0.070)	0.365	-0.097	(0.059)	0.099	-0.021	(0.072)	0.774
Effect of tax on investment	-0.454	(0.042)	0.000	-0.416	(0.045)	0.000	-0.451	(0.042)	0.000	-0.423	(0.045)	0.000
FDI inflows per GDP	-2.129	(0.487)	0.000	-2.190	(0.483)	0.000	-2.114	(0.479)	0.000	-2.164	(0.479)	0.000
Annual GDP per capita growth	-0.001	(0.010)	0.907	0.003	(0.011)	0.780	-0.003	(0.010)	0.805	0.001	(0.011)	0.937
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage	-0.010	(0.004)	0.010	-0.011	0.003843	0.004	-0.009	(0.004)	0.019	-0.010	(0.004)	0.009
Performance below social aspirations	-0.571	(0.078)	0.000	-0.571	(0.078)	0.000	-0.568	(0.078)	0.000	-0.569	(0.078)	0.000
R&D intensity	0.799	(0.041)	0.000	0.799	(0.041)	0.000	0.798	(0.041)	0.000	0.798	(0.041)	0.000
Percentage of foreign sales	-0.167	(0.162)	0.303	-0.165	(0.162)	0.308	-0.170	(0.162)	0.294	-0.168	(0.162)	0.299
Log total assets	-0.143	(0.032)	0.000	-0.143	(0.032)	0.000	-0.141	(0.032)	0.000	-0.142	(0.032)	0.000
Current ratio	0.088	(0.014)	0.000	0.087	(0.014)	0.000	0.088	(0.0136)	0.000	0.087	(0.0136)	0.000
Debt-to-equity ratio	0.001	(0.003)	0.704	0.001	(0.003)	0.704	0.001	(0.003)	0.708	0.001	(0.003)	0.708
Earnings per share ($1000)	0.256	(0.155)	0.098	0.255	(0.155)	0.099	0.256	(0.155)	0.099	0.255	(0.155)	0.100
Inflate model												
Log total assets	-0.634	(0.044)	0.000	-0.634	(0.044)	0.000	-0.634	(0.044)	0.000	-0.634	(0.044)	0.000
Current ratio	0.137	(0.018)	0.000	0.137	(0.018)	0.000	0.138	(0.018)	0.000	0.137	(0.018)	0.000
Number of observations	80,127			80,127			80,127			80,127		
Wald chi2	2884.80			2890.51			2892.80			2896.05		
Prob > chi2	0.000			0.000			0.000			0.000		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence.

Column 4 of Table 3.3 presents the result when I include independent variables of interest and all control variables. The coefficient of ethical behavior remains a negative coefficient, but the statistical power drop ($\beta = -0.136$; $p = 0.071$). The p-value now indicates a 7.1% probability that the true relationship between ethical behavior and the number of pharmaceutical R&D in the host country is not negative. The coefficient of government effectiveness in enforcing regulations is also negative ($\beta = -0.278$; $p = 0.018$). The p-value indicates a 1.8% chance that the true relationship between government effectiveness in enforcing regulations and the count of international R&D in the host country is not negative. These findings provide support to hypotheses 1 and 2 that firms are choosing locations with lax ethical standards and weak government effectiveness in enforcing regulations to perform applied R&D, implying the strategic motive of institutional arbitrage.

Table 3.4 provides the regression results to test the moderating effect of performance relative to social aspirations. In these regressions, I include the interaction between two main independent variables of interest (ethical behavior and government effectiveness) and the binary variable of firms with performance below social aspirations (1= firms with performance below social aspirations). Column 1 in Table 3.4 presents the result when I include the interaction between ethical behavior and the performance below social aspirations. The interaction between ethical behavior and the performance below social aspirations has a negative coefficient ($\beta = -0.172$; $p = 0.000$). The p-value indicates that the chance of the true relationship between the interaction term and the count of international R&D in the host country is not negative is below 0.00%. This result

provides support to hypothesis 3a. The coefficients and statistical power of the remaining control variables are qualitatively similar to the previous results.

Column 2 in Table 3.4 presents the result when I include the interaction between the government effectiveness in enforcing regulations and the performance below social aspirations. The interaction between the score of government effectiveness in enforcing regulations and the performance below social aspirations has a negative coefficient ($\beta = -0.238$; $p = 0.000$). Again, the coefficients and statistical power of the remaining control variables are qualitatively similar to the previous results.

Column 3 in Table 3.4 presents the results when I include all interaction terms in one regression. The interaction between the host country's ethical behavior and performance below social aspirations is negative ($\beta = -0.086$; $p = 0.390$). The sign of coefficient supports the hypothesis 3a. However, the p-value indicates there is a 39% chance that the true moderating effect of performance below social aspirations on the relationship between host country ethical standards and the international R&D is not negative. The interaction between the host country's government effectiveness and the binary variable of the performance below social aspirations is also negative ($\beta = -0.134$; $p = 0.330$). The sign of coefficient provides support to hypothesis 3b. However, there is a chance of 33% that the true coefficient is not negative. It is important to note that the statistical power of interaction terms and the direct effect of main explanatory variables drop in this last model. A high correlation may be behind this change in statistical power among main independent variables. To address this problem, I run a robustness check in which their residual values replace the score of host country ethical behavior and government effectiveness in enforcing regulations.

Table 3.4. Results for the moderating effect of performance relative to social aspirations

DV: International R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior	-0.036	(0.080)	0.655	-0.145	(0.075)	0.055	-0.091	(0.098)	0.355
Government effectiveness	-0.301	(0.118)	0.010	-0.141	(0.123)	0.253	-0.213	(0.149)	0.152
Ethical behavior x Perf. below soc. asp.	-0.172	(0.048)	0.000				-0.086	(0.100)	0.390
Govt effective. x Perf. below soc. asp				-0.238	(0.066)	0.000	-0.134	(0.137)	0.330
Patent application in million	-0.610	(0.328)	0.063	-0.623	(0.327)	0.057	-0.620	(0.328)	0.059
Healthcare expenditure per capita	0.078	(0.030)	0.010	0.079	(0.030)	0.009	0.079	(0.030)	0.009
Business friendly regulations	1.329	(0.103)	0.000	1.326	(0.103)	0.000	1.328	(0.103)	0.000
IPR score	-0.023	(0.072)	0.750	-0.030	(0.072)	0.677	-0.027	(0.072)	0.709
Effect of tax on investment	-0.413	(0.045)	0.000	-0.412	(0.045)	0.000	-0.412	(0.045)	0.000
FDI inflows per GDP	-2.171	(0.480)	0.000	-2.194	(0.481)	0.000	-2.184	(0.481)	0.000
Annual GDP per capita growth	0.002	(0.011)	0.871	0.002	(0.011)	0.836	0.002	(0.010)	0.848
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage	-0.010	(0.004)	0.013	-0.010	(0.004)	0.012	-0.010	(0.004)	0.013
Performance below social asp.	0.254	(0.242)	0.293	-0.346	(0.099)	0.001	-0.031	(0.380)	0.935
R&D intensity	0.801	(0.041)	0.000	0.802	(0.041)	0.000	0.802	(0.041)	0.000
Percentage of foreign sales	-0.192	(0.163)	0.238	-0.186	(0.162)	0.252	-0.190	(0.163)	0.242
Log total assets	-0.142	(0.032)	0.000	-0.144	(0.032)	0.000	-0.143	(0.032)	0.000
Current ratio	0.087	(0.014)	0.000	0.087	(0.013)	0.000	0.087	(0.013)	0.000
Debt-to-equity ratio	0.001	(0.003)	0.728	0.001	(0.003)	0.711	0.001	(0.003)	0.719
Earnings per share ($1000)	0.250	(0.154)	0.104	0.253	(0.154)	0.101	0.251	(0.154)	0.103
Inflate model									
Log total assets	-0.631	(0.044)	0.000	-0.632	(0.044)	0.000	-0.631	(0.044)	0.000
Current ratio	0.137	(0.018)	0.000	0.137	(0.018)	0.000	0.137	(0.018)	0.000
Number of observations	80,127			80,127			80,127		
Wald chi2	2909.06			2909.27			2910.01		
Prob > chi2	0.000			0.000			0.000		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence.

Robustness checks

***Low cost as an alternative explanation and multicollinearity problem*.** High multicollinearity between primary independent variables, as well as other pairs of country-level independent variables, maybe due to the lurking effect of level of income. One could expect that as the income level of a country increases, ethical behavior, government effectiveness, and other development indicators also improve. These lurking factors may cause a high correlation among country-level variables. To address this problem, I do the following procedure. First, I run a regression for each of the variables on the GDP per capita, as shown in the following equations.

$$ET_{j,t} = \beta_0 + \beta_1 GDP_{j,t} + \varepsilon_{j,t} \quad \text{(Eq. 3.2)}$$

$$GE_{j,t} = \beta_0 + \beta_1 GDP_{j,t} + \varepsilon_{j,t} \quad \text{(Eq. 3.3)}$$

Where $ET_{j,t}$ denotes the score of perception of ethical business behavior in country j at time t. $GE_{j,t}$ denotes the score of perception of government effectiveness in enforcing regulations in country j at time t. $\varepsilon_{j,t}$ in each regression reflects the residuals or the level of dependent variables (ethical standards and government effectiveness) that are unexplained by GDP per capita. These residuals, therefore, take out the effect of host country income level in each of the variables. I then use these residuals as new independent variables of interest. This approach also addresses the argument of low cost (due to low level of income per capita) as alternative explanations to explain the offshoring of pharmaceutical R&D to developing countries, which happen to have low ethical standards and weak regulatory enforcement.

Table 3.5. Correlation matrix – with residual variables

No	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	International R&D	1.00																	
(2)	Ethical behavior (residual)	0.01	1.00																
(3)	Government effectiveness (residual)	0.00	0.41	1.00															
(4)	Patent application in million	0.00	0.06	0.23	1.00														
(5)	Healthcare expenditure per capita (in $000)	0.06	0.07	0.05	-0.03	1.00													
(6)	Business friendly regulations	0.04	0.47	0.04	-0.06	0.21	1.00												
(7)	IPR score	0.06	0.42	0.20	0.07	0.24	0.22	1.00											
(8)	Effect of tax on investment	-0.01	0.39	0.06	0.03	-0.08	0.08	0.43	1.00										
(9)	FDI inflows per GDP	-0.02	-0.12	-0.18	-0.07	-0.14	-0.11	0.15	0.25	1.00									
(10)	Annual GDP per capita growth in %	-0.04	0.07	-0.01	0.09	-0.31	-0.11	-0.20	0.19	0.11	1.00								
(11)	Non-industry clinical trials	0.11	0.05	0.15	0.44	0.29	0.04	0.35	-0.02	-0.11	-0.11	1.00							
(12)	Average immunization coverage rate in %	0.00	-0.06	0.06	0.12	-0.02	0.13	0.01	-0.12	0.06	-0.01	-0.01	1.00						
(13)	Performance below social aspirations	-0.09	-0.03	0.00	0.01	0.04	-0.01	0.02	0.00	0.00	-0.02	0.04	0.00	1.00					
(14)	R&D intensity	0.23	-0.01	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	0.02	0.01	0.00	-0.21	1.00				
(15)	Percentage of foreign sales	0.09	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.18	0.19	1.00			
(16)	Log total assets	0.20	-0.01	0.00	0.00	0.01	-0.01	0.01	0.00	0.00	0.01	0.01	0.00	-0.22	0.82	0.21	1.00		
(17)	Current ratio	-0.02	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	-0.04	-0.11	-0.09	-0.02	1.00	
(18)	Debt-to-equity ratio	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.05	1.00
(19)	Earnings per share ($1000)	0.01	-0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.07	0.03	0.01	0.04	0.02	0.01

Note: correlation coefficient above |0.3| is significant at a 90% level of confidence

Table 3.5 provides the correlation matrix with the residual values of ethical standards as well as government effectiveness in enforcing regulations. The correlation coefficient between the two main explanatory variables is now only 0.41. The correlation coefficients of pairs of country-level variables also drop to below 0.5.

Table 3.6 presents the regression results when I use the residual values of ethical standards and government effectiveness to test the baseline hypotheses. Column 1 presents the results when I add the residual value of ethical behavior alongside the control variables. The coefficient of ethical behavior is negative ($\beta = -0.456$; $p = 0.000$). The p-value indicates the probability that the true relationship between ethical behavior and the number of pharmaceutical R&D in the host country, not negative, is below 0.0%. The coefficients and statistical power of the remaining control variables are qualitatively similar to the previous models. In column 2, I add the residual values of government effectiveness in enforcing regulations as an additional explanatory variable alongside all control variables. The coefficient of government effectiveness in enforcing regulations remains negative ($\beta = -0.669$; $p = 0.000$). The p-value is below 0.0%. Again, the coefficients and statistical power of the remaining control variables are qualitatively similar.

Column 3 presents the result when I include independent variables of interest and all control variables. The coefficient of residual value of ethical behavior remains negative ($\beta = -0.356$; $p = 0.000$). The p-value indicates the probability that the true relationship between ethical behavior and the number of pharmaceutical R&D in the host country, not negative, is below 0.0%. The coefficient of residual values of government

effectiveness in enforcing regulations is also negative (β = -0.449; p = 0.000). The p-value of the interaction term is now very low. These findings provide strong support to hypotheses 1 and 2 that firms are choosing locations with lax ethical standards and weak government effectiveness in enforcing regulations to perform applied R&D, implying the strategic motive of institutional arbitrage.

Table 3.7 provides the regression results to test the moderating effect of performance relative to social aspirations, using the residual values of ethical standards and government effectiveness in enforcing regulations. Column 1 in Table 7 presents the result when I include the interaction between the residual value of ethical behavior and the performance below social aspirations. The interaction between the residual value of ethical behavior and the performance below social aspirations has a negative coefficient (β = -0.174; p = 0.029). The p-value indicates that the chance of the true relationship between the interaction term and the count of international R&D in the host country is not negative is below 2.9%. This result provides support to hypothesis 3a. The coefficient of residual value of ethical behavior remains negative (β = -0.249; p = 0.003). The coefficients and statistical power of the remaining control variables are qualitatively similar to the previous results.

Column 2 in Table 3.7 presents the result when I include the interaction between the residual value of government effectiveness in enforcing regulations and the performance below social aspirations. The interaction between the residual value of government effectiveness in enforcing regulations and the performance below social aspirations has a negative coefficient (β = -0.224; p = 0.266). The p-value indicates a 26.6% chance of the true relationship between the interaction term and the count of

international R&D in the host country is not negative. The sign of coefficient support hypothesis 3b, but the statistical power is weak. The coefficient of residual value of government effectiveness in enforcing regulations remains negative ($\beta = -0.317$; $p = 0.055$). Again, the coefficients and statistical power of the remaining control variables are qualitatively similar to the previous results.

Column 3 in Table 3.7 presents the results when I include all interaction terms in one regression. The interaction between the residual value of host country ethical behavior and performance below social aspirations is negative ($\beta = -0.165$; $p = 0.058$). The sign of coefficient supports hypothesis 3a, and the p-value indicates a 5.8% chance that the true relationship between the interaction of ethical behavior and the performance below social aspirations and the count of international R&D in the host country is not negative. The interaction between the residual value of host country government effectiveness and the binary variable of the performance below social aspirations is also negative ($\beta = -0.059$; $p = 0.789$). The sign of coefficient provides support to hypothesis 3b. However, there is a 78.9% chance that the true coefficient is not negative, and therefore the statistical power to support hypothesis 3b is weak.

Table 3.6. Robustness check 1 – using the residual value for ethical standards and government effectiveness

DV: International R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior (residual)	-0.456	(0.063)	0.000				-0.356	(0.067)	0.000
Government effectiveness (residual)				-0.669	(0.106)	0.000	-0.449	(0.114)	0.000
Patent application in million	-1.095	(0.326)	0.001	-0.866	(0.329)	0.009	-0.852	(0.329)	0.010
Healthcare expenditure per capita (in $000)	0.221	(0.041)	0.000	0.216	(0.041)	0.000	0.219	(0.041)	0.000
Business friendly regulations	0.967	(0.069)	0.000	0.747	(0.065)	0.000	0.906	(0.071)	0.000
IPR score	0.471	(0.036)	0.000	0.400	(0.033)	0.000	0.472	(0.036)	0.000
Effect of tax on investment	-0.378	(0.045)	0.000	-0.474	(0.043)	0.000	-0.392	(0.045)	0.000
FDI inflows per GDP	-1.385	(0.538)	0.010	-1.027	(0.528)	0.052	-1.441	(0.524)	0.006
Annual GDP per capita growth in %	0.000	(0.011)	0.989	-0.016	(0.010)	0.134	-0.003	(0.011)	0.785
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage rate in %	-0.012	(0.004)	0.001	-0.007	(0.004)	0.056	-0.011	(0.004)	0.006
Performance below social aspirations	-0.563	(0.078)	0.000	-0.555	(0.078)	0.000	-0.560	(0.077)	0.000
R&D intensity	0.799	(0.041)	0.000	0.798	(0.041)	0.000	0.798	(0.041)	0.000
Percentage of foreign sales	-0.169	(0.163)	0.302	-0.178	(0.163)	0.275	-0.173	(0.163)	0.288
Log total assets	-0.154	(0.032)	0.000	-0.150	(0.032)	0.000	-0.150	(0.032)	0.000
Current ratio	0.084	(0.014)	0.000	0.085	(0.013)	0.000	0.084	(0.014)	0.000
Debt-to-equity ratio	0.001	(0.003)	0.675	0.001	(0.003)	0.683	0.001	(0.003)	0.686
Earnings per share ($1000)	0.252	(0.154)	0.102	0.254	(0.154)	0.100	0.252	(0.154)	0.102
Inflate model									
Log total assets	-0.640	(0.043)	0.000	-0.640	(0.043)	0.000	-0.640	(0.043)	0.000
Current ratio	0.130	(0.018)	0.000	0.132	(0.018)	0.000	0.131	(0.018)	0.000
Number of observations	80,127			80,127			80,127		
Wald chi2	2844.94			2832.41			2860.40		
Log pseudolikelihood	-8462.89			-8469.15			-8455.16		
Prob > chi2	0.000			0.000			0.000		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence.

Table 3.7. Robustness check 1 –residual value for ethical standards and government effectiveness – with interactions

DV: International R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior (residual)	-0.249	(0.083)	0.003	-0.356	(0.067)	0.000	-0.255	(0.086)	0.003
Government effectiveness (residual)	-0.464	(0.114)	0.000	-0.317	(0.165)	0.055	-0.429	(0.175)	0.014
Ethical beh.(res.) x Perf. below soc. asp.	-0.174	(0.079)	0.029				-0.165	(0.087)	0.058
Govt. eff. (res.) x Perf. below soc. asp.				-0.224	(0.201)	0.266	-0.059	(0.219)	0.789
Patent application in million	-0.842	(0.330)	0.011	-0.835	(0.331)	0.012	-0.838	(0.331)	0.011
Healthcare expenditure per capita (in $000)	0.220	(0.041)	0.000	0.220	(0.041)	0.000	0.220	(0.041)	0.000
Business friendly regulations	0.904	(0.071)	0.000	0.906	(0.071)	0.000	0.904	(0.071)	0.000
IPR score	0.471	(0.036)	0.000	0.470	(0.036)	0.000	0.470	(0.036)	0.000
Effect of tax on investment	-0.388	(0.045)	0.000	-0.392	(0.045)	0.000	-0.388	(0.045)	0.000
FDI inflows per GDP	-1.454	(0.521)	0.005	-1.456	(0.523)	0.005	-1.458	(0.521)	0.005
Annual GDP per capita growth in %	-0.003	(0.011)	0.759	-0.003	(0.011)	0.750	-0.003	(0.011)	0.751
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage rate in %	-0.010	(0.004)	0.008	-0.010	(0.004)	0.007	-0.010	(0.004)	0.008
Performance below social aspirations	-0.560	(0.078)	0.000	-0.566	(0.078)	0.000	-0.562	(0.078)	0.000
R&D intensity	0.799	(0.041)	0.000	0.798	(0.041)	0.000	0.799	(0.041)	0.000
Percentage of foreign sales	-0.184	(0.163)	0.259	-0.171	(0.163)	0.294	-0.183	(0.163)	0.263
Log total assets	-0.150	(0.032)	0.000	-0.149	(0.032)	0.000	-0.150	(0.032)	0.000
Current ratio	0.084	(0.013)	0.000	0.084	(0.014)	0.000	0.084	(0.014)	0.000
Debt-to-equity ratio	0.001	(0.003)	0.698	0.001	(0.003)	0.672	0.001	(0.003)	0.693
Earnings per share ($1000)	0.248	(0.154)	0.106	0.251	(0.154)	0.103	0.248	(0.154)	0.106
Inflate model									
Log total assets	-0.639	(0.043)	0.000	-0.640	(0.043)	0.000	-0.639	(0.043)	0.000
Current ratio	0.131	(0.018)	0.000	0.132	(0.018)	0.000	0.131	(0.018)	0.000
Number of observations	80,127			80,127			80,127		
Wald chi2	2865.17			2861.64			2865.24		
Prob > chi2	0.000			0.000			0.000		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence.

***Clinical trials for tropical diseases as an alternative explanation*.** The proponent of R&D offshoring in the pharmaceutical industry also argue that another motive of clinical trials globalization is to test the drug candidate for tropical diseases. Most tropical diseases are in developing countries, which happen to have low ethical standards and weak regulatory enforcement. However, based on data available in clinicaltrials.gov, there are only 1302 clinical trials for tropical diseases or 0.45% of total clinical trials. If we count only foreign clinical trials, those for tropical diseases are only 0.61% of clinical trials. In the population of registered clinical trials, I found industry-sponsored clinical trials for tropical diseases are only 356, or 0.12% of total clinical trials. Within the samples, I found that clinical trials for tropical diseases are only 0.04% of the total projects in the sample. Nevertheless, to account for this alternative explanation, I run a series of regressions, in which clinical trials for tropical diseases are excluded from the sample despite their low proportion in the sample. The results are provided in Table 3.8. Column 1 of Table 3.8 presents the result without the interaction terms. The coefficient of residual value of ethical behavior is negative ($\beta = -0.352$; $p = 0.000$). The p-value indicates that the probability of the true relationship between ethical behavior and the number of pharmaceutical R&D in the host country not negative is below 0.0%. The coefficient of residual values of government effectiveness in enforcing regulations is also negative ($\beta = -0.458$; $p = 0.000$). The p-value of this interaction term is also very low. These findings provide strong support to hypotheses 1 and 2.

Table 3.8. Robustness check 2 – clinical trials for tropical diseases are excluded

DV: International R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior (residual)	-0.352	(0.067)	0.000	-0.252	(0.086)	0.003
Government effectiveness (residual)	-0.458	(0.114)	0.000	-0.431	(0.175)	0.014
Ethical behavior (res.) x Performance below social aspirations				-0.161	(0.087)	0.064
Government effectiveness (res.) x Performance below social aspirations				-0.069	(0.219)	0.753
Patent application in million	-0.828	(0.329)	0.012	-0.814	(0.331)	0.014
Healthcare expenditure per capita (in $000)	0.220	(0.041)	0.000	0.221	(0.041)	0.000
Business friendly regulations	0.903	(0.071)	0.000	0.901	(0.071)	0.000
IPR score	0.472	(0.036)	0.000	0.470	(0.036)	0.000
Effect of tax on investment	-0.392	(0.045)	0.000	-0.389	(0.045)	0.000
FDI inflows per GDP	-1.438	(0.524)	0.006	-1.456	(0.521)	0.005
Annual GDP per capita growth in %	-0.003	(0.011)	0.774	-0.004	(0.011)	0.739
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage rate in %	-0.011	(0.004)	0.006	-0.010	(0.004)	0.007
Performance below social aspirations	-0.565	(0.078)	0.000	-0.567	(0.078)	0.000
R&D intensity	0.799	(0.041)	0.000	0.800	(0.041)	0.000
Percentage of foreign sales	-0.210	(0.164)	0.201	-0.219	(0.164)	0.182
Log total assets	-0.147	(0.032)	0.000	-0.146	(0.032)	0.000
Current ratio	0.086	(0.014)	0.000	0.085	(0.014)	0.000
Debt-to-equity ratio	0.001	(0.003)	0.671	0.001	(0.003)	0.677
Earnings per share ($1000)	0.251	(0.154)	0.103	0.248	(0.153)	0.107
Inflate model						
Log total assets	-0.635	(0.043)	0.000	-0.634	(0.043)	0.000
Current ratio	0.132	(0.018)	0.000	0.132	(0.018)	0.000
Number of observations	80,127			80,127		
Wald chi2	2857.78			2862.54		
Prob > chi2	0.000			0.000		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence.

Column 2 of Table 3.8 presents the result with interaction terms to test for the moderating effect of performance relative to social aspirations. The interaction between the residual value of ethical behavior and the binary variable indicating firms with performance below social aspirations is negative ($\beta = -0.161$; $p = 0.064$). The p-value indicates a 6.4% chance that the true effect of the interaction terms between ethical behavior and the performance below social aspirations on the number of pharmaceutical R&D in the host country is not negative. Thus, the result provides supports to hypothesis 3a. The interaction between the residual value of government effectiveness and the binary variable indicating firms with performance below social aspirations is negative ($\beta = -0.069$; $p = 0.753$), which confirms hypothesis 3b. However, the p-value indicates a 75.3% chance that the true effect of the interaction terms between ethical behavior and the performance below social aspirations on the number of pharmaceutical R&D in the host country is not negative.

Alternative specifications. I run alternative specifications to check the robustness of results from zero-inflated negative binomial regression. I run three regressions of panel data method: (i) random effect negative binomial regression, (ii) fixed-effect negative binomial regression, and (iii) mixed-effect negative binomial regression. The random effect model assumes that variation across observations (firm-location dyad) is random and uncorrelated with the independent variables. The fixed-effect model, on the other hand, assumes that variation across observations is correlated with the independent variables included in the model. The fixed-effect model controls for time-invariant unobserved characteristics to solve the potential correlations between independent variables and the variation across observations. Lastly, the mixed effect model assumes

that variation across the lowest level observations (firm-location dyad) is random uncorrelated with the independent variables. However, the variation in higher-level observations (in this case, firm-level) may be correlated with the independent variables. The mixed-effect model solves this problem by controlling for time-invariant unobserved characteristics at the firm level. Results from these regressions are presented in Table 3.9. Again, results from these regressions are qualitatively similar to results presented in previous sections, in which I find strong support for hypotheses 1, 2, and 3a.

Additional analysis: The limit of institutions-arbitraging motive

In this section, I explore the limit to institutions-arbitraging motives. Firms are unlikely to choose locations with the lowest ethical requirements or the weakest regulatory enforcements if those locations do not have sufficient knowledge infrastructure to support R&D activities. This proposition indicates that the negative effect of host country ethical standards or regulatory enforcements on the number of international R&D is weaker in a set of locations with low knowledge infrastructure than in a set of locations with high knowledge infrastructure. To test for such a proposition, I run additional regressions (presented in Table 3.10), in which I separate the sample into two groups. The first group consists of host countries with a low level of knowledge creation activity, which is defined as countries in the bottom 25th percentile distribution of aggregate R&D expenditure per capita. Hence, locations with a high level of knowledge creation activity are defined as countries above the 25th percentile distribution of aggregate R&D expenditure per capita.

Table 3.9. Robustness check 3 – alternative specifications

DV: International R&D count	Random Effect			Fixed Effect			Mixed Effect		
	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior (residual)	-0.296	(0.071)	0.000	-0.297	(0.072)	0.000	-0.246	(0.105)	0.019
Government effectiveness (residual)	-0.614	(0.153)	0.000	-0.605	(0.153)	0.000	-0.447	(0.187)	0.017
Ethical behavior (res.) x Performance below social aspirations	-0.146	(0.075)	0.050	-0.144	(0.075)	0.055	-0.203	(0.099)	0.041
Government effectiveness (res.) x Performance below social aspirations	-0.173	(0.189)	0.361	-0.182	(0.190)	0.339	-0.151	(0.232)	0.517
Patent application in million	-0.078	(0.273)	0.775	0.273	(0.320)	-0.622	-0.653	(0.301)	0.030
Healthcare expenditure per capita (in $000)	0.184	(0.034)	0.000	0.184	(0.034)	0.000	0.212	(0.035)	0.000
Business friendly regulations	0.996	(0.063)	0.000	0.993	(0.063)	0.000	0.957	(0.075)	0.000
IPR score	0.476	(0.033)	0.000	0.474	(0.033)	0.000	0.462	(0.045)	0.000
Effect of tax on investment	-0.271	(0.038)	0.000	-0.270	(0.038)	0.000	-0.332	(0.053)	0.000
FDI inflows per GDP	-1.856	(0.475)	0.000	-1.849	(0.476)	0.000	-1.582	(0.397)	0.000
Annual GDP per capita growth in %	-0.001	(0.009)	0.930	-0.001	(0.009)	0.935	-0.004	(0.009)	0.619
Non industry clinical trials	0.003	(0.000)	0.000	0.003	(0.000)	0.000	0.003	(0.000)	0.000
Average immunization coverage rate in %	-0.012	(0.003)	0.000	-0.012	(0.003)	0.000	-0.011	(0.004)	0.011
Performance below social aspirations	0.048	(0.078)	0.541	0.027	(0.079)	0.730	0.049	(0.266)	0.854
R&D intensity	0.314	(0.057)	0.000	0.277	(0.059)	0.000	0.329	(0.179)	0.066
Percentage of foreign sales	0.171	(0.276)	0.535	0.286	(0.281)	0.308	0.961	(0.817)	0.240
Log total assets	0.094	(0.040)	0.019	0.085	(0.042)	0.042	0.185	(0.132)	0.162
Current ratio	0.001	(0.006)	0.872	0.001	(0.006)	0.877	0.001	(0.020)	0.969
Debt-to-equity ratio	0.002	(0.003)	0.397	0.002	(0.003)	0.362	0.003	(0.003)	0.356
Earnings per share ($1000)	0.312	(0.214)	0.146	0.306	(0.215)	0.154	0.327	(0.246)	0.184
LR test vs. pooled	2101.91			NA			NA		
Prob chi-sq	0.000			0.000			0.000		
No of observations	80,127			80,127			80,127		
Wald chi-sq	2905.450			2837.530			21447.88		

Note: Year fixed effects are included to account for the unobserved time-varying effects. However, for the sake of brevity, the results of year fixed effects are not presented in the table. Wald chi-squared are all significant at a 99% level of confidence. For mixed-effect, observations are grouped in the firm-level for the second level of the hierarchy.

Table 3.10. Regression in two groups: locations with low-level knowledge infrastructure vs. high-level knowledge infrastructure

DV: International R&D count	Low knowledge-creation locations			High knowledge-creation locations		
	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Ethical behavior (residual)	-1.377	(0.677)	0.042	-0.281	(0.069)	0.000
Government effectiveness (residual)	1.192	(0.728)	0.110	-0.686	(0.119)	0.000
Patent application in million	14.197	(32.677)	0.664	-0.941	(0.331)	0.005
Healthcare expenditure per capita	-0.327	(0.963)	0.734	0.214	(0.041)	0.000
Business friendly regulations	3.197	(0.707)	0.000	0.841	(0.071)	0.000
IPR score	0.455	(0.618)	0.462	0.391	(0.038)	0.000
Effect of tax on investment	-0.353	(0.343)	0.303	-0.360	(0.046)	0.000
FDI inflows per GDP	-7.298	(7.912)	0.356	-1.455	(0.516)	0.005
Annual GDP per capita growth	0.007	(0.059)	0.909	-0.001	(0.011)	0.919
Non industry clinical trials	0.022	(0.016)	0.167	0.003	(0.000)	0.000
Average immunization coverage rate	-0.005	(0.026)	0.862	-0.013	(0.004)	0.001
Performance below social aspirations	-0.980	(0.346)	0.005	-0.556	(0.079)	0.000
R&D intensity	0.607	(0.156)	0.000	0.818	(0.043)	0.000
Percentage of foreign sales	-3.351	(1.118)	0.003	-0.071	(0.164)	0.666
Log total assets	-0.091	(0.148)	0.538	-0.166	(0.033)	0.000
Current ratio	0.289	(0.102)	0.005	0.086	(0.014)	0.000
Debt-to-equity ratio	-0.084	(0.098)	0.390	0.002	(0.003)	0.578
Earnings per share	-0.002	(0.035)	0.960	0.598	(0.343)	0.081
Inflate model						
Log total assets	-0.315	(0.128)	0.014	-0.659	(0.044)	0.000
Current ratio	0.300	(0.098)	0.002	0.132	(0.017)	0.000
Number of observations	12,374			67,753		
LR chi2	133.26			2559.11		
Prob > chi2	0.000			0.000		

Note: The group of countries with a low level of knowledge creation activity is defined as countries in the bottom 25th percentile distribution of aggregate R&D expenditure per capita. The group of countries with a high level of knowledge creation activity is defined as countries above the 25th percentile distribution of aggregate R&D expenditure per capita.

The result in Table 3.10 shows that the effect of host ethical standards on the number of international R&D is negative and statistically significant in the group of countries with a low level of knowledge creation activities (β = -1.377; p = 0.042). In the group of countries with a high level of knowledge creation activities, the effect of host ethical standards on the number of international R&D is also negative and statistically significant (β = -1281; p = 0.000). The t-test reveals that the effect of ethical standards is weaker in the group of countries with a high level of knowledge infrastructure. The effect of host country government effectiveness in enforcing regulations is not statistically significant in the group of countries with a low level of knowledge creation (β = 1.192; p = 0.110). On the contrary, the effect of government effectiveness in enforcing regulations is negative and statistically significant in the group of countries with a high level of knowledge creation activities (β = -0.686; p = 0.000). The t-test shows that the coefficients in the two groups are statistically different. This result may indicate that when selecting locations among countries with a high level of knowledge infrastructure, pharmaceutical firms are looking for countries with an ineffective government.

Visual illustration on the moderating effect of social aspirations of performance

I draw a graph to facilitate the understanding of the negative moderating impact of social aspirations of performance. I use the result from column 3 of Table 3.7 in creating the graphs. Figure 3.3 shows that when ethical behavior score in the host country is low, firms with performance below social aspirations have more international R&D counts than firms with performance above social aspirations. As ethical behavior in the host country improves, both groups show a decline in international R&D count, but the diminishing rate of international R&D count is faster for firms with performance below

social aspirations than for firms with performance above social aspirations. When the host country's ethical behavior standard is high, firms with performance below social aspirations, on average, have less international R&D counts than firms with performance above social aspirations.

Figure 3.3 Interaction between ethical standards and social aspirations of performance

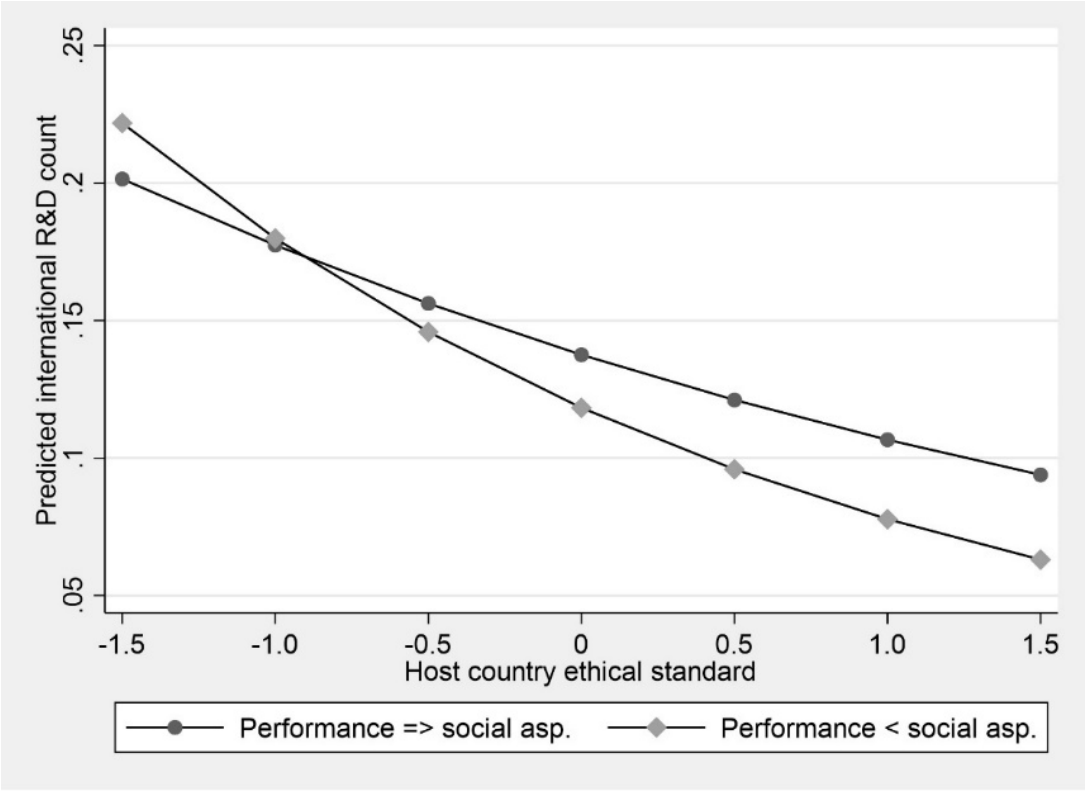
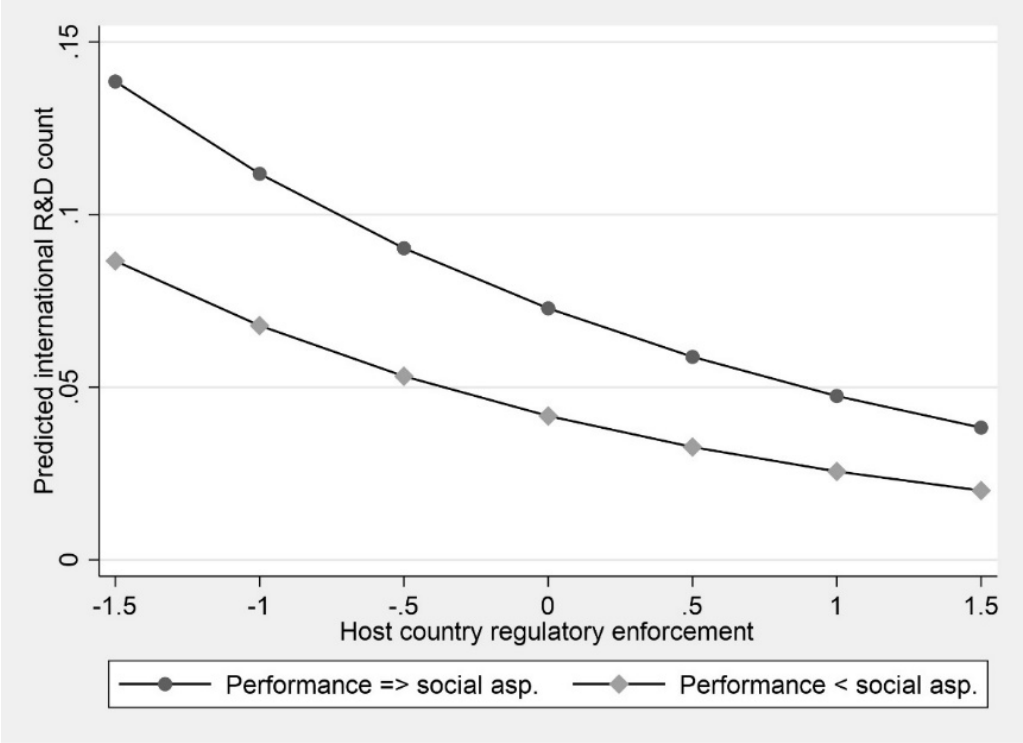


Figure 3.4 shows that when the government's effectiveness in enforcing regulations is low, both groups have higher predicted counts of R&D. As the effectiveness of the host country government in enforcing regulation improves, both groups show a decline in international R&D counts, at a similar rate.

Figure 3.4. Interaction between regulatory enforcement and social aspirations of performance



VI. DISCUSSION AND CONCLUSION

I have discussed how pharmaceutical firms can use international R&D as a mechanism to avoid regulatory oversights and conceal their inability to meet regulatory requirements. I further argue that such institutions-arbitraging R&D search for locations with lax ethical standards and weak regulatory enforcement. Using the information on the location choice of clinical trials by the pharmaceutical firms, I find that the count of international R&D undertaken by US-based pharmaceutical firms is negatively associated with the ethical standards and weaker regulatory enforcement in the host countries. Furthermore, I also find that firms that perform below social aspirations have a greater likelihood to engage in institutions-arbitraging R&D. Therefore, they are more likely to locate R&D in host countries with low ethical standards.

How this study contributes to theories of international R&D?

The literature on R&D internationalization (Almeida, 1996; Bartlett & Ghosal, 1989; Cantwell, 1989; Florida & Kenney, 1994; Frost, Birkinshaw & Ensign, 2002; Jaffe, Trajtenberg & Henderson, 1993; Nobel & Birkinshaw, 1998; Frost, 2001) often portray international R&D as innovation-based strategy and are motivated by the need to search and transfer knowledge around the world. Using the institutional arbitrage perspective, I suggest that there exists a hidden motive of international R&D, in which some pharmaceutical firms use it as a strategy to avoid home country regulatory oversights. Two conditions make such institutions-arbitraging R&D possible. First, there are discrepancies in the ethical standards or regulatory enforcements around the world. Second, home country regulatory agencies do not often evaluate the ethical merits, or the regulatory merits, of R&D activities undertaken in foreign locations on the basis that such R&D activities fall outside the jurisdictions of home country government. The findings of this study echo the pollution-haven hypothesis, which argues that firms are looking for lax environmental regulations to gain their competitiveness in the market.

Moreover, this study contributes to the literature on institutional theory by examining a condition under which firms are more inclined to engage in institutions-arbitraging strategy. Using insights from behavioral theory, I argue that underperformed firms have more pressure to engage in an institutions-arbitraging strategy that can help them reduce the costs, albeit unethically. This finding also sheds light on the firm-level heterogeneity in operating the institutional avoidance strategy.

How can this study inform managers and policymakers?

This study has several implications for managerial practice. First, managers need to realize that engaging in institutions-arbitraging R&D activities, although it can reduce the costs of regulatory compliance and speed up the product development process, can also have a detrimental effect on the firm's reputation. The costs to repair the firm's reputation may be greater than the cost saved by such a strategy. The result of this study also shows the importance of monitoring international R&D activities. Many multinational companies outsource their product development process to foreign contractors (or known as a contract research organization in the case of the pharmaceutical industry) to lower the total costs of R&D. Managers of a multinational company need to realize that those foreign contractors may adhere to a set of ethical principles that may be different from the ethical regulations at home. Monitoring ethical practices of foreign contractors and incentivizing them to adhere to the universally accepted ethical standards are essentials to prevent future reputational damages.

Given the possibility of institutions-arbitraging as a hidden motive of international R&D, there is a need for policymakers to scrutinize the globalization of R&D, especially the movement of R&D activities to developing countries. The institutions-arbitraging R&D can put consumers in danger, as anecdotal evidence of clinical (mis)trials in China and India have shown. Unethical practices of international R&D by some firms can also have a negative spillover effect on other firms that engage in knowledge-seeking or knowledge-exploiting international R&D.

This study also implies that differences in institutional quality across the world can undermine the objectives of rules and regulations imposed by the domestic government. The institutions-arbitraging R&D can incentivize the government to lower

down their ethical standards to attract international R&D, which may lead to the race to the bottom. Lowering ethical standards and regulatory enforcements to attract foreign R&D is harmful to society as it violates human rights and endangers the life of research participants. Race to the bottom situation in ethical standards can also undermine the efforts of some government to attract innovation-based foreign direct investment through the development of knowledge infrastructure.

Given the potential negative impact of institutions-arbitraging R&D on consumers, other firms, and the overall institutional quality, the need for policy coordination around the world to prevent firms from arbitrarily choose institutions is imperative. Supranational institutions have the capability and incentives to coordinate the policy that can limit the arbitrage opportunity. This study also shows that supranational institutions should look into regulatory enforcement and create incentives for the government to enforce them. Government and supranational institutions can also work with industry associations to ensure the ethical practices in international R&D because unethical practices by some firms, in the end, can create a bad reputation for the entire industry.

Limitations and future studies

This study is not without limitations. First, this study relies on an important assumption that R&D regulatory oversights can impose significant costs or limit the scope of R&D activities. The regulatory oversights on R&D, however, varies across industries. R&D activities that do not require human participants are subject to fewer regulatory oversights. Thus, in some industries, institutions-arbitraging R&D motives do not apply. Nevertheless, this argument can still apply to other industries because there are plenty of

sectors, in which R&D activities are subject to ethical standards and regulations (Weinbaum *et al.,* 2019). For example, there are regulations on data protection or privacy in the finance and financial technology industry that affects the big data analytics or consumer research. Such regulations on data protection vary across locations, and this can encourage institutions-arbitraging consumer research. In the agriculture industry, there are regulatory oversights on biodiversity that affect agriculture R&D. In the engineering-based industry, such as automotive, R&D regulatory oversights are aiming to protect the research workers. This type of regulatory oversight, again, varies across countries.

Second, there could be a potential endogeneity problem between low performance and the use of institutions-arbitraging strategy. The decision of underperformed firms to engage in institutional escape strategy may not be driven by problemistic search, but by the low ethical values of managers. Future studies should attempt to separate the problemistic search motive from the ethical values of the manager to remedy the potential self-selection problem.

Another topic for future consideration is the impact of institutions-arbitraging international R&D on the reputation of the firm. Despite its potential benefit in terms of reducing the cost of operations, engaging in institutions-arbitraging international R&D can also jeopardize a firm's reputation. Future studies can account for the importance of reputation for the firm and how the value of current reputation affects the likelihood to locate international R&D in countries with low ethical standards or weak regulatory enforcements.

CHAPTER FOUR

THE DOMESTIC IMPACT OF INTERNATIONAL R&D

I. INTRODUCTION

The escalation of companies' foreign activities has attracted attention from policymakers and the public, some of whom argue that foreign activities by firms negatively affect the domestic employment and the growth of real wages, particularly of the low-skilled labor (Brainard & Riker, 1997; Crino, 2012; Hummels, Jørgensen, Munch, & Xiang, 2014; Ottaviano, Peri, & Wright, 2013; Wright, 2014). The supporters, on the other hand, argue that increased internationalization across various spectrums of a firm's activities will have a positive benefit on investments, employment, and wages at home (Desai, Foley, & Hines, 2005; Feenstra & Hanson, 1996). In the past, such debate had focused exclusively on the offshoring of low value-added activity and how it influences the employment in the United States (Brainard & Riker, 1997; Feenstra & Hanson, 1996; Freeman, 1995). Recently, this debate shifts to discussion on the benefit and risks of the offshoring of high value-added activity, such as research and development. This shift reflects the changing landscape of globalization as scholars have documented the internationalization of research and development (Cantwell & Mudambi, 2005; Demirbag & Glaister, 2010; Lewin, Massini, & Peeters, 2009; Manning, Massini, & Lewin, 2008; Von Zedtwitz & Gassmann, 2002). Manning *et al.* (2008) have also found that the offshoring of the new product development process, including R&D, was the second most offshored business function.

In the popular press, the discussion of R&D offshoring often has been distorted with the discussion on outsourcing. Many analysts and commentators equate the offshoring strategy to outsourcing. This distortion of offshoring definition has led to the assumption that R&D internationalization causes a reduction in domestic R&D-related

jobs. In his op-ed in the Washington Post, Wadhwa (2016)[8] argued that the internationalization of R&D had increased the dependence of American firms to foreign technology and labors. Branstetter, Glennon, and Johnson (2019), in their policy brief, also documented the raising concern about the loss of United States competitiveness and technological leadership due to the offshoring of R&D, particularly the offshoring to developing countries. Analysts and observers in the popular media have also linked the product development offshoring to the foreign original design manufacturer (ODM) and original equipment manufacturer (OEM) to the decline in American firms' aggregate R&D expenditure in 2002 (CIO, 2005)[9]. The medical profession has expressed similar concerns that the growth of pharmaceutical companies' clinical studies in foreign locations contributes to the decline in the number of clinical studies in the United States (Glickman *et al.*, 2009).

The negative perception of the impact of international R&D on the domestic economy is founded on two assumptions (Branstetter *et al.*, 2019; Hufbauer, Moran & Oldenski, 2013). The first assumption is that foreign R&D activities are a substitute for domestic R&D activities. Second, international R&D is assumed to provide little benefit to the domestic economy, and perhaps can be detrimental to domestic employment and innovation capabilities.

These assumptions may not provide an accurate description of reality. Offshored R&D by multinational companies can complement and support domestic R&D activities. For example, an R&D laboratory in the headquarters can collaborate with foreign

[8] https://www.washingtonpost.com/news/innovations/wp/2016/05/17/trumps-demand-that-apple-must-make-iphones-in-the-u-s-actually-isnt-that-crazy/?utm_term=.fcb2b73516c0
[9] https://www.cio.com/article/2448823/innovation-ships-out.html

subsidiary laboratories to speed up the product development process. Foreign research organizations often conduct local experiments that provide the knowledge inputs to multinational companies, and the resulting knowledge combination can help multinational companies expand their productivity and competitiveness.

The contradicting narratives about the nature of the relationship between international R&D and domestic R&D warrant an empirical examination. This study attempts to provide evidence to such questions by evaluating the domestic impact of the foreign applied R&D projects. To comprehend their impacts on the extent of domestic R&D activities, we must first recognize the heterogeneous motives and characteristics of international R&D activities. I propose that there exist two generic types of international R&D, the cost-reducing and the knowledge augmenting foreign R&D activities. These two types of R&D differ in their objectives and other characteristics. The cost-reducing international R&D is driven by efficiency motive, whereas the knowledge-augmenting international R&D is driven by knowledge creation. Because of this difference, the cost-reducing and the knowledge-augmenting R&D activities, and how they influence the extent of domestic R&D, must be analyzed from different theoretical viewpoints. In this study, I draw from the economics argument of cost-economizing offshoring to evaluate cost-reducing international R&D and use the knowledge-based perspective to evaluate knowledge-augmenting international R&D.

It is important to note that the cost-reducing and the knowledge-augmenting international R&D activities, in reality, may not be mutually exclusive. Foreign R&D units may have both cost-reducing and knowledge-augmenting mandates. However, such a conceptual distinction of various international R&D activities can help us better

comprehend the mechanism in which international R&D influence the extent of domestic R&D activities.

Furthermore, I argue that the effect of international R&D on domestic R&D is contingent on the variation of the firm's resources and the managerial discretion in operating those resources. I extend the conceptual prediction of the domestic impact of international R&D by accounting for the firm-level heterogeneity of slack resources, defined as a stock of potential resources beyond the minimum level necessary that can be redeployed for the achievement of organizational objectives (George, 2005; Nohria & Gulati, 1996; Sharfman, Wolf, Chase, & Tansik, 1988). I focus on two classifications of slack resources based on the manager's discretionary power: high-discretion slack resources that can be redeployed easily by managers to execute a strategic action, and low-discretion slack resources that are intended for specific usage and cannot be redeployed for different purposes (George, 2005; Lin, Cheng, & Liu, 2009). I argue that firms with greater high-discretion slack resources have greater flexibility than firms with smaller high-discretion slack resources to expand international R&D activities that complement the expansion of domestic R&D. Hence, I argue that high-discretion slack resources strengthen the positive association between international and domestic R&D. On the other hand, low-discretion slack resources make managers more selective in foreign R&D projects. As a consequence, they are likely to choose foreign R&D that can substitute, rather than complement, domestic R&D. Hence, I submit that the extent of low-discretion slack resources weakens the relationship between foreign R&D and domestic R&D.

This study has important theoretical and policy implications. Drawing from economic and strategic management literature, this study contributes to the development of the conceptual typology of international R&D, which can advance the understanding of the various characteristics of different types of foreign R&D and how they influence the domestic R&D. Second, this study contributes to the literature of offshoring by shifting the analysis from the offshoring of labor-intensive and low value-added activity to the offshoring of high value-added activity. In the policy arena, this study helps to clarify the two contradicting views on the domestic impact of international R&D activities by multinational companies. This study suggests that the apprehension of international R&D is not warranted.

II. THEORETICAL BACKGROUND

Offshoring from cost-economizing perspective

There are two conflicting theoretical predictions concerning the effect of offshoring on domestic activity (Barbe & Riker, 2017; Desai *et al.*, 2005; Freeman, 1995). The first camp argues that offshoring is motivated by the differences in the price of labor across locations, and therefore they argue that offshoring substitutes the domestic activity. As a result, this camp argues that the growth of offshoring is associated with a decline in domestic activities. The second camp, on the other hand, argues that offshoring increases the productivity of the firm because firms follow the logic of comparative advantage in choosing the best location for certain activities. The process of matching certain activities and the locations that can best support such activities results in increased productivity at home, which then encourages the expansion of domestic activities.

Past studies report mixed results in analyzing the impact of offshoring on domestic economic activity. Lipsey (1995) analyzed the offshoring behavior of American multinational firms and reported a small positive correlation between production offshoring and the domestic employment levels. Stevens and Lipsey (1992) analyzed the foreign investment behavior of seven multinational firms, concluding that offshoring in multiple locations substitutes for each other due to costly external financing. Using ten years average of aggregate data, Feldstein (1995) analyzes the relationship between foreign direct investment and domestic investment in OECD economies. Feldstein (1995) found evidence that direct investment abroad reduces domestic investment levels.

Other studies found a positive association between offshoring and domestic activity. Devereux and Freeman (1995) studied bilateral flows of aggregate investment funds between seven OECD countries and found no evidence of tax-induced substitution between domestic and foreign investment. Desai *et al.* (2005) reported that the growth of foreign investment by American firms has a positive effect on domestic investment, after correcting for potential endogeneity. A study by Blonigen (2001), however, finds both substitute and complementary effect between foreign investment and domestic production. Table 4.1 provides a summary of economic studies on the impact of offshoring on domestic economic activities. These economic studies demonstrate the productivity benefits of offshoring. In general, these studies found that offshoring activities enable firms to increase domestic investments and create more high-skilled jobs at the expense of low-skilled jobs.

Most past studies analyze offshoring in aggregate, which includes both the offshoring of low value-added activities, such as routinized manufacturing and the

offshoring of high value-added activities undertaken by the firm. By not recognizing the difference between low value-added and high value-added activities, past studies might misinterpret the mechanism that explains the effect of offshoring on domestic activities. For example, a foreign subsidiary that serves as the center of R&D has a different purpose than a foreign subsidiary that functions as the hub of assembly works. While the former complements the associated domestic activities, the later substitutes the equivalent domestic activities. Hence, equating the offshoring of R&D activities to the offshoring of assembly works can create a false assumption with regards to the domestic impact of international R&D. By focusing on the offshoring of applied R&D, this study can a more nuanced theoretical mechanism to explain the nature of the relationship between foreign activity and domestic activity.

Table 4.1. Summary of economic studies on the domestic impact of offshoring

No	Authors	Dependent Variable	Level of analysis	Summary of findings
1	Stevens and Lipsey (1992)	Domestic investment	Firm-level	Offshore investments substitute domestic activities
2	Lipsey (1995)	Domestic employment	Firm-level	Offshore activities complement domestic activities
3	Feldstein (1995)	Domestic investment	Country-level	Foreign investments substitute domestic investments
4	Devereux and Freeman (1995)	Domestic investment	Country-level	No evidence of tax-induced substitution between domestic and foreign investment
5	Feenstra and Hanson (1996)	The demand for skilled labor in the domestic market	Industry-level	Offshore activities complement domestic activities, such that an increase in offshore investment is positively associated with an increase in the demand for skilled labor
6	Brainard and Riker (1997)	Domestic labor wage	Industry-level	The substitution effect between offshore activities and domestic employment is small
7	Blonigen (2001)	Domestic production	Firm-level	There are both substitute and complementary effects of foreign investment and domestic production.
8	Desai et al. (2005)	Growth of domestic investments	Firm-level	Foreign investments complement domestic investments, after correcting for potential endogeneity
9	Crino (2012)	The demand for high- and medium-skilled workers in domestic markets	Industry-level in multiple countries setting	Offshore activities are associated with an increase in demand for high- and medium-skilled workers, suggesting the complementary effect of offshore activities
10	Hummels *et al.* (2014)	The wage of high-skilled and low-skilled workers	Industry-level	Offshore activities increase the wage of high-skilled workers but decrease the wage of low-skilled workers
11	Ottaviano *et al.* (2013)	The employment level of natives and immigrants	Industry-level	Easier offshoring does not have significant effects on the employment level of natives and immigrants in the United States
12	Wright (2014)	Domestic production workers employment	Industry-level	Offshore activities increased total production workers but decreases the employment of "offshorable" workers

Knowledge-based perspective on international R&D

In the knowledge-based economy, the ability of the firm to absorb and combine knowledge from various locations through international research and development has become one of the key drivers of competitive advantage. In the pursuit of global knowledge creation, many multinational companies have started to internationalize (and decentralize) their R&D to foreign locations since the late 1980s (Kono & Lynn, 2007). Past studies pointed out two primary objectives of international R&D (Kuemmerle, 1999; Cantwell & Mudambi, 2005). The first objective is knowledge exploiting, in which foreign R&D is tasked to absorb the knowledge created in headquarter and transform such knowledge to satisfy the local demands or requirements. The second objective of foreign R&D is knowledge-creating, in which foreign R&D is designed to absorb local knowledge and transfer them to headquarter or to other locations within a multinational company's network.

These past studies argue that either knowledge-exploiting or knowledge-creating foreign R&D serves as complements to R&D activities undertaken at home. D'Agostino, Laursen, and Santangelo (2013) further found that variations in locations' comparative advantages explain the nature of complementarity between foreign R&D and domestic R&D. Building on the view of international R&D as a mechanism for knowledge augmentation, I develop the theoretical predictions about the effect of foreign R&D on domestic R&D.

Organizational theories of slack resources

Organizational theories have been interested in the impact of resources on firm strategy and performance. One type of resources that has been widely discussed in the

management literature is slack resources, which is defined as a pool of potential assets or resources beyond the minimum level necessary that can be directed or redeployed for the achievement of organizational objectives (George, 2005; Nohria & Gulati, 1996; Sharfman, Wolf, Chase, & Tansik, 1988). Slack resources, therefore, the abundance of resources or the opposite of resource constraints. Studies have used financial slack resources in different forms as a predictor of risk-taking (Wiseman & Bromiley, 1996), innovation (Nohria & Gulati, 1996), and performance (Tan & Peng, 2003). Specifically, researchers have shown that slack loosens internal controls and creates capital that can be allocated toward risky projects, and therefore nurturing an environment for innovation (Damanpour, 1987; Greve, 2003).

The financial slack resources vary in forms depending on the degree of managers' discretionary power in using and redeploying the resources (George, 2005; Sharfman *et al.*, 1988). The first category is high-discretion slack resources, which can be used in a wide variety of situations. Because of its generic purpose, the high-discretion slack resources provide managers flexibility to execute a strategic action. Some examples of high-discretion slack resources are unused cash, receivables, material inventory, temporary workers, and general-purpose machinery that can be re-deployed for different products (George, 2005). Another category of slack resources is the low-discretion slack resources, which can be used only as protection in a very few specific situations such as demand shocks, paying off debt, or capacity failure (Sharfman *et al.*, 1988). Because they are available only for a specific situation, low-discretion slack resources cannot be re-deployed for other purposes. Hence, managers do not have flexibility in utilizing these low-discretion slack resources because of the situation-specific purpose of such

resources. Typical examples of low-discretion slack resources are the capacity of debt, fixed assets, and specific-purpose production technology.

Sharfman *et al.* (1988) argued that when a firm has slack resources, the total level of such resources consists of both high- and low-discretion slack resources. However, evidence found that the two types of slack resources are negatively correlated (Sharfman, 1985). The low-discretion slack resources that can be used in specific situations are not likely to be found at the same time when flexible high-discretion slack resources are needed. This finding implies that firms face a trade-off in accumulating high-discretion and low-discretion slack resources.

Building on the organizational theories of slack resources, I argue that the availability of slack resources moderates the relationship between foreign R&D and domestic R&D. Still, the moderating effect of slack resources varies depending on their category. While high-discretion slack resources provide flexibility for firms to augment their innovative activities through foreign locations, low-discretion slack resources limit the knowledge augmentation purpose of foreign R&D. Thus, while firms with a high level of high-discretion slack resources view foreign R&D more as a complementary than a substitute of domestic R&D, firms with a high level of low-discretion slack resources view foreign R&D more as a substitute. I discuss this argument in detail in the hypothesis development section.

Research setting: the pharmaceutical industry

The research setting of this study is the clinical trials or the applied R&D in the pharmaceutical industry. Clinical trials primarily involve the testing of chemical compounds discovered in the primary research stage on human subjects. Pharmaceutical

firms are increasingly offshoring clinical trials to foreign locations through clinical research organizations (CROs), foreign affiliates, and universities or research institutes (Azoulay, 2004). Based on data from clinicaltrials.gov, pharmaceutical firms in the US are highly active in internationalizing their clinical trials. As of April 2019, data shows that 57% of clinical trials in the recruiting stages took place exclusively outside the US, and 5% took place in both the US and foreign locations. In addition to knowledge-augmenting motive, as suggested by international business scholars, experts in the medical profession argue that the offshoring of R&D activities is also motivated by cost-saving. One estimation shows that offshoring clinical trials to foreign countries, on average, cut the total costs by 40% (Glickman *et al.*, 2009). Another estimation shows that the costs of clinical trials in developing countries are less than one-tenth of the clinical trial cost in the United States (Garnier, 2008). The reduction in costs in foreign clinical trials is associated with lower labor costs, as well as lower regulatory-associated expenses. Based on this cost-saving perspective, I argue that the growth in foreign R&D increases the total capacity of the R&D budget, and therefore leads to the expansion of domestic R&D.

It is important to note that the clinical trial is only a subset of whole R&D activities undertaken by pharmaceutical industries. Thus, the use of clinical trials as a measurement of R&D activities should be taken with precautions that this measurement does not include the drug discovery process (or the component of basic research in the R&D).

III. HYPOTHESES DEVELOPMENT

The relationship between foreign R&D and domestic R&D

I submit that there exists a positive relationship between foreign R&D and domestic R&D. To understand such a relationship, one should recognize the two types of international R&D: the cost-reducing and the knowledge-augmenting international R&D. The cost-reducing international R&D is driven by efficiency motive and is established in low costs location. The knowledge-augmenting international R&D, on the other hand, is driven by either knowledge-exploiting or knowledge-creating motives. The knowledge-augmenting R&D search for knowledge-intensive locations so that it can take advantage of local knowledge infrastructure. The expansion of either cost-reducing or knowledge-augmenting international R&D is positively associated with the expansion of domestic R&D. However, the underlying mechanism in each type of international R&D is different. The positive effect of cost-reducing international R&D on domestic R&D can be understood through a cost minimization perspective. Whereas the positive effect of knowledge-augmenting international R&D can be explained through competence-creating and competence-exploiting framework from strategic management.

The cost-minimization perspective submits that the offshoring of activities is the result of cost disparity across locations (Kedia & Mukherjee, 2009; Lewin *et al.*, 2009). This view then further argues that the firm strategically selects locations for a specific activity that can minimize the total costs of this activity. In the context of international R&D, the advocates of this view suggest that firms locate their R&D subsidiaries in labor-intensive countries (Chung & Yeaple, 2008; Manning *et al*., 2008) or in countries with minimum regulatory-associated costs (Glickman *et al.*, 2009). The cost-saving resulted from international R&D enables the firm to allocate more resources for the expansion of R&D projects at home.

In the pharmaceutical industry, this view can explain the offshoring of clinical trials in developing countries. Glickman *et al.* (2009) found that the costs of clinical trials undertaken in developing countries on average are 40% lower than the costs of domestic trials. The reduction in costs of clinical trials undertaken in developing countries comes from two sources. First, the labor costs (e.g., the salary of physicians, scientists, and other medical workers) in developing countries are generally lower than labor costs in the United States or other developed countries. Based on the interview with executives, Garnier (2008) found that the labor costs of conducting clinical trials in India are one-tenth of the labor costs of conducting clinical trials in the second-tier labs in the United States. Second, the costs associated with the regulatory compliance of ethical requirements are generally lower in developing countries. Past studies have shown anecdotal evidence that pharmaceutical firms locate clinical trials in countries with lower ethical standards to reduce the burden of regulatory costs (Glickman *et al.*, 2009). Manning *et al.* (2008) also showed that 72% of executives reported that the secondary motive of R&D offshoring is costs-saving in a non-labor related expense. The unused financial resources resulted from the cost-savings of international R&D can be re-deployed to fund the expansion of domestic R&D. Hence, the cost minimization perspective predicts the positive effect of the expansion of international R&D on the expansion of domestic R&D.

Now I turn into the knowledge-based perspective from the strategic management literature. Early studies on the internationalization of R&D, in general, has argued that firm international R&D is more an expansion than a substitute of domestic knowledge creation activities (Almeida, 1996; Cantwell, 1989; Jaffe, Trajtenberg & Henderson,

1993; Nobel & Birkinshaw, 1998; Frost, 2001; Frost & Zhou, 2005). This literature suggests the two objectives of international R&D units, knowledge exploitation, and knowledge creation (Ambos, 2005; Cantwell & Mudambi, 2005; Kuemmerle, 1999; Shimizutani & Todo, 2008). The knowledge-exploiting foreign R&D units are local adaptors, that is, their purpose is to adapt knowledge developed at the home country in the host country. The local adaptation of knowledge is essential when the product of the firm is not universal, and when local institutional and cultural context influence the purchase decision. The knowledge-creating foreign R&D units are the knowledge provider. The knowledge-creating foreign R&D units are tasked by the headquarter to absorb unique knowledge endowment available in the host countries (Cantwell & Mudambi, 2005; Frost, 2001). The result of learning in foreign locations is then transferred and processed further in the headquarter or other locations within the network of the multinational company. The knowledge-creating foreign R&D units are attracted to host country knowledge infrastructures, such as the availability of local scientists or engineers, or the quality of the national system of innovation (Kuemmerle, 1999). Jaffe *et al.* (1993) found that R&D by the subsidiaries of multinational companies have a higher likelihood to cite the host country patents than local firms, signifying the knowledge creation objective of foreign R&D. The two purposes of foreign R&D units imply that R&D offshoring to foreign locations serves more as an extension than as a substitute for domestic R&D.

In the context of clinical research in the pharmaceutical industry, supporters of clinical trials offshoring argue that foreign clinical trials enable American pharmaceutical firms to tap into the large pool of scientists and healthcare workers in foreign locations.

Also, foreign clinical trials enable firms to test location-specific diseases, such as tropical diseases (Nundy & Gulhati, 2005). This argument would suggest that the internationalization of R&D in the pharmaceutical industry can broaden the knowledge base of pharmaceutical firms because the unique knowledge acquired in foreign locations can stimulate the growth of knowledge creation activities at home. Hence, I submit

> *Hypothesis 1: The expansion of foreign R&D undertaken by pharmaceutical firms is positively associated with the expansion of domestic R&D.*

The moderating effect of high-discretion slack resources

High-discretion slack resources reflect the readily available resources (e.g., current assets) under the discretion of managers (Lin, Cheng, Liu, 2009; Sharfman *et al.*, 1988). High-discretion slack resources can easily be re-deployed by top managers to help in achieving organizational goals. Hence, a high degree of high-discretion slack resources allows managers to pursue innovative projects because the possession of high-discretion slack resources can protect the organization from the uncertain outcomes of those projects and to experiment with a strategy such as new product development (Nohria & Gulati, 1996). Accumulating high-discretion slack resources can provide several benefits for firms in financing R&D projects.

First, because high-discretion slack resources are under the foresight of managers, they allow the pursuit of risky R&D projects that may not appear justifiable from the perspective of shareholders but may have high potential from the perspective of scientists or internal management. Holding high-discretion slack resources also means that firm does not have to raise capital to fund R&D projects. Because raising new capital is costly

and taking time, holding high-discretion slack resources also provides the benefits of cost-saving and time-saving in pursuing new R&D projects.

In line with the above arguments, I argue that holding high-discretion slack resources increases the capacity fo the firm that enables them to complement domestic R&D with more foreign R&D projects. There are three ways that high-discretion slack resources encourage a more positive relationship between domestic and international R&D activities. First, holding high-discretion slack resources can help a firm avoids raising new capital to finance foreign R&D projects. Furthermore, high-discretion slack resources do not need approval from shareholders. Thus managers can make a timely decision on the international R&D expansion. Second, high-discretion slack resources can protect firms from a relatively higher risk of offshoring R&D to foreign locations, as they served as a buffer when risky R&D projects failed. Therefore, high-discretion slack resources enable firms to select complementing, rather than substituting, foreign R&D projects. In the context of the pharmaceutical industry, firms with high-discretion slack resources have a greater capacity to extend on-going domestic clinical trials to foreign locations, for example, by recruiting more participants in foreign countries. Holding high-discretion slack resources also means that pharmaceutical firms can speed up the foreign clinical trials, and thus shorten the time for the drug development process. For this reason, I argue that in firms with a high level of high-discretion slacks, the domestic R&D activities are growing faster in response to the growth of domestic R&D activities than in firms with a low level of high-discretion slacks. Hence,

> *Hypothesis 2: The availability of high-discretion slack resources positively moderates the relationship between the expansion of foreign R&D and the expansion of domestic R&D*

The moderating effect of low-discretion slack resources

The second type of slack resource is low-discretion slacks that represent the excess resources that can only be used in few specific situations, such as demand shocks, capacity failure, or paying off debt (Sharfman *et al.*, 1988). Because they can only be used in specific situations, low-discretion slack resources can only be re-deployed for certain uncommon circumstances. Hence, managers cannot use low-discretion slack resources flexibly, which can limit the strategic actions of managers. Stockpiling low-discretion slack resources increases the protection over some special situations like a capacity failure or risk failure in paying off debts, but low-discretion slacks resources constrain the potential strategic experimentation such as risky and uncertain R&D projects.

Thus, firms that accumulate low-discretion slack resources face more significant constraints in deciding to expand their R&D projects to foreign locations because assets are mostly directed towards the protection of specific situations. Facing such limitations, firms with a high level of low-discretion slack resources become more selective when deciding to invest in foreign R&D projects. As a result, firms with a high level of low-discretion slack resources are likely to prefer foreign R&D projects that can substitute, rather than complement, domestic R&D projects. In the context of the pharmaceutical industry, firms with low-discretion slack resources are likely to prefer foreign clinical trials that can replace the high-costs domestic clinical trials. For this reason, I argue that low-discretion slacks weaken the positive association between the growth of foreign and the growth of domestic R&D activities. Hence,

Hypothesis 3: The availability of low-discretion slack resources negatively moderates the relationship between the expansion of foreign R&D and the expansion of domestic R&D

IV. EMPIRICAL DESIGN

Data and variables

I test the above propositions in the context of the pharmaceutical industry. I randomly select 200 pharmaceutical firms from the list of firms in the pharmaceutical industry provided by Mergent Horizon. Out of 200 samples, 14 firms do not have firm-level data. Thus, the final sample consists of data from 186 pharmaceutical firms. I then collect the location information of phase three clinical trial data for these186 firms from clinicaltrials.gov. I look for clinical trials in the period between 2000 to 2017. From the clinical trial location information, I can identify how many R&D (specifically drug development) projects were undertaken in foreign locations and how many projects were undertaken domestically. After eliminating missing values, the final dataset consists of 1,434 firm-year observations.

The dependent variable is the number of domestic R&D undertaken by pharmaceutical firms. In a robustness check, I also use the estimated domestic R&D expenditure as an alternative variable. The estimated domestic R&D expenditure is calculated based on the information on average clinical trial costs in the United States as available in Moore, Zhang, Anderson, and Alexander (2018). The costs of clinical trials differ depending on the type of diseases. For example, clinical trials in the area of cardiovascular disease, on average, cost USD 157.2 million, while clinical trials in the area of respiratory disease, on average, costs only USD 20 million. I combine this estimation of clinical trial costs (by the disease areas) with the information of disease

areas for each of the pharmaceutical firms' R&D portfolio in the sample, and the result is the annual estimated domestic R&D expenditure for each firm in the sample.

The primary independent variable is the count of foreign R&D, which is measured as the number of clinical trials undertaken in foreign countries over the year. The moderating variables are high-discretion slack resources and low-discretion slack resources. I use the previous period's current ratio to measure the level of high-discretion slack resources. The current ratio is a liquidity ratio that reflects how a firm's current assets relative to its short-term obligations. The current ratio has been used as a proxy for high-discretion slack resources in past studies (George, 2005; Sharfman *et al.*, 1988). Moreover, I use the previous period equity-to-debt ratio to proxy for low-discretion slack resources. Equity-to-debt ratio measures how a firm can absorb its debt. This measure also reflects a firm's borrowing capacity in the case of economic shocks. The equity-to-debt ratio has been used to measure low-discretion slack resources in past studies (George, 2005; Lin *et al.*, 2009).

I include various control variables. First, I include the R&D intensity, measured by the ratio of R&D expenditure to total assets. Firms with high R&D intensity are likely to have more international and domestic R&D. Second, I include the percentage of foreign sales. This control variable accounts for the market orientation of the firm. Firms with international orientation are more likely to have greater domestic and international R&D activities. Third, I include the firm size, as measured by the log of total assets. Firm size is expected to have a positive effect on both domestic and international R&D. Fourth, I include the total assets turnover to account for the firm's efficiency level. More efficient firms are likely to have more domestic and international R&D activities. Fifth, I

include the change in cashflows per share. Firms with higher cashflows per share have greater financial capability to finance more R&D. Thus, cashflows per share are positively associated with domestic and international R&D. Lastly, I include a firm's financial performance, measured by return on assets ratio. Firms with higher performance will have greater ability to accumulate resources to finance future R&D, both domestic and international. All these firm-level variables are drawn from Mergent Horizon.

Econometric specification

The nature of the dataset in this study is time-variant cross-sectional data. The estimation method is the first-differenced equation, in which dependent and independent variables (except previous period slack resources are differenced over time. The first differencing variables allow for the elimination of the unobserved time-invariant factors that may cause a bias in estimation. The resulting intercept from a first-differenced equation is the change in the intercept from period one to period two.

As a robustness check, I also include a fixed effect panel data estimation. In fixed-effect panel data estimation, variables are not differenced, and I included firm-level and year fixed effects to account for firm-specific and time-specific unobserved heterogeneity.

Empirical strategy in addressing endogeneity problem

Examining the effect of the foreign R&D activities on the domestic R&D, however, is not straightforward. Foreign R&D and domestic R&D are jointly determined, which can make the evidence inconclusive due to potential bias. The use of instrumental variables that predict growth in foreign R&D but do not directly affect domestic R&D has the potential to identify any effect of foreign R&D on domestic R&D. The change in

locational factors, such as economic performance, institutional quality, and knowledge creation activities in foreign locations (host countries of R&D activities), have promise for such an instrument. Since the locations of foreign R&D differ significantly across firms, it is possible to construct firm-specific weighted averages of change in locational factors in a foreign location (e.g., foreign GDP growth, foreign institutional quality). These firm-specific change in locational factors of host countries can be used to generate predicted change of foreign R&D, which then be used to explain the change in domestic R&D. A similar method has been used by Desai et al. (2005) to measure the impact of foreign investment on domestic investment.

In this study, I use the firm-specific weighted averages of change in host country characteristics as instrumental variables. The host country characteristics are set of indicators that measure the change in (i) economic characteristics, (ii) institutional quality, and (iii) aggregate knowledge-creation activities in foreign locations where firm performs its R&D. There are two reasons to use the firm-specific weighted averages of change in host country characteristics. First, the locations of foreign R&D differ significantly across firms. Thus, there is a significant variation in the instrumental variables. The second reason is more conceptual. Firms change the extent and proportion of foreign R&D as a response to economic characteristics, institutional quality, and knowledge endowment of host countries (Cantwell & Mudambi, 2005; Demirbag & Glaister, 2010; Rosenbusch *et al.*, 2019). The change in those locational characteristics, however, do not have a direct influence on domestic activity. The locational characteristics of foreign countries influence the domestic activity of the firm only through the firm's activities in foreign countries. Thus, the firm-specific weighted

averages of change in host country characteristics in host countries can serve as instruments to identify the change in international R&D.

There are several steps in creating the instrumental variable. First, I created the yearly change for the following country-level indicators: GDP per capita, the level of business-friendly regulations, the rule of law, the government effectiveness in enforcing regulations, ethical behavior, and the ratio of total R&D expenditure to GDP. The yearly change of country-level indicator is calculated by differencing its score or value at the end of the period with the beginning of the period. These indicators are created for each host country of international R&D. Second, I created an aggregate country-level indicator that reflects the average of yearly change of all country-level indicators. The Cronbach-alpha score for this multidimensional indicator is 0.76, which implies that the host country characteristics are highly correlated. The last step is to aggregate the country-level multidimensional indicator at the firm level using the weights, measured as the proportion of R&D activity in each host country to the total R&D activity for the particular year.

Data on GDP per capita is drawn from the World Development Indicators and Michigan State University's globalEdge database. Indicators of business-friendly regulations, the rule of law, and government effectiveness are drawn from the World Governance Indicators. The indicator of business ethical behavior is drawn from the World Economic Forum Indicators.

V. RESULTS

Table 4.2 presents the descriptive statistics and correlation coefficient of all variables. The average change of domestic R&D count is 0.33, which indicates that domestic R&D,

on average, expands on an annual basis. The average change in international R&D is -0.05. The correlation between the change in domestic R&D and change in international R&D is 0.47. The change in estimated domestic R&D expenditure, as an alternative dependent variable, has an average of -1.67, indicating that the average estimated domestic R&D expenditure is declining on an annual basis.

Baseline results (without interaction terms) of the first-differenced estimation are presented in Table 4.3. In these regressions, change in international R&D count is instrumented with the firm-level weighted average of host-country characteristics. Column 1 in Table 3 shows the results when I include only control variables. Change in total assets turnover is significant at 95% level of confidence ($\beta = -0.229$; $p = 0.046$). Change in return on assets is also significant at 99% ($\beta = -0.018$; $p < 0.000$). Column 2 in Table 4.3 shows the regression result when I include only the predicted change in international R&D based on the regression with the firm-level weighted average change in host country characteristics as instrumental variables. The coefficient of the predicted change in international R&D is positive and statistically significant at a 99% level of confidence ($\beta = 0.971$; $p < 0.000$). Column 3 in Table 4.3 shows the results when I include all control variables and the predicted change in international R&D count. The coefficient of the predicted change in international R&D is again positive and statistically significant at a 99% level of confidence ($\beta = 1.008$; $p < 0.000$). This result supports hypothesis 1 that the change in international R&D is positively associated with the change of domestic R&D, implying the complementing relationship between foreign and domestic R&D.

Table 4.2. Descriptive statistics and correlation matrix

No	Variable	Obs	Mean	Std. Dev.	Correlation coefficient										
					(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Change in domestic R&D count	1,434	0.33	10.19	1.00										
(2)	Change in international R&D count	1,434	-0.05	2.02	0.47	1.00									
(3)	High-discretion slack $_{t-1}$	1,434	7.06	12.64	-0.04	0.00	1.00								
(4)	Low-discretion slack $_{t-1}$	1,434	20.29	32.23	0.00	0.03	0.08	1.00							
(5)	Change in R&D intensity	1,434	0.19	5.59	-0.01	-0.01	0.08	-0.02	1.00						
(6)	Change in log total assets	1,434	0.17	0.83	0.02	0.01	-0.12	0.00	-0.25	1.00					
(7)	Change in foreign Sales	1,434	0.00	0.07	0.02	0.02	0.00	0.01	0.00	0.06	1.00				
(8)	Change in total assets turnover	1,434	-0.01	0.27	-0.02	-0.02	0.00	-0.01	0.02	-0.14	-0.03	1.00			
(9)	Change in cashflows per share	1,434	0.07	1.45	0.01	0.00	-0.02	0.00	0.00	0.00	0.02	-0.02	1.00		
(10)	Change in return on assets (in %)	1,434	0.45	7.473	-0.07	0.16	-0.02	-0.04	-0.01	0.04	-0.05	-0.02	0.00	1.00	
	Alternative Dependent Variable:														
(11)	Change in estimated domestic R&D exp.	1,434	-1.67	77.04	0.93	0.46	0.03	0.02	-0.01	0.01	0.02	-0.02	0.01	-0.07	1.00

Note: |correlation coefficient| above 3 are significant at a 95% level of confidence. The current ratio measures High-discretion slack, while the equity-to-debt ratio measures low-discretion slack.

Table 4.3. Results of baseline regression. Method: first-differenced estimation with instrumental variables.

Dependent Variable: Change in domestic R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Change in international R&D count				0.971	(0.058)	0.000	1.008	(0.064)	0.000
High-discretion slack t-1	0.004	(0.003)	0.197				0.004	(0.002)	0.114
Low-discretion slack t-1	0.001	(0.001)	0.179				0.001	(0.001)	0.330
Change in R&D intensity	-0.004	(0.004)	0.385				-0.001	(0.003)	0.881
Change in log total assets	0.046	(0.043)	0.276				0.034	(0.032)	0.298
Change in foreign sales	0.536	(0.768)	0.485				0.451	(0.451)	0.318
Change in total assets turnover	-0.229	(0.114)	0.046				-0.320	(0.111)	0.004
Change in cashflows per share	-0.013	(0.009)	0.172				-0.006	(0.005)	0.299
Change in return on assets	-0.018	(0.001)	0.000				-0.018	(0.003)	0.000
Year fixed effect		Yes			Yes			Yes	
Number of observations		1434			1434			1434	
R-squared		4.93%			14.42%			14.29%	
F-stat		3.20		28.83				7.00	

Note: Change in international R&D count is instrumented using the firm-level weighted average host country characteristic. High-discretion slack is measured by the current ratio, while low-discretion slack is measured by the equity-to-debt ratio. F-stats are all significant at a 99% level of confidence.

Table 4.4 presents the results of the first-differencing estimation method for equations with interaction terms. In this model, each interaction term is instrumented with the interaction between instrument variable (indicator of host country characteristics) and the high- or low-discretion slack resources. The first column presents the result of regression with the interaction term between the change in international R&D and the high-discretion slack. In this specification, the direct effect of the change in international R&D is positive and remains significant at a 99% confidence level ($\beta = 0.890$; $p < 0.000$). The interaction between the change in international R&D and the high-discretion slack is positive and significant at a 99% level ($\beta = 0.008$; $p = 0.030$). The second column presents the result of regression with the interaction term between the change in international R&D and the low-discretion slack. The direct effect of change in international R&D is positive and remains significant at a 99% level ($\beta = 0.984$; $p < 0.000$). The interaction between the change in international R&D and the low-discretion resources is not significant ($\beta = 0.001$; $p = 0.536$). The last column shows the results when I include all interaction terms in one regression. The direct effect of the change in international R&D is positive and remains significant at a 99% level ($\beta = 0.884$; $p < 0.000$). The interaction between the change in international R&D and the high-discretion slack is positive and significant at a 99% level ($\beta = 0.008$; $p < 0.000$). Implying that hypothesis 2 is supported. The interaction between the change in international R&D count and the low-discretion slack resources is positive, but not statistically significant ($\beta = 0.006$; $p = 0.747$). This result does not support hypothesis 3 that low-discretion slack resources negatively moderate the positive association between the growth of international R&D and the growth of domestic R&D.

Table 4.4 Results of regression with interaction terms. Method: first-differenced estimation with instrumental variable.

Dependent Variable: Change in domestic R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Change in international R&D count	0.890	(0.077)	0.000	0.984	(0.066)	0.000	0.884	(0.085)	0.000
Change in international R&D x High-discretion slack t-1	0.008	(0.003)	0.030				0.008	(0.004)	0.000
Change in international R&D x Low-discretion slack t-1				0.001	(0.001)	0.536	0.001	(0.002)	0.747
High-discretion slack t-1	0.002	(0.002)	0.396	0.003	(0.002)	0.166	0.002	(0.002)	0.390
Low-discretion slack t-1	0.000	(0.001)	0.700	0.000	(0.001)	0.803	0.000	(0.001)	0.775
Change in R&D intensity	-0.001	(0.001)	0.880	-0.001	(0.002)	0.872	-0.000	(0.002)	0.871
Change in log total assets	0.040	(0.038)	0.284	0.038	(0.038)	0.308	0.040	(0.037)	0.282
Change in foreign sales	0.449	(0.726)	0.535	0.459	(0.725)	0.527	0.451	(0.726)	0.535
Change in total assets turnover	-0.279	(0.120)	0.020	-0.289	(0.122)	0.018	-0.278	(0.120)	0.021
Change in cashflows per share	-0.003	(0.007)	0.676	-0.005	(0.007)	0.433	-0.003	(0.008)	0.672
Change in return on assets	-0.001	(0.001)	0.761	-0.001	(0.001)	0.759	-0.001	(0.001)	0.762
Year fixed effect		Yes			Yes			Yes	
Number of observations		1434			1434			1434	
R-squared		14.38%			14.27%			14.39%	
F-stat		14.38			17.49			17.08	

Note: Change in international R&D count is instrumented using the firm-level weighted average host country characteristics. The interaction between change in international R&D and high-discretion slacks is instrumented with the interaction between host country characteristics and high-discretion slacks. The interaction between change in international R&D and low-discretion slacks is instrumented with the interaction between host country characteristics and low-discretion slacks. High-discretion slack is measured by the current ratio, while low-discretion slack is measured by the equity-to-debt ratio. F-stats are all significant at a 99% level of confidence.

Robustness checks

Estimated domestic R&D expenditure as an alternative dependent variable. For the first robustness check, I run a regression to examine the impact of international R&D on the change in domestic R&D expenditure. The estimated domestic R&D expenditure is calculated based on clinical trials estimated costs by disease areas available in Moore *et al.* (2018). Table 4.5 presents the result of the baseline regression. The international R&D count is the predicted value based on instrumental regression. The coefficient of change in international R&D is again positive and significant ($\beta = 33.293$; $p < 0.000$).

Table 4.6 presents the results of an alternative dependent variable with interaction terms. Interaction terms are predicted values from instrumental variable regression. The first column presents the result of regression with the interaction term between the change in international R&D and the high-discretion slacks. In this specification, the direct effect of the change in international R&D is positive and remains significant at a 99% level of confidence ($\beta = 28.648$; $p < 0.000$). The interaction between change in international R&D and high-discretion slack is positive, and significant at 95% level ($\beta = 0.316$; $p = 0.021$). The second column presents the result of regression with the interaction term between the change in international R&D and the low-discretion slack. The direct effect of the change in international R&D is positive and remains significant at a 99% confidence level ($\beta = 32.179$; $p < 0.000$). The interaction between change in international R&D and low-discretion slack resources is positive, but not significant ($\beta = 0.058$; $p = 0.349$). The last column of Table 4.6 shows the results when I include all interaction terms in one model. In this specification, the direct effect of change in international R&D is positive and remains significant at a 99% level of confidence ($\beta =$

28.171; $p < 0.000$). The interaction between the change in international R&D count and the high-discretion slack resources is positive and significant at a 95% confidence level ($\beta = 0.308$; $p = 0.023$). Implying that hypothesis 2 is again supported. The interaction between the change in international R&D and low-discretion slack resources is positive, but not statistically significant ($\beta = 0.037$; $p = 0.534$). This result does not support hypothesis 3 that low-discretion slack resources negatively moderates the positive association between the growth of international R&D and the growth of domestic R&D.

Alternative specification: fixed-effect panel data. I run a fixed-effect panel data estimation method to account for unobserved time-invariant, as well as time-specific factors that may correlate with independent variables. The count of international R&D is again instrumented. The baseline regressions (without interaction terms) of fixed-effect panel data are presented in Table 4.7. The coefficient of the predicted international R&D count is positive and significant at a 99% level of confidence ($\beta = 0.656$; $p < 0.000$). The last column in Table 4.8 displays the results when all variables are accounted in the model. In this regression, the coefficient of the predicted international R&D count is again positive and significant ($\beta = 0.620$; $p < 0.000$). Thus, hypothesis 1 is again supported. The interaction between predicted international R&D and high-discretion slack is positive and significant ($\beta = 0.012$; $p = 0.005$). Thus, the second hypothesis is also supported. However, in contrary to the third hypothesis, the interaction between predicted international R&D count and slow-discretion slack resources is positive, but not statistically significant ($\beta = 0.001$; $p = 0.553$).

Table 4.5. Robustness check 1: Estimated domestic R&D expenditure as the dependent variable. Baseline regression

Dependent Variable: Estimated domestic R&D expenditure	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Change in international R&D count				32.867	(1.992)	0.000	33.293	(2.216)	0.000
High-discretion slack t-1	0.103	(0.1001)	0.308				0.068	(0.086)	0.432
Low-discretion slack t-1	0.028	(0.041)	0.489				0.015	(0.037)	0.691
Change in R&D intensity	-0.112	(0.117)	0.337				0.041	(0.075)	0.586
Change in log total assets	2.109	(1.580)	0.182				1.053	(1.446)	0.466
Change in foreign sales	17.071	(27.322)	0.532				15.379	(27.017)	0.569
Change in total assets turnover	-7.117	(4.268)	0.096				-10.102	(4.586)	0.028
Change in cashflows per share	0.487	(0.325)	0.134				-0.143	(0.241)	0.553
Change in return on assets	-0.007	(0.022)	0.787				-0.007	(0.022)	0.755
Year fixed effect		Yes			Yes			Yes	
Number of observations		1434			1434			1434	
R-squared - overall		4.25%			11.86%			11.29%	
F-stat		2.57			21.68			13.24	

Note: Change in international R&D count is instrumented using the firm-level weighted average host country characteristics. High-discretion slack is measured by the current ratio, while low-discretion slack is measured by the equity-to-debt ratio. Domestic R&D expenditure is estimated based on Moore *et al.* (2018). Note: F-stats are all significant at a 99% level of confidence. The estimation method is the first-differenced equation with instrumental variables

Table 4.6. Robustness check 1: Estimated domestic R&D expenditure as the dependent variable - interaction terms

Dependent Variable: Change in estimated domestic R&D expenditure	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
Change in international R&D count	28.648	(2.847)	0.000	32.179	(2.705)	0.000	28.171	(3.205)	0.000
Change in international R&D x High-discretion slack t-1	0.316	(0.137)	0.021				0.308	(0.135)	0.023
Change in international R&D x Low-discretion slack t-1				0.058	(0.062)	0.349	0.037	(0.060)	0.534
High-discretion slack t-1	0.003	(0.081)	0.975	0.069	(0.086)	0.417	0.004	(0.082)	0.960
Low-discretion slack t-1	0.006	(0.037)	0.876	-0.003	(0.039)	0.946	-0.001	(0.038)	0.975
Change in R&D intensity	0.034	(0.058)	0.560	0.033	(0.053)	0.537	0.032	(0.059)	0.587
Change in log total assets	1.191	(1.391)	0.392	1.124	(1.396)	0.421	1.202	(1.395)	0.389
Change in foreign sales	15.457	(26.912)	0.566	15.852	(26.921)	0.556	15.523	(26.911)	0.564
Change in total assets turnover	-8.383	(4.557)	0.066	-8.794	(4.631)	0.058	-8.352	(4.553)	0.067
Change in cashflows per share	-0.046	(0.261)	0.863	-0.141	(0.241)	0.561	-0.048	(0.262)	0.854
Change in return on assets	-0.007	(0.022)	0.759	-0.007	(0.022)	0.756	-0.007	(0.022)	0.759
Number of observations	1434			1434			1434		
R-squared - overall	11.47%			11.35%			11.48%		
F-stat	12.61			14.48			14.24		

Note: International R&D count is instrumented using the firm-level weighted average host country characteristics. The interaction between change in international R&D and high-discretion slacks is instrumented with the interaction between host country characteristics and high-discretion slacks. The interaction between change in international R&D and low-discretion slacks is instrumented with the interaction between host country characteristics and low-discretion slacks. Domestic R&D expenditure is estimated based on Moore *et al.* (2018). Note: F-stat are all significant at a 99% level of confidence. The estimation method is the first-differenced equation with instrumental variables

Table 4.7. Robustness check 2: Baseline results with fixed-effect panel estimation

Dependent Variable: Domestic R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
International R&D count				0.698	(0.057)	0.001	0.656	(0.070)	0.000
High-discretion slack t-1	0.002	(0.004)	0.567				0.001	(0.004)	0.685
Low-discretion slack t-1	-0.002	(0.002)	0.258				-0.002	(0.001)	0.134
R&D intensity	0.001	(0.001)	0.103				0.001	(0.001)	0.185
Log total assets	0.235	(0.115)	0.042				0.184	(0.119)	0.127
Proportion of foreign sales	-0.872	(1.349)	0.519				-0.956	(1.375)	0.488
Total assets turnover	-0.051	(0.116)	0.658				-0.019	(0.103)	0.852
Cashflows per share	-0.039	(0.026)	0.141				0.013	(0.019)	0.518
Return on assets	0.016	(0.000)	0.348				0.017	(0.017)	0.315
Firm fixed effect		Yes			Yes			Yes	
Year fixed effect		Yes			Yes			Yes	
Number of observations		1802			1802			1802	
R-squared - within		7.94%			13.51%			14.04%	
R-squared - between		19.04%			13.71%			24.14%	
R-squared - overall		12.94%			12.78%			18.22%	
F-stat		7.38			31.42			22.43	

Note: International R&D count is instrumented using the firm-level weighted average host country characteristics. Note: F-stats are all significant at a 99% level of confidence. The estimation method is the fixed-effect panel data estimation.

Table 4.8. Robustness check 2: Results of moderating variables with fixed-effect panel estimation

Dependent Variable: Domestic R&D count	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value	Coefficient	Standard Error	p-value
International R&D count	0.644	(0.074)	0.000	0.627	(0.095)	0.000	0.620	(0.097)	0.000
International R&D x High-discretion slack t-1	0.008	(0.003)	0.017				0.012	(0.004)	0.005
International R&D x Low-discretion slack t-1				0.001	(0.001)	0.440	0.001	(0.001)	0.553
High-discretion slack t-1	0.001	(0.003)	0.798	-0.001	(0.001)	0.710	-0.002	(0.001)	0.173
Low-discretion slack t-1	-0.002	(0.001)	0.129	-0.002	(0.001)	0.144	-0.002	(0.002)	0.202
R&D intensity	0.001	(0.001)	0.183	0.001	(0.001)	0.175	0.001	(0.001)	0.176
Log total assets	0.186	(0.120)	0.124	0.241	(0.163)	0.143	0.243	(0.164)	0.141
Proportion of foreign sales	-0.982	(1.380)	0.478	-1.434	(1.938)	0.461	-1.473	(1.942)	0.449
Total assets turnover	-0.007	(0.102)	0.943	0.037	(0.158)	0.816	0.059	(0.156)	0.706
Cashflows per share	-0.037	(0.026)	0.154	-0.051	(0.040)	0.212	-0.053	(0.041)	0.198
Return on assets	0.013	(0.019)	0.521	0.037	(0.035)	0.282	0.036	(0.035)	0.304
Firm fixed effect		Yes			Yes			Yes	
Year fixed effect		Yes			Yes			Yes	
Number of observations		1802			1802			1802	
R-squared - within		14.20%			13.67%			13.86%	
R-squared - between		24.11%			24.46%			24.10%	
R-squared - overall		18.27%			18.64%			18.70%	
F-stat		22.44			17.60			17.38	

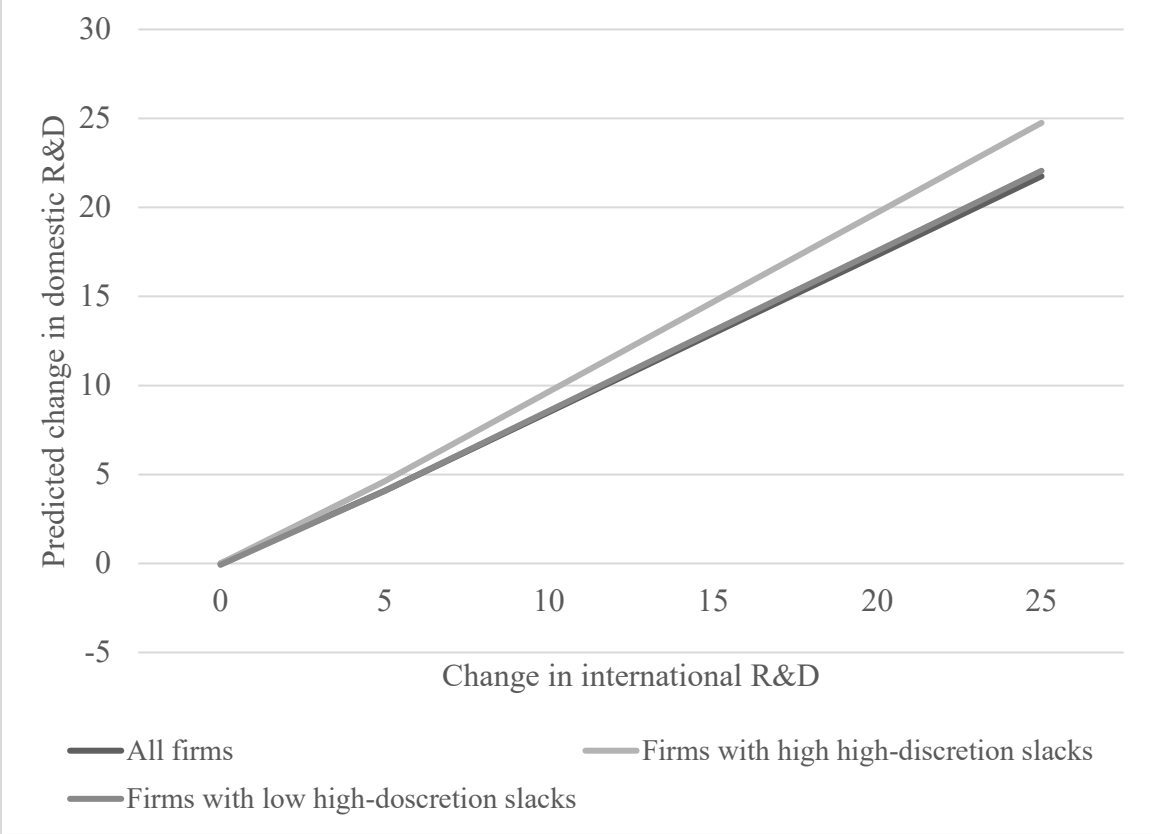
Note: International R&D count is instrumented using the firm-level weighted average host country characteristics. The interaction between change in international R&D and high-discretion slacks is instrumented with the interaction between host country characteristics and high-discretion slacks. The interaction between change in international R&D and low-discretion slacks is instrumented with the interaction between host country characteristics and low-discretion slacks. Note: F-stat are all significant at a 99% level of confidence. The estimation method is the fixed-effect panel data estimation.

Economic effect and graphical illustration

To facilitate the understanding of the relationship between international R&D and domestic R&D and how high-discretion slack resources moderate such relationship, I discuss the economic effect and their graphical illustration in Figures 4.1. Figure 4.1 shows the relationship between the growth of international R&D and the growth of domestic R&D for three categories (i) all firms (ii) firms with high high-discretion slacks, defined as firms with the current ratio above or equal to the industry average and (iii) firms with low high-discretion slacks, defined as firms with the current ratio below the industry average. On average, for all firms, as represented by the black line, an increase of the international R&D projects by five units is associated with an increase of domestic R&D projects by four units. On average, an increase of the international R&D projects by 10 units is associated with an increase of domestic R&D projects by eight units, while an increase of the international R&D projects by 20 units is associated with an increase of domestic R&D projects by 17 units. For firms with a high level of high-discretion slack resources, an increase of 10 international R&D projects is associated with additional nine domestic R&D projects, while an increase of 25 international R&D projects is associated with an increase of 24 domestic R&D projects.

For firms with a low level of high-discretion slack resources, an increase of five units of international R&D is associated with additional four domestic R&D projects, while an increase of 25 international R&D projects is associated with an increase of only 22 domestic R&D projects. Therefore, the marginal rate of domestic R&D in response to an increase in international R&D is higher in firms with abundant high-discretion slacks than in firms with a low level of high-discretion slack resources.

Figure 4.1. Moderating effect of high-discretion slack resources



Note: The graphs are modeled using the results of the last column of Table 4.4 Firms with high high-discretion slacks are defined as firms with the current ratio above or equal to the industry average, while firms with low high-discretion slacks are defined as firms with the current ratio below the industry average.

VI. DISCUSSION AND CONCLUSION

I analyze the domestic impact of international R&D. Using the cost-saving assumption from economic theory as well as the knowledge augmentation perspective from management literature, I propose that the R&D projects undertaken in foreign locations have a positive effect on the extent of R&D activities at home. Both perspectives suggest a complementary relationship between foreign R&D and domestic R&D. Furthermore, I argue that the positive relationship between foreign R&D and domestic R&D is contingent on the firm's slack resources. Following past studies, I divide slack resources

into two categories, high- and low-discretion slack resources. I argue that high-discretion slack resources strengthen the positive relationship between the international R&D and domestic R&D, while the low-discretion slack resources weaken such a relationship. Using clinical trials project data by American firms, I find support for the positive relationship between foreign and international R&D, and for the positive moderating impact of high-discretion slack resources.

How this study contributes to the literature on international R&D and offshoring?

This study contributes to the literature on international R&D by providing firm-level evidence of the relationship between international and domestic R&D. This study shows that the firms that expand their international R&D activities simultaneously expand their domestic R&D. This evidence runs counter to a simple, yet popular, intuition that the multinational companies growing R&D investments in foreign locations substitute for the domestic R&D activities.

Furthermore, the ideas and evidence presented in this study provide more nuances to the literature on the domestic impact of offshoring (Lipsey, 1995; Stevens and Lipsey, 1992; Feldstein, 1995; Devereux and Freeman, 1995; Blonigen, 2001; Desai *et al*., 2005). Extant studies have focused primarily on the impact of offshored manufacturing. In this paper, I discuss the domestic impact of R&D offshoring, which typically involves knowledge-creation activities. Third, this study contributes to a better understanding of the impact of R&D internationalization. Extant studies have focused primarily on the impact of R&D internationalization on firms' financial performance (Nieto & Rodriguez, 2011; Steinberg, Procher, & Urbig, 2017; Rosenbusch *et al.*, 2019) or the technological scope of the multinational companies (Scalera *et al.*, 2018). This study provides another

evidence that international R&D can complement domestic knowledge-creation activities.

Nevertheless, there exist boundary conditions under which the complementary effect of foreign R&D can change. This study finds that high-discretion slack resources encourage knowledge-augmentation through foreign R&D, whereas the accumulation of low-discretion slacks promotes substituting foreign R&D. These boundary conditions suggest that although we could expect that aggregate domestic R&D activities to increase following an expansion of international R&D, this suggested relationship may not always be appropriate when evaluating individual firms.

This study also contributes to a broader literature on the domestic impact of foreign direct investment. In contrary to popular beliefs, extant studies have found evidence that outward foreign investments bring a positive impact on domestic production capacity (Desai *et al.*, 2005; Lipsey, 1995), and the average wage of medium- or high-skilled labor (Crino, 2012; Hummels *et al.,* 2014). This study adds that multinational companies' R&D investment in foreign locations does not harm innovative activities at home.

How can this study inform managers and policymakers?

For managers, this study provides another evidence that the internationalization of R&D can bring another benefit for productivity at home. I submit that there are at least two types of international R&D, the cost-reducing R&D that can help multinational companies decrease a portion of R&D expenditures. The cost-savings can then be used for the expansion of domestic R&D to different areas. The second type of international R&D is the knowledge-augmenting R&D, in which firms tap into unique knowledge-

creation or the knowledge-exploitation opportunity in foreign locations. I argue that both types of international R&D have a positive impact on the expansion of knowledge creation activities at home.

In the policy arena, there is an ongoing debate among analysts and economists that the offshoring of R&D activities can harm the innovation advantage of American firms (see Branstetter *et al*., 2019 and Wadhwa's op-ed article in Washington Post in 2016). Those who advocate limitation on R&D offshoring assume that R&D activities by American firms' affiliates in foreign locations substitute for the domestic R&D activities. This study finds that such claims are unjustified. The evidence in this study points out that foreign R&D projects, in general, are complementary to domestic R&D, except for firms with a high level of low-discretion slacks. This evidence also shows that firms, in aggregate, do not operate on a zero-sum basis, in which an increase in foreign R&D takes away resources from domestic R&D. Thus, the R&D activities in the foreign location do not harm, but rather enhance, the domestic R&D activities. Indeed, the growing pool of highly educated scientists and engineers, especially in the developing world, could increase the rate of global productivity growth to the advantage of multinational companies. Policymakers, therefore, should promote more knowledge augmenting international R&D, for example, by promoting the strengthening of international intellectual protection rights.

Limitations and future studies

The paper has a few limitations that future research can address. First, the use of the pharmaceutical industry limits the generalizability of the findings. Future research in a different industry may provide insights into the relationship between foreign new

product development and the same activity at home. Second, this study points towards the moderating role of slack resources. However, there could be other boundary conditions that influence the nature of the relationship between foreign R&D and domestic R&D. Future research can evaluate other potential boundary conditions for such a relationship. Third, this study measures the quantitative change in domestic R&D following the expansion of international R&D. The evidence presented in this study does not measure the change in the quality of domestic R&D following the expansion of offshored R&D. Future studies could investigate whether the expansion of international R&D enable the multinational companies to focus on the high-impact domestic R&D projects, and thus increase the quality of domestic R&D activities. Lastly, future studies can also consider evaluating the impact of R&D internationalization on domestic employment and domestic investment.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

I. CONCLUSION

In this dissertation, I study the strategic motives and location choices of international R&D by multinational companies from institutions-based perspective. I also examine the domestic impact of R&D internationalization from cost economizing and knowledge augmentation perspective. The theoretical perspectives that I use offer different approach to analyze international R&D, and therefore have potentials to advance our understanding of international R&D. I examine the strategic motive and the implication of international R&D in two empirical studies. In the first study, I introduce the institutions-arbitraging as a strategic motive of international R&D. The institutions-arbitraging strategic motive of international R&D has not been explored in past studies. Using an integration of institutions-based perspective and performance feedback model, I develop a theoretical argument suggesting that institutions-arbitraging motive encourage firms to choose foreign countries with low ethical standards or weak regulatory enforcements for R&D locations.

In the second essay, I argue that international R&D complement R&D activities at home, and thus there is a positive relationship between the expansion of international and domestic R&D. However, the relationship between the strategic choices and a firm's performance is contingent on the availability of slack resources. I develop a theoretical argument on the relationship between international and domestic R&D using the integration of economics view on offshoring and competence-creation framework from strategic management. I test the theoretical arguments presented in the two studies on a sample of 186 pharmaceutical firms during the period from 2000 to 2017. The

pharmaceutical industry makes a perfect setting for my study because firms in this industry have a high propensity of R&D internationalization.

To test the institutions-arbitraging motive of international R&D, I examine the R&D locations preference of pharmaceutical firms. Specifically, I examine the relationship between host country ethical standards and regulatory enforcement and the number of international R&D undertaken by pharmaceutical firms in that location. Using the zero-inflated negative binomial regression, I find that there exists a negative relationship between host country ethical standards and the number of international R&D. Similarly, I also find a negative relationship between regulatory enforcement and the number of international R&D. These findings suggest that pharmaceutical firms, on average, prefer to locate their R&D in locations with low ethical requirements or weak regulatory enforcement. Furthermore, I find that firms whose performance below industry average have a greater propensity to locate R&D in countries with low ethical standards in comparison to firms with the above-average industry average.

For the second empirical study, I use instrumental variable regression to address the endogeneity in examining the relationship between international and domestic R&D. I find that international R&D positively influences domestic R&D activities, suggesting the complementary relationship between international and domestic R&D activities. Furthermore, I find that holding high-discretion slack resources positively moderates the relationship between international and domestic R&D while holding low-discretion slack resources negatively moderates such a relationship.

In summary, while I find that firms can use international R&D as a strategy to arbitrage institutions across borders, but on average international R&D activities have

positive impacts on the expansion of domestic R&D. The possible existence of institutions-arbitraging international R&D, nonetheless, suggests that it is important for policymakers to monitor the ethical conduct of multinational companies' R&D activities overseas to minimize the negative social impacts of such activities.

II. CONTRIBUTIONS

Several contributions emerge from my dissertation. First, this dissertation is a call to analyze international R&D from various theoretical perspective. Extant studies have dominantly used knowledge-based perspective to understand international R&D. This study use institutions-based perspective to analyze how regulatory oversights influences the motive and location choices of international R&D. In doing so, I depart from the traditional approach that views international R&D from a knowledge creation perspective. A focus on the regulatory aspect of R&D is suitable for studying international R&D activities that involve human experiments or that are governed by ethical standards. Second, by analyzing international R&D from institutions-based perspective, this study contributes to the existing literature by proposing institutions-arbitraging as a plausible strategic motive. The institutions-arbitraging motive of international R&D is also a call to scrutinize the ethical merits of international R&D.

Third, this dissertation also adds to the study on the consequences of international R&D. Extant studies focus on the impact of international R&D on the performance of the firm, while this study provides empirical evidence on the nature of relationship between international R&D activities and domestic R&D. In doing so, this study resolves the debate on the domestic impact of international R&D. Furthermore, this study proposes high-discretion and low-discretion slack resources as boundary conditions under which

the expected complementary effect of foreign R&D can change. These boundary conditions suggest that although we could expect aggregate domestic R&D activities to increase following an expansion of international R&D, this prediction may not always be appropriate when evaluating individual firms.

Additionally, this study contributes to the literature on the institutions-based view of global strategy. In the first essay, I integrate institutional economics and behavioral perspective to propose how past performance of the firm influences the likelihood to engage in institutions-arbitraging strategy. This integration sheds light on the boundary conditions of institutions-arbitraging strategy.

This study also contributes to a broader literature on the domestic impact of foreign direct investment. In contrary to popular beliefs, extant studies have found evidence that outward foreign investments bring a positive impact on domestic production capacity (Desai *et al.*, 2005; Lipsey, 1995), and the average wage of medium- or high-skilled labor (Crino, 2012; Hummels *et al.,* 2014). This study echoes past studies on the domestic impact of foreign investment and adds that multinational companies' R&D investment in foreign locations can also augment the innovative activities at home. Thus, this study suggests that the concern that foreign R&D activities by multinational companies reduce innovative activities at home is unfounded.

This dissertation has several implications for managers. First, managers of a multinational company need to realize the importance of monitoring international R&D activities. Many multinational companies outsource their product development process to foreign contractors (or known as a contract research organization in the case of the pharmaceutical industry) so that they can lower the total costs of R&D. Managers need to

realize that those foreign contractors may adhere to a set of ethical principles that could be different from the regulations at home. Monitoring ethical practices of foreign contractors and incentivizing them to adhere to the universally accepted ethical standards are essentials to prevent future reputational damages.

III. FUTURE DIRECTIONS

Several extensions to this dissertation are possible. First, I used the pharmaceutical industry as the empirical context of this study. It would be interesting to see whether the theoretical arguments developed in this dissertation also apply to a different context. Second, given the reputation risk of engaging in institutions-arbitraging R&D, the future study can account for the importance of reputation for the firm and how it affects the likelihood to locate international R&D in countries with low ethical standards or weak regulatory enforcements.

With regards to the implications of international R&D, future research could investigate whether the expansion of international R&D enable the multinational companies to focus on the high-impact domestic R&D projects, and thus increase the quality of domestic R&D activities. Lastly, future studies can also consider evaluating the impact of R&D internationalization on domestic employment and domestic investment.

The theoretical framework of this dissertation could be extended by accounting for the governance structure of the firms. It would be interesting to examine how the monitoring of managers can limit the institutions-arbitraging international R&D, and whether corporate transparency can moderate the likelihood to engage in institutions-arbitraging R&D activities. Insights from behavioral perspective can also help to push forward the literature on international R&D. Drawing from cognitive psychology, for

example, a future study could investigate how cognitive aspects of top managers (e.g., risk-taking) influence the location choices of international R&D.

To conclude, I believe that the theoretical framework and the findings of my dissertation will stimulate global strategy scholars to approach international R&D from different theoretical perspectives. Researchers should be motivated to study international R&D not only as a strategy that can help a firm augments its knowledge but also a strategy that can help the firm avoid pressures at home. Managers should be motivated to institute better monitoring practices that could prevent them from engaging in unethical R&D activities.

REFERENCES

Ambos, B. (2005). Foreign direct investment in industrial research and development: A study of German MNCs. *Research Policy*, *34*(4), 395-410.

Ambos, B., & Schlegelmilch, B. B. (2007). Innovation and control in the multinational firm: A comparison of political and contingency approaches. *Strategic Management Journal*, *28*(5), 473-486.

Ambos, T. C., Ambos, B., & Schlegelmilch, B. B. (2006). Learning from foreign subsidiaries: An empirical investigation of headquarters' benefits from reverse knowledge transfers. *International Business Review*, *15*(3), 294-312.

Asakawa, K., & Lehrer, M. (2003). Managing local knowledge assets globally: the role of regional innovation relays. *Journal of World Business*, *38*(1), 31-42.

Asakawa, K., & Som, A. (2008). Internationalization of R&D in China and India: Conventional wisdom versus reality. *Asia Pacific Journal of Management*, *25*(3), 375-394.

Awate, S., Larsen, M. M., & Mudambi, R. (2015). Accessing vs. sourcing knowledge: A comparative study of R&D internationalization between emerging and advanced economy firms. *Journal of International Business Studies*, *46*(1), 63-86.

Ayalew, K. (2013). *FDA perspective on international clinical trials*. United States Foods and Drugs Administrations. Accessed online: https://www.fda.gov/media/91849/download

Azoulay, P. (2004). Capturing knowledge within and across firm boundaries: evidence from clinical development. *American Economic Review*, *94*(5), 1591-1612.

Baier, E., Rammer, C., & Schubert, T. (2015). The impact of captive innovation offshoring on the effectiveness of organizational adaptation. *Journal of International Management*, *21*(2), 150-165.

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

Baum, J. A., & Haveman, H. A. (1997). Love thy neighbor? Differentiation and agglomeration in the Manhattan hotel industry, 1898-1990. *Administrative Science Quarterly*, 304-338.

Belderbos, R. (2001). Overseas innovations by Japanese firms: an analysis of patent and subsidiary data. *Research Policy*, *30*(2), 313-332.

Belderbos, R., Lokshin, B., & Sadowski, B. (2015). The returns to foreign R&D. *Journal of International Business Studies*, *46*(4), 491-504.

Berry, H. (2006). Leaders, laggards, and the pursuit of foreign knowledge. *Strategic Management Journal*, *27*(2), 151-168.

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

Blomkvist, K., Kappen, P., & Zander, I. (2010). Quo vadis? The entry into new technologies in advanced foreign subsidiaries of the multinational enterprise. *Journal of International Business Studies*, *41*(9), 1525-1549.

Boddewyn, J.J. & Brewer, T.L. (1994). International-business political behavior: New theoretical directions. *Academy of Management Review*, 19(1), 119-143.

Branstetter, L. G., Glennon, B., & Jensen, J. B. (2019). *19-9 The Rise of Global Innovation by US Multinationals Poses Risks and Opportunities*. Peterson Institute of

International Economics Policy Brief. Accessed online: https://www.piie.com/system/files/documents/pb19-9.pdf

Cantwell, J. (1989). *Technological Innovation and Multinational Corporations*, Blackwell: New York.

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

Castellani, D., Jimenez, A., & Zanfei, A. (2013). How remote are R&D labs? Distance factors and international innovative activities. *Journal of International Business Studies*, *44*(7), 649-675.

Chen, W. R. (2008). Determinants of firms' backward-and forward-looking R&D search behavior. *Organization Science*, 19(4), 609-622.

Cheng, J. L., & Bolon, D. S. (1993). The management of multinational R&D: a neglected topic in international business research. *Journal of International Business Studies*, *24*(1), 1-18.

Chung, W., & Yeaple, S. (2008). International knowledge sourcing: Evidence from US firms expanding abroad. *Strategic Management Journal*, *29*(11), 1207-1224.

Cockburn, I. M. (2006). Is the pharmaceutical industry in a productivity crisis? *Innovation Policy and the Economy*, *7*, 1-32.

Coffee Jr, J. C. (2002). Racing towards the top? The impact of cross-listings and stock market competition on international corporate governance. *Columbia Law Review*, 1757-1831.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The Economic Journal*, 99(397), 569-596.

Cuervo-Cazurra, A. (2006). Who cares about corruption? *Journal of International Business Studies*, 37(6), 807-822.

Cuervo-Cazurra, A. (2016). Corruption in international business. *Journal of World Business*, 51(1), 35-49.

Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. Englewood Cliffs, New Jersey: Prentice Hall.

De Faria, P., & Sofka, W. (2010). Knowledge protection strategies of multinational firms—A cross-country comparison. *Research Policy*, *39*(7), 956-968.

Desai, V. M. (2016). The behavioral theory of the (governed) firm: Corporate board influences on organizations' responses to performance shortfalls. *Academy of Management Journal*, 59(3), 860-879.

Di Minin, A., & Bianchi, M. (2011). Safe nests in global nets: Internationalization and appropriability of R&D in wireless telecom. *Journal of International Business Studies*, *42*(7), 910-934.

Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science*, 35(12), 1504-1511.

Driffield, N., Love, J. H., & Menghinello, S. (2010). The multinational enterprise as a source of international knowledge flows: Direct evidence from Italy. *Journal of International Business Studies*, *41*(2), 350-359.

Driffield, N., Love, J. H., & Yang, Y. (2016). Reverse international knowledge transfer in the MNE:(Where) does affiliate performance boost parent performance? *Research Policy*, *45*(2), 491-506.

Emanuel, E. J., Wendler, D., & Grady, C. (2000). What makes clinical research ethical? *Journal of American Medical Association*, 283(20), 2701-2711.

Ervits, I. (2018). Geography of corporate innovation. *Multinational Business Review,* 26 *(1), 25-49*

Filippaios, F., Papanastassiou, M., Pearce, R., & Rama, R. (2009). New forms of organization and R&D internationalization among the world's 100 largest food and beverages multinationals. *Research Policy*, *38*(6), 1032-1043.

Fiegenbaum, A., & Thomas, H. (1995). Strategic groups as reference groups: Theory, modeling and empirical examination of industry and competitive strategy. *Strategic Management Journal*, 16(6), 461-476.

Findlay, S. M. (2007). Outsourcing in pharma. *Pharmaceutical Technology Europe*, *19*(5), 13-14.

Fisch, J. H. (2003). Optimal dispersion of R&D activities in multinational corporations with a genetic algorithm. *Research policy*, *32*(8), 1381-1396.

Florida, R., & Kenney, M. (1994). The globalization of Japanese R&D: the economic geography of Japanese R&D investment in the United States. *Economic Geography*, *70*(4), 344-369.

Friedman, L. M., Furberg, C., DeMets, D. L. (2010). *Fundamentals of clinical trials* (Vol. 4). New York: Springer.

Foley, C. F., & Kerr, W. R. (2013). Ethnic innovation and US multinational firm activity. *Management Science*, *59*(7), 1529-1544.

Garcia-Sanchez, I. M., Cuadrado-Ballesteros, B., & Frias-Aceituno, J. (2013). Determinants of government effectiveness. *International Journal of Public Administration*, 36(8), 567-577.

Gassmann, O., & Von Zedtwitz, M. (1999). New concepts and trends in international R&D organization. *Research Policy*, *28*(2-3), 231-250.

Gaur, A., Ma, X. & Ding, Z. (2018). Home country supportiveness/unfavorableness and outward foreign direct investment from China. *Journal of International Business Studies*, 49(3), 324-345.

Gaur, A., & Kumar, M. (2018). A systematic approach to conducting review studies: An assessment of content analysis in 25 years of IB research. *Journal of World Business*, 53(2), 280-289.

Getz, K. A., & Volkema, R. J. (2001). Culture, perceived corruption, and economics: A model of predictors and outcomes. *Business & Society*, 40(1), 7-30.

Glickman, S. W., McHutchison, J. G., Peterson, E. D., Cairns, C. B., Harrington, R. A., Califf, R. M., & Schulman, K. A. (2009). Ethical and scientific implications of the globalization of clinical research. *The New England Journal of Medicine*, 360(8), 816-823.

Globerman, S., & Shapiro, D. (2003). Governance infrastructure and US foreign direct investment. *Journal of International Business Studies*, 34(1), 19-39.

Granstrand, O., Håkanson, L., & Sjölander, S. (1993). Internationalization of R&D—a survey of some recent research. *Research Policy*, *22*(5-6), 413-430.

Greve, H. R. (1998). Performance, aspirations, and risky organizational change. *Administrative Science Quarterly*, 58-86.

Greve, H. R. (2003). A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Academy of Management Journal*, 46(6), 685-702.

Guellec, D., & De la Potterie, B. V. P. (2001). The internationalizations of technology analyzed with patent data. *Research Policy*, *30*(8), 1253-1266.

Guimón, J., Chaminade, C., Maggi, C., & Salazar-Elena, J. C. (2018). Policies to attract R&D-related FDI in small emerging countries: Aligning incentives with local linkages and absorptive capacities in Chile. *Journal of International Management*, *24*(2), 165-178.

Håkanson, L., & Kappen, P. (2016). Live and let die: A survival analysis of foreign R&D units in Swedish MNEs. *International Business Review*, *25*(6), 1185-1196.

Håkanson, L., & Nobel, R. (1993). Determinants of foreign R&D in Swedish multinationals. *Research Policy*, *22*(5-6), 397-411.

Hall, J. M., & Reynders, L. (2000). The future role of CROs. *Drug Discovery World*, 13-16.

Hansen, M. T., & Løvås, B. (2004). How do multinational companies leverage technological competencies? Moving from single to interdependent explanations. *Strategic Management Journal*, *25*(8-9), 801-822.

Harris, J., & Bromiley, P. (2007). Incentives to cheat: The influence of executive compensation and firm performance on financial misrepresentation. *Organization Science*, 18(3), 350-367.

Hegde, D., & Hicks, D. (2008). The maturation of global corporate R&D: Evidence from the activity of US foreign subsidiaries. *Research Policy*, *37*(3), 390-406.

Helfat, C. E. (1997). Know-how and asset complementarity and dynamic capability accumulation: The case of R&D. *Strategic Management Journal*, 18(5), 339-360.

Henderson, R., & Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15(S1), 63-84.

Herstad, S. J., Aslesen, H. W., & Ebersberger, B. (2014). On industrial knowledge bases, commercial opportunities and global innovation network linkages. *Research Policy*, *43*(3), 495-504.

Hibbs, D. A., & Piculescu, V. (2010). Tax toleration and tax compliance: How government affects the propensity of firms to enter the unofficial economy. *American Journal of Political Science*, 54(1), 18-33.

Hirschler, B. (2011). Special report: Big Pharmas' global guinea pigs. Online access: https://www.reuters.com/article/us-pharmaceuticals-trials/special-report-big-pharmas-global-guinea-pigs-idUSTRE7450SV20110506

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. *The Quarterly Journal of Economics*, *108*(3), 577-598.

Jeong, Y., & Weiner, R. J. (2012). Who bribes? Evidence from the United Nations' oil-for-food program. *Strategic Management Journal*, 33(12), 1363-1383.

John, S. (2006). Leadership and strategic change in outsourcing core competencies: Lessons from the pharmaceutical industry. *Human Systems Management*, 25(2), 135-143.

Joshi, A. M., & Lahiri, N. (2015). Language friction and partner selection in cross-border R&D alliance formation. *Journal of International Business Studies*, *46*(2), 123-152.

Kappen, P. (2011). Competence-creating overlaps and subsidiary technological evolution in the multinational corporation. *Research Policy*, *40*(5), 673-686.

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., Palmié, M., & Gassmann, O. (2011). Achieving subsidiary integration in international innovation by managerial "tools". *Management International Review*, *51*(2), 213-239.

Kono, T., & Lynn, L. (2007). *Strategic new product development for the global economy*. Springer.

Kuemmerle, W. (1999a). The drivers of foreign direct investment into research and development: an empirical investigation. *Journal of International Business Studies*, *30*(1), 1-24.

Kuemmerle, W. (1998). Optimal scale for research and development in foreign environments—an investigation into size and performance of research and development laboratories abroad. *Research Policy*, *27*(2), 111-126.

Kuemmerle, W. (1999b). Foreign direct investment in industrial research in the pharmaceutical and electronics industries—results from a survey of multinational firms. *Research Policy*, *28*, 179-193.

Kwon, H. U., & Park, J. (2018). R&D, foreign ownership, and corporate groups: Evidence from Japanese firms. *Research Policy*, *47*(2), 428-439.

Lagerström, K., Schweizer, R., & Jakobsson, J. (2019). Building R&D capability in subsidiaries–conceptualization of a process perspective. *Multinational Business Review*.

Lant, T. K., & Baum, J. A. C. 1995. Cognitive sources of socially constructed competitive groups: Examples from the Manhattan hotel industry. In W. R. Scott & S. Christensen (Eds.), *The institutional construction of organizations: International and longitudinal studies*: 15–38. Thousand Oaks, CA: Sage.

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.

Li, J., & Xie, Z. (2016). Governance structure and the creation and protection of technological competencies: International R&D joint ventures in China. *Management International Review*, *56*(1), 123-148.

Li, X., & Zhou, Y. M. (2017). Offshoring pollution while offshoring production? *Strategic Management Journal*, 38(11), 2310-2329.

Lloyd-Roberts, S. (2012). Have India's poor become human guinea pigs? Online access: https://www.bbc.com/news/magazine-20136654

Liu, Y. (2019). The processes of new product development recentralization towards a transnational emphasis in multinational corporations. *Journal of International Management*, *25*(1), 19-36.

Low, P., & Yeats, A. (1992). Do dirty industries migrate? International Trade and the Environment. *World Bank Discussion Paper* #159.

Luo, Y. (2006). Political behavior, social responsibility, and perceived corruption: A structuration perspective. *Journal of International Business Studies*, 37(6), 747-766.

Manolopoulos, D., Dimitratos, P., Young, S., & Lioukas, S. (2009). Technology sourcing and performance of foreign subsidiaries in Greece: The impact of MNE and local environmental contexts. *Management International Review*, *49*(1), 43-60.

Manolopoulos, D., Papanastassiou, M., & Pearce, R. (2005). Technology sourcing in multinational enterprises and the roles of subsidiaries: An empirical investigation. *International Business Review*, *14*(3), 249-267.

Manolopoulos, D., Söderquist, K. E., & Pearce, R. (2011). Coordinating decentralized research and development laboratories: A survey analysis. *Journal of International Management*, 17(2), 114-129.

Mansfield, E., & Romeo, A. (1980). Technology transfer to overseas subsidiaries by US-based firms. *The Quarterly Journal of Economics*, 95(4), 737-750.

Marin, A., & Bell, M. (2010). The local/global integration of MNC subsidiaries and their technological behaviour: Argentina in the late 1990s. *Research Policy*, *39*(7), 919-931.

Meyer-Krahmer, F., & Reger, G. (1999). New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe. *Research policy*, *28*(7), 751-776.

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

Morescalchi, A., Pammolli, F., Penner, O., Petersen, A. M., & Riccaboni, M. (2015). The evolution of networks of innovators within and across borders: Evidence from patent data. *Research Policy*, *44*(3), 651-668.

Mudambi, R., & Navarra, P. (2004). Is knowledge power? Knowledge flows, subsidiary power and rent-seeking within MNCs. *Journal of International Business Studies*, *35*(5), 385-406.

Najafi-Tavani, Z., Giroud, A., & Sinkovics, R. R. (2012). Mediating effects in reverse knowledge transfer processes. *Management International Review*, *52*(3), 461-488.

Narula, R. (2019). Enforcing higher labor standards within developing country value chains: Consequences for MNEs and informal actors in a dual economy. *Journal of International Business Studies*, 50(9), 1622-1635.

Niosi, J., & Godin, B. (1999). Canadian R&D abroad management practices. *Research Policy*, *28*(2-3), 215-230.

Nobel, R., & Birkinshaw, J. (1998). Innovation in multinational corporations: control and communication patterns in international R&D operations. *Strategic Management Journal*, *19*(5), 479-496.

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Nundy, S., & Gulhati, C. M. (2005). A new colonialism? Conducting clinical trials in India. *New England Journal of Medicine*, 352(16), 1633-1636.

Nuruzzaman, N., Gaur, A. S., & Sambharya, R. B. (2019). A microfoundations approach to studying innovation in multinational subsidiaries. *Global Strategy Journal*, *9*(1), 92-116.

Oliver, C., & Holzinger, I. (2008). The effectiveness of strategic political management: A dynamic capabilities framework. *Academy of Management Review*, 33(2), 496-520.

Oxley, J. E., & Sampson, R. C. (2004). The scope and governance of international R&D alliances. *Strategic Management Journal*, *25*(8-9), 723-749.

Papanastassiou, M., Pearce, R., & Zanfei, A. (2019). Changing perspectives on the internationalization of R&D and innovation by multinational enterprises: A review of the literature. Journal of International Business Studies, 1-42.

Patel, P., & Pavitt, K. (1991). Large firms in the production of the world's technology: an important case of "non-globalisation". *Journal of International Business Studies*, 22(1), 1-21.

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.

Penner-Hahn, J. D. (1998). Firm and environmental influences on the mode and sequence of foreign research and development activities. *Strategic Management Journal*, *19*(2), 149-168.

Perri, A., & Andersson, U. (2014). Knowledge outflows from foreign subsidiaries and the tension between knowledge creation and knowledge protection: Evidence from the semiconductor industry. *International Business Review*, *23*(1), 63-75.

Phene, A., & Almeida, P. (2008). Innovation in multinational subsidiaries: The role of knowledge assimilation and subsidiary capabilities. *Journal of International Business Studies*, *39*(5), 901-919.

Piachaud, B. (2004). *Outsourcing of R&D in the pharmaceutical industry: from conceptualization to implementation of the strategic sourcing process*. Springer.

Pierik, R. (2015). Human Rights and the Regulation of Transnational Clinical Trials. *Political Studies*, 63(4), 870-886.

Pisani, N., & Ricart, J. E. (2018). Offshoring innovation to emerging countries: The effects of IP protection and cultural differences on firms' decision to augment versus exploit home-base-knowledge. *Management International Review*, *58*(6), 871-909.

Popli, M., Akbar, M., Kumar, V., & Gaur, A. (2017). Performance Impact of Temporal Strategic Fit: Entrainment of Internationalization with Pro-Market Reforms. *Global Strategy Journal*, 7(4), 354-374.

Porac, J. F., Thomas, H., & Baden-Fuller, C. (1989). Competitive groups as cognitive communities: The case of Scottish knitwear manufacturers. *Journal of Management Studies*, 26(4), 397-416.

Porac, J. F., Thomas, H., Wilson, F., Paton, D., & Kanfer, A. (1995). Rivalry and the industry model of Scottish knitwear producers. *Administrative Science Quarterly*, 203-227.

Rosenbusch, N., Gusenbauer, M., Hatak, I., Fink, M., & Meyer, K. E. (2019). Innovation offshoring, institutional context and innovation performance: A meta-analysis. *Journal of Management Studies*, *56*(1), 203-233.

Sambharya, R. B., & Lee, J. (2014). Renewing dynamic capabilities globally: An empirical study of the world's largest MNCs. *Management International Review*, 54(2), 137-169.

Sapouna, P., Manolopoulos, D., & Dimitratos, P. (2016). How do MNC R&D laboratory roles affect employee international assignments? *Management International Review*, *56*(5), 759-779.

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.

Scalera, V. G., Perri, A., & Hannigan, T. J. (2018). Knowledge connectedness within and across home country borders: Spatial heterogeneity and the technological scope of firm innovations. *Journal of International Business Studies*, *49*(8), 990-1009.

Schrempf-Stirling, J. (2014). Roche's clinical trials with organs from prisoners: Does profit trump morals? *Journal of Business Ethics*, 121(2), 315-328.

Schubert, T., Baier, E., & Rammer, C. (2018). Firm capabilities, technological dynamism and the internationalisation of innovation: A behavioural approach. *Journal of International Business Studies*, *49*(1), 70-95.

Schumpeter, JA. (1942). *Capitalism, Socialism, and Democracy*. Harper and Row: New York

Shah, S. (2003). Globalization of clinical research by the pharmaceutical industry. *International Journal of Health Services*, 33(1), 29-36.

Shleifer, A., & Vishny, R. W. (1993). Corruption. *The Quarterly Journal of Economics*, 108(3), 599-617.

Shimizutani, S., & Todo, Y. (2008). What determines overseas R&D activities? The case of Japanese multinational firms. *Research Policy*, *37*(3), 530-544.

Siegel, J. (2005). Can foreign firms bond themselves effectively by renting US securities laws? *Journal of Financial Economics*, *75*(2), 319-359.

Sofka, W., Shehu, E., & de Faria, P. (2014). Multinational subsidiary knowledge protection—Do mandates and clusters matter? *Research Policy*, *43*(8), 1320-1333.

Teece, D. J. (1993). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *22*(2), 112-113.

Tüselmann, H., Sinkovics, R. R., & Pishchulov, G. (2016). Revisiting the standing of international business journals in the competitive landscape. *Journal of World Business*, 51(4), 487-498.

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

Un, C. A., & Cuervo-Cazurra, A. (2008). Do subsidiaries of foreign MNEs invest more in R&D than domestic firms? *Research Policy*, *37*(10), 1812-1828.

Un, C. A., & Rodríguez, A. (2018). Local and global knowledge complementarity: R&D collaborations and innovation of foreign and domestic firms. *Journal of International Management*, *24*(2), 137-152.

Veliyath, R., & Sambharya, R. B. (2011). R&D investments of multinational corporations. *Management International Review*, 51(3), 407-428.

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics*, 190-207.

Von Zedtwitz, M., & Gassmann, O. (2002). Market versus technology drive in R&D internationalization: four different patterns of managing research and development. *Research Policy*, *31*(4), 569-588.

Weinbaum, C., Landree, E., Blumenthal, M.S., Piquado, T., & Gutierrez, C.I. 2019. *Ethics in Scientific Research: An Examination of Ethical Principles and Emerging Topics*. Santa Monica, CA: RAND Corporation. https://www.rand.org/pubs/research_reports/RR2912.html.

Weyzig, F., & Schipper, I. (2008). *SOMO briefing paper on ethics in clinical trials: #1 Examples of unethical trials*. Stichting Onderzoek Multinationale Ondernemingen (SOMO). https://www.wemos.nl/wp-content/uploads/2016/07/examples_of_unethical_trials_feb_2008.pdf

Xu, D., Zhou, K. Z., & Du, F. (2019). Deviant versus aspirational risk taking: The effects of performance feedback on bribery expenditure and R&D intensity. *Academy of Management Journal*, 62(4), 1226-1251.

Yang, Y. T., Chen, B., & Bennett, C. L. (2018). *Offshore pharmaceutical trials: Evidence, economics, and ethics*. Mayo Clinic Proceedings: Innovations, Quality & Outcomes, 2(3), 226-228.

Zander, I. (1998). The evolution of technological capabilities in the multinational corporation—dispersion, duplication and potential advantages from multinationality. *Research Policy*, *27*(1), 17-35.

Zander, I. (1999). How do you mean 'global'? An empirical investigation of innovation networks in the multinational corporation. *Research Policy*, *28*(2-3), 195-213

Zarin, D. A., Tse, T., Williams, R. J., Califf, R. M., & Ide, N. C. (2011). The ClinicalTrials. gov results database—update and key issues. *New England Journal of Medicine*, 364(9), 852-860.

Zhang, D., Yin, P., Freemantle, N., Jordan, R., Zhong, N., & Cheng, K. K. (2008). An assessment of the quality of randomized controlled trials conducted in China. *Trials*, 9(1), 22.

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