The impact of knowledge flows on asset specificity from the perspective of open innovation

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Abstract

Purpose – *This study aims to examine how different modes of knowledge flows affect the changes of asset specificity and how ownership control moderates the relationship between knowledge flows and asset specificity in the open innovation paradigm.*

Design/methodology/approach – *This paper selects information technology outsourcing as the research base. It uses the feasible weighted least squares modeling method for its analysis and has collected the data from 2,369 research and development contracts of multinational vendor firms in China.*

Findings – *The coupled and outbound knowledge flows have a direct and positive effect on asset specificity. Moreover, the results show that weak corporate control has significant moderating effects on the relationship between both coupled and outbound knowledge flows and asset specificity; the strong control positively moderates the relationship between outbound knowledge flows and asset specificity.*

Practical implications – *In open innovation, firms build a higher degree of asset specificity to maximize the efficiency of knowledge flows, which then helps them to enhance innovation capacity and market performance.*

Originality/value – *Preceding studies have tended to examine the influences of asset specificity as an independent variable in a closed innovation paradigm. Asset specificity is hence often left as the antecedent "black box." This paper, however, opens the "black box" of asset specificity, which is set as a dependent variable, by investigating the influences of knowledge flows on the asset specificity in the context of open innovation. It also reinterprets the role of asset specificity by adopting the lens of open innovation theory.*

Keywords *Ownership control, R&D outsourcing, Open innovation, Knowledge flows, Asset specificity, Knowledge transfer modes*

Paper type *Research paper*

1. Introduction

Open innovation has become widely adopted as a new business strategy by firms across many industries (Gassmann *et al.*, 2010; West *et al.*, 2014; Natalicchio *et al.*, 2017). In contrast to closed innovation, it requires firms to integrate internal and external sources by undertaking extensive cooperation with external organizations to improve both their innovative and financial performance (Chesbrough, 2003; Mazzola *et al.*, 2012; Chesbrough *et al.*, 2014). According to the open innovation theory (Chesbrough, 2003, 2006), external resources are no longer just simply a supplement to internal resources but are now a critical element of firms' innovation performance (Vrande *et al.*, 2010). Yet, the shift from closed to open innovation is likely to increase the transaction cost, as it requires additional efforts to coordinate, manage and control the partners' research and development (R&D) activities (Gulati and Singh, 1998; Ferraris *et al.*, 2017).

Open innovation stresses the processes of knowledge flows through permeable boundaries (Ahn *et al.*, 2016). In this respect, previous studies have identified three modes of knowledge flows – inbound, outbound and coupled open innovation processes (Chesbrough, 2003; Gassmann and Enkel, 2004; Enkel *et al.*, 2009). Based on the open innovation paradigm, firms can selectively use inflows of external knowledge resources and also leverage the outflows of internal knowledge resources to expand the opportunities of innovation in the market (Chesbrough, 2006).

A wide range of studies have contributed to the open innovation literature from different perspectives: knowledge flows and process (Gassmann and Enkel, 2004; Enkel *et al.*, 2009; Dahlander and Gann, 2010), forms of openness (Dahlander and Gann, 2010; Kratzer *et al.*, 2017; Öberg and Alexander, 2019), the parties involved (Sieg *et al.*, 2010; Howells, Gagliardi and Malik, 2012), required capabilities (Vanhaverbeke *et al.*, 2008; Spithoven *et al.*, 2011; West and Bogers, 2014; Beaugency *et al.*, 2015) and firm performance (Laursen and Salter, 2006b; Dahlander and Gann, 2010; Huizingh, 2011; Ahn *et al.*, 2016). From the view of knowledge flows and processes of open innovation, most studies focus on examining the tailored practices and activities to different modes of knowledge flows to support firms' innovation processes (Natalicchio *et al.*, 2017). Hence, there is a lack of research addressing the influences of knowledge flows on the degree of firms' asset specificity.

Asset specificity refers to as "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value" Williamson (1991, p. 282). The literature on asset specificity has been mainly driven by the three traditional theories – transaction cost economics (TCE), resource-based view (RBV) and relational exchange theory (RET) (De Vita *et al.*, 2011). These theories, though, are in accordance with the closed innovation paradigm which stresses more on the importance of internal resources (Lichtenthaler and Lichtenthaler, 2009). Under closed innovation, the knowledge flows are often restricted, and asset specificity is left as the antecedent "black box" (Odagiri, 2003; Geyskens *et al.*, 2006). This leads to asset specificity being often treated as an independent variable in the empirical studies (Stanko and Calantone, 2011). However, in the open innovation paradigm with active knowledge flows across firm boundaries, asset specificity and governance structure often experience significant changes (Zheng *et al.*, 2018). This thus stimulates the first research question of how different modes of knowledge flows affect the asset specificity among firms in an open innovation paradigm.

In addition, the interfirm governance literature suggests that effective mechanisms are necessary to protect partners' asset specificity investments and maintain an effective business relationship in the process of interfirm cooperation (Xie *et al.*, 2016; Yang *et al.*, 2016). In this respect, the second research question of this paper is how ownership control moderates the relationship between knowledge flows and the asset specificity in an open innovation environment.

In response to the above two research questions, we have selected information technology outsourcing (ITO) as the research context. ITO is a type of R&D outsourcing, which is at the heart of the open innovation paradigm (Teirlinck and Spithoven, 2013). In addition, information and communication technologies (ICTs) and their role in the corporate development and implementation of successful strategies have been the key issues in the debate on knowledge management (Caputo *et al.*, 2019). Specifically, we have collected the data on R&D contracts for ITO activities in China from the Beijing Municipal Office of Technology and Marketing (BMOTM).

Traditional offshore outsourcing generally refers to firms from developed countries contracting with a third party usually located in developing countries to accomplish low value-added activities (Maskell *et al.*, 2007). For traditional offshore outsourcing, the key

motivation for MNCs' outsourcing is to exploit their advantages and transfer non-core business activities to firms from developing countries. The client MNCs from developed countries can thus benefit from cost reduction and obtaining the manufacturing knowledge from the developing country's vendor firms (Chen, 2005). However, over the past 20 years, there has been a growing trend of reverse outsourcing activities by firms from developing countries that offer outsourcing projects to developed country firms (Sen, 2005; Chanda and Bangalore, 2006; Modwel and Jelassi, 2010). On the other hand, reverse onshore outsourcing refers to the outsourced R&D activities, which are executed in the client firms' country (Zheng and Chang, 2016).

Based on the data of this paper, we found that the ITO activities carried out in China have shown different characteristics from the observations of previous studies. A large number of ITO activities are initiated by Chinese clients. Foreign vendor MNCs from developed countries come to China and are willing to participate in the outsourced projects. These ITO activities are thus featured as reverse onshore outsourcing. This study places the focus of its observation on vendor MNCs and examines their specific activities for the outsourced projects to meet the demands of clients or local firms in China.

Through the lens of open innovation approach, this study reveals that in such an environment, asset specificity is positively influenced by coupled and outbound knowledge flows. Ownership control also has a crucial moderating effect on the relationship between knowledge flows and asset specificity. By integrating the literature of open innovation, asset specificity and R&D outsourcing, this paper provides the following key contributions.

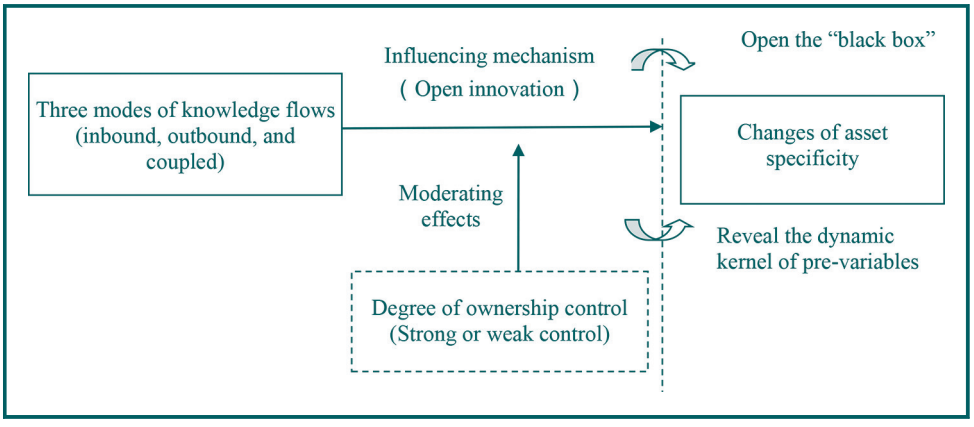
First, in contrast to the preceding studies that have mainly examined asset specificity as the independent variable under closed innovation (Karimi-Alaghehband *et al.*, 2011; Stanko and Calantone, 2011; Shi *et al.*, 2018; Wang *et al.*, 2019), this paper has adopted the open innovation theory and investigated the influences of knowledge flows on the dynamic changes of asset specificity. Furthermore, as the existing research on inbound open innovation process has been the largest bodies of open innovation (Enkel *et al.*, 2009; West and Bogers, 2014; West *et al.*, 2014), our study has enriched the literature on open innovation by examining the coupled and outbound innovation flows.

Second, according to TCE, the degree of asset specificity influences the variation of ownership control. The higher degree of asset specificity is often associated with a higher degree of control (Anderson and Gatignon, 1986; Teece, 1986; Erramilli and Rao, 1993; Delios and Henisz, 2000; Brouthers and Brouthers, 2001). However, this paper investigates the inverse influence of control mechanism on asset specificity which has been neglected in the literature. The results show that different degrees of ownership control can adjust the effects of knowledge flows on asset specificity in open innovation.

By specifying the asset specificity into human and physical dimensions and investigating the impacts of knowledge flows on asset specificity, this study helps open the "black box" of asset specificity and reinterprets its role in an open innovation environment. The preceding studies emphasize the strength of "isolating mechanisms" to protect the core competence from rivals' imitation in closed innovation (Mahoney and Pandian, 1992). Yet, in an open innovation paradigm, building asset specificity contributes to firms' absorptive capacity and helps firms better leverage various modes of knowledge flows that can enhance their innovative and financial performance. Moreover, it requires firms to adjust the degree of ownership control to maximize the efficiency of knowledge flows within and beyond firm boundaries. Figure 1 shows the research design and analytical logic of this paper.

The contents of this paper [1] are as follows. In the next section, we review the theoretical background of the three fields including open innovation, asset specificity and R&D outsourcing. We then develop the hypotheses in Section 3. Section 4 describes the research method including the sample, data, variables and measures and empirical

Figure 1 Research design and analytical logic



specification. Following this, we present the statistical results in Section 5 and analyze the results in Section 6. Finally, in Section 7, the paper concludes by presenting the theoretical contributions, managerial implications and limitations and future directions.

2. Theoretical background

2.1 Open innovation

Chesbrough (2003) first coined the term "open innovation" and proposed two paradigms – inbound ("outside-in") and outbound ("inside-out") knowledge flows. The open innovation paradigm is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006, p. 1).

Specifically, inbound innovation process refers to the combination of resources that flow into firms from outside, including the use of external research projects, venture capital and product/technology through mergers and acquisitions (M&A), strategic alliances or joint ventures. On the other hand, outbound innovation process refers to the outflows of firms' internal resources through licensing, joint venture, M&A and other governance, which not only help firms enter other markets and enlarge their existing business but also, more importantly, help firms explore new markets and new business models. The "coupled" process identified by Gassmann and Enkel (2004) is defined as "coupling the outside-in and inside-out processes by working in alliances with complementary partners in which give and take is crucial for success."

The open innovation paradigm assumes the boundary between firms and the environment has become more permeable, and outsourcing and collaboration in R&D have become a viable option for firms to improve their innovative performance (Lichtenthaler, 2005; Albors-Garrigos *et al.*, 2010; Papa *et al.*, 2020). The concept of open innovation has also helped firms shift R&D activities away from the internal discovery toward external engagement (West *et al.*, 2014). Since Chesbrough's (2003) introduction of the open innovation concept, its literature has covered various topics, including areas for adopting open innovation (Schroll and Mild, 2011), knowledge flows or innovation processes (Gassmann and Enkel, 2004; Enkel *et al.*, 2009; Dahlander and Gann, 2010; Frey *et al.*, 2011; Moellers *et al.*, 2020), forms of openness (Dahlander and Gann, 2010; Kratzer *et al.*, 2017; Öberg and Alexander, 2019), required capabilities (Castro, 2005; Ahn *et al.*, 2016; Scuotto *et al.*, 2020), knowledge management and operational practices (Lopes *et al.*, 2017; Dezi *et al.*, 2018; Santoro *et al.*, 2018; Abdulkader *et al.*, 2020; Bereznoy *et al.*, 2021) and impacts on firms' innovative and overall performance (Laursen and Salter, 2006b; Dahlander and Gann, 2010; Bianchi *et al.*,

2015). Although previous studies have acknowledged that different open innovation processes should be accompanied with tailored knowledge management practices, they lack detailed research on how the direction of knowledge flows affects firms' asset specificity investment.

2.2 Asset specificity

According to Williamson (1991, p. 282), asset specificity is a term closely related to "opportunism" and defined as "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value." Special assets in transactions are difficult to allocate elsewhere, so they often require physical or human investments dedicated to specific tasks. Scholars have acknowledged the multi-dimensional characteristics of asset specificity. Williamson (1983) identified four distinct types of asset specificity – physical, human, site and dedicated assets specificity. Brand name capital specificity (Williamson, 1985) was later added. Malone *et al.* (1987) then added temporal specificity. Zaheer and Venkatraman (1994) further summarized the aforementioned four types of asset specificity into two types, namely, human asset specificity and procedural asset specificity. The latter type refers to organizational workflows and routines customized to a particular transactional relationship (De Vita *et al.*, 2011).

Asset specificity is one of the attributes that has received the most attention in the literature on outsourcing (Espino-Rodríguez *et al.*, 2016). Previous studies that assess the impact of asset specificity have mainly derived from the three most prominent theories –TCE, RBV and RET (De Vita *et al.*, 2011). Asset specificity is regarded as the core concept of TCE (Geyskens *et al.*, 2006).

According to TCE, asset specificity is one of the most important factors in determining the governance choice with transaction costs explanation (Williamson, 1985). With a higher level of asset specificity, firms will prefer a hierarchical governance structure rather than market-based transactional ones, due to the higher transaction costs for safeguarding against opportunistic hazards. Therefore, asset specificity of the outsourced activities should be relatively low, when firms choose the outsourcing governance. The TCE approach argues that due to the uncertainty surrounding the transactions, it is difficult to build a perfect contract that encompasses the foreseeable scenarios and outcomes (Rilla and Squicciarini, 2011). For this, safeguarding measures are necessary such as strong administrative control and exclusive property rights for core resources (Ulset, 1996).

Within most of the RBV literature on firms' governance choice, the concept of "core competence" has been used interchangeably with asset specificity (Cox, 1996; Espino-Rodríguez and Padrón-Robaina, 2006; De Vita *et al.*, 2011). Instead of stressing transaction costs, RBV focuses on value gains from the outsourced activities (Zajac and Olsen, 1993; Moon and Yin, 2020). However, as firms' competitive advantages and performance depend on their core competence, firms should internalize such highly asset-specific activities within the firm rather than outsource the core competency (Barney, 1991; Conner, 1991; Poppo and Zenger, 1998; Quinn, 2000). Hence, firms will outsource activities that are not central to their resources, while protecting those resources critical to their core competences (Odagiri, 2003).

On the other hand, RET focuses on the properties of relationships (De Vita *et al.*, 2011). This theory argues that the investment in relation-specific assets, people and procedures will increase co-operative behavior and improve the inter-firm relationship performance (Anderson and Weitz, 1992; Ganesan, 1994; Liu *et al.*, 2009). Based on RET, one key mechanism that promotes asset and relation specificity and hence increases switching costs are client-specific investments to customize the needs of clients (Manning *et al.*,

2011). These interdependencies induce business partners to commit to an existing relationship (Manning *et al.*, 2011).

Despite different types of focus for the three theories, they commonly analyze the impacts of asset specificity on governance selection and firm performance. Hence, the preceding studies construct asset specificity as an independent variable for their empirical test, thereby leaving it as antecedent "black box." This is due to the fact that these theories focus mainly on internal resources in accordance with a closed innovation paradigm (Lichtenthaler and Lichtenthaler, 2009). There are two main approaches to the empirical research about the effects of assets specificity on firm activities (Cruz *et al.*, 2014); one approach is to analyze the influence of asset specificity on firms' governance choice for outsourcing, and the other approach is to examine the impact of asset specificity on both firm performance and governance selection. Therefore, asset specificity is commonly treated as an independent variable or influential factor and we lack a clear understanding of the influential factors that affect the degree of firms' asset specificity investment.

2.3 Research and development outsourcing

Over the past 20 years, R&D outsourcing has been widely adopted by firms from developed countries that have generally moved labor-intensive projects or production processes to developing countries (Maskell *et al.*, 2007). In doing this, they seek to benefit from cost reduction and to obtain manufacturing knowledge from the local vendor firms (Chen, 2005; Cha *et al.*, 2009). Such outsourcing activities are referred to as "traditional offshore outsourcing." However, throughout this period there has also been reverse outsourcing activities by developing country firms (Chanda and Bangalore, 2006; Zheng *et al.*, 2018). This reverse outsourcing means that developing countries become clients and release outsourcing businesses to developed countries (Wang and Song, 2017). Sen (2005) first identified the phenomenon of reverse outsourcing pursued by Chinese and Indian pilot firms. Such a strategy has become an important link for Chinese firms taking part in the global supply chain, to explore and execute outsourcing projects for more complicated technology (Bunyaratavej and Hahn, 2012). To be specific, such outsourcing activities are referred to as "offshore reverse outsourcing."

On the other hand, outsourced activities executed in the client firms' country are called "onshore outsourcing," and those executed outside of client firms' country as "offshore outsourcing" (Zheng *et al.*, 2019). An interesting phenomenon which has emerged since 2001 is that many foreign MNCs' R&D subsidiaries in China have acted as the vendor firms (or suppliers) for R&D outsourcing activities and most of the client firms (or buyers) are local Chinese firms or those foreign-invested Chinese firms (Zheng *et al.*, 2018). Such reverse outsourcing activities are called "onshore reverse outsourcing," which is the focus of the investigation for the hypotheses described in the section below.

3. Hypothesis

3.1 The impact of knowledge flows on asset specificity

In a closed innovation environment, firms mainly rely upon their internal resources to carry out high-cost R&D activities. Yet modern innovation processes require firms to comprehend highly specific knowledge about diverse users, technologies and markets (Laursen and Salter, 2006b). This then encourages firms to increasingly rely on external resources for their R&D activities (Albors-Garrigos *et al.*, 2010). In this respect, open innovation broadens the scope of knowledge resources and provides multiple channels for developing higher-order knowledge (Ahn *et al.*, 2016). The open innovation paradigm assumes that firms open up their rigid boundaries to allow valuable knowledge flows in and also bring their knowledge resources to the market (Chesbrough, 2003; Gassmann and Enkel, 2004). Therefore, the boundaries between firms and the external market have become more

permeable (Chesbrough, 2003). This implies that asset specificity will undergo elastic changes. Various modes of knowledge flows affect the sources and coordination efficiency with regard to asset specificity, and this then leads to the dynamic changes in the role of asset specificity for building the competitiveness of firms.

In the ITO context, according to different characteristics of outsourced projects, firms are required to integrate their existing dedicated knowledge related to workflows and routines to generate new solutions or invest in new knowledge and skills to meet more sophisticated demand of clients. When firms carry out inbound or outbound knowledge flows at various levels, such a process leads to dynamic changes in firms' asset specificity. Therefore, different modes of knowledge flows (inbound, outbound and coupled) influence the degree of asset specificity. Some studies (Westner and Strahringer, 2010) have argued that when suppliers undertake the outsourced R&D projects, knowledge sharing and flows between clients and suppliers will promote the successful implementation of the outsourced projects (Shim *et al.*, 2019). This will encourage the two parties to maintain closer relationships and establish long-term contracts, thereby leading to an increase in the degree of asset specificity (Masten and Crocker, 1985).

On the other hand, Andreou and Bontis (2007) argued that knowledge management affects the components and structure of intellectual capital and business performance. They stressed that the knowledge management which emphasizes the flows of knowledge resources, is linked to the concept of knowledge flows in open innovation and intellectual capital is linked to the human asset specificity. Accordingly, we hypothesize that knowledge flows positively affect the asset specificity of the outsourced ITO projects.

3.1.1 The impact of inbound knowledge flows on asset specificity. Multinational vendor firms can acquire new markets, technologies and other related knowledge resources through cooperation with partner organizations, universities, research institutions and clients in particular (Enkel *et al.*, 2009). This is because clients have accumulated a large amount of technology and process-related knowledge resources. Obtaining such resources from clients will help the vendor firms improve the technology and management capabilities, thereby improving work efficiency and project quality (Teo and Bhattcherjee, 2014). In addition, the new knowledge acquired from clients not only helps expand the knowledge base of vendors but also updates the existing knowledge of vendor firms (Atuahene-Gima and Murray, 2007). By better understanding customers, products, technologies and markets via knowledge exchanges with clients, vendor firms can perform better in completing the outsourced projects (Zack, 1999).

At the same time, to effectively integrate the inflows of knowledge resources, vendor firms should build up their absorptive capabilities on such resources (Arbussa and Coenders, 2007; Lopes *et al.*, 2017). This will also lead to an increase in the asset specificity investment by vendor firms. As growth in inflows and the integration of external knowledge resources can help eliminate information asymmetry, cultural differences and trials and errors, it will then support more in-depth R&D activities and raise the degree of asset specificity (Yang, 2011). Hence, the first hypothesis is as follows:

H1. Inbound knowledge flows positively affect the degree of asset specificity.

3.1.2 The impact of outbound knowledge flows on asset specificity. Under the ITO context, vendor MNCs can usually adopt different modes of knowledge flows to meet the demand of clients (Lichtenthaler, 2007, 2008). A common method is to effectively integrate internal knowledge and then externalize or commercialize it. This can also be linked to Chesbrough's (2006) "external exploitation of knowledge," which he defines as "the use of purposive outflows of knowledge to expand the markets for external use of innovation." Due to differences in knowledge structure, educational background and career experiences, MNCs can not only bring different solutions during the process of completing the outsourced tasks but also can promote the optimal solutions of implementation. This can be

done through efficient integration of different ideas, viewpoints, expertise and capabilities among internal members (Tiwana and Mclean, 2005). By sharing and integrating individual knowledge, firms can create new knowledge resources (Nonaka, 1994). Furthermore, MNCs' integration of internal knowledge can help establish a consensus about the goals among participants, thereby alleviating the possible behavioral deviations of vendors (Tiwana, 2008). The above-mentioned improvement of efficiency and project quality increases the degree of asset specificity of vendors. Once MNCs develop customized knowledge modules specified for clients, they can maintain closer interactions with clients and establish a long-term relationship with them. This thus leads to the second hypothesis as below:

H2. Outbound knowledge flows positively affect the degree of asset specificity.

3.1.3 The impact of coupled knowledge flows on asset specificity. In the context of ITO, as vendor firms' exploitation of existing knowledge and exploration of external knowledge complement each other, the impact of coupled knowledge flows on asset specificity will be more evident (Guisado-Gonzalez *et al.*, 2017). On the one hand, the outbound knowledge flows will maximize the value of the vendor firms' existing knowledge resources via successful commercialization of internal knowledge resources (Lichtenthaler, 2007, 2008). On the other hand, the inbound knowledge flows can expand the vendors' knowledge stocks and avoid the capacity rigidity due to the lack of new knowledge resources (Bogers and West, 2012). Moreover, inbound knowledge flows can help improve vendors' effectiveness and efficiency of outbound knowledge flows. The synergistic combination of knowledge exploration (inbound knowledge flows) and knowledge exploitation (outbound knowledge flows) can ensure that the new knowledge resources are successfully commercialized in the market, and thus realize the expected or over-expected market performance and profits (Yang, 2011). Hence, the third hypothesis is as follows:

H3. Coupled knowledge flows positively affect the degree of asset specificity.

3.2 The moderating effects of ownership control on the relationship between knowledge flows and asset specificity

When a firm carries out various directions of knowledge flows, as these resources may come from different departments within the organization or from outside the organizational boundaries, the degree of corporate control will impact upon the effectiveness of its knowledge management. According to Alchian (1977), people are usually different in their talents and knowledge structure, which enable their specialization in different areas by applying the knowledge resources to the management and operation of the company. People's attitudes toward risks are also different. The ownership can thus imply different degrees of risk preference among firms and their control over the knowledge resources. Within a hierarchical firm, strong ownership control is often conducive to the rapid integration of internal knowledge resources. However, weak ownership control is more efficient for complementary knowledge flows beyond the boundary of a firm, as it facilitates the fast flow and integration between internal and external knowledge. Therefore, changes in the degree of ownership control will impose various moderating effects on the knowledge flows, which, in turn, affects the degree of asset specificity. The above mechanism is important to understand the changing performance of outsourced projects.

Based on the data analysis of this paper, vendor MNCs in China are usually faced with two types of uncertainty. The first is the volatility of the task which originates from the exogenous uncertainty due to changing technology and market demand (Rustagi *et al.*, 2008). The second is the complexity of the task, which is more related to the difficulty of the task itself, and hence it is considered as endogenous uncertainty (Narayanan *et al.*, 2011). The external environmental fluctuations and the complexity of the task require vendors to

assure the appropriate governance structure to support effectively carrying out different modes of knowledge flows when undertaking outsourced projects.

For example, when facing complicated demand of clients, vendors may need to open the firm's boundary and increase its knowledge base, as well as update its existing knowledge resources and structure by sharing knowledge with clients. Vendors will then relax their control over the knowledge resources, thereby facilitating the knowledge inflows and integration with firms' internal knowledge resources. Meanwhile, this logic can also be applied to outbound knowledge flows. If vendor firms have to respond to clients' needs timely, they have to interact more frequently with the clients based on its own knowledge resources. Vendor firms will then relax their control over the outflows of their knowledge resources. Hence, we propose the following hypothesis:

H4a. Weak ownership control positively moderates the relationship between coupled knowledge flows and asset specificity.

For "onshore reverse outsourcing" activities in China, our sample shows that vendor firms are often more willing to develop application services based on their existing technologies. This not only meets the practical needs of local clients in China but is also the most convenient option for vendor firms to enter the Chinese market. Our data observations further show that this contractual type for trading technologies accounts for a high proportion. Usually, vendor firms enter the Chinese market aiming to exploit local cheap but high-quality engineers. On the other hand, vendor firms need to rapidly integrate their technological advantages within their internal departments. Due to the fierce local competition and substantial investments of internal knowledge resources, it is necessary for multinational vendor firms to have strong control over the outflows of their knowledge base (Hymer, 1976). We hereby propose the hypothesis as follows:

H4b. Strong ownership control positively moderates the relationship between the outbound knowledge flows and asset specificity.

4. Research method

4.1 Sample

We collected data from the BMOTM. This data set consists of 2,481 transactions related to R&D contracts in the IT industry offered by vendor MNC in Beijing during the period from 2001 to 2011. After preliminary screening, the sample was reduced to 2,369 transactions. The sellers of the contracts are all foreign-invested firms such as wholly foreign-owned firms and Sino-foreign joint ventures or cooperative firms, including Hong Kong, Macao and Taiwan-invested firms. There are two categories of buyers: the first type (Type I) is foreign firms in China and the second type (Type II) is domestic firms and institutions, including all domestic-funded firms, research institutes, universities and government agencies in China. This paper also uses Corporate Patent Application Database in China, which provides data on patent applicants, the number of corporate patents, patent types and the number of cited patents. This information can be used to match and calculate the human and physical asset specificity of the vendor firms Table 1.

4.2 Variables

4.2.1 Dependent variable: asset specificity. Although there are various methods for measuring asset specificity (Stanko and Calantone, 2011), there has still been no common agreement on the operationalization of the asset specificity constructs (Lohtia *et al.*, 1994; Shelanski and Klein, 1995; David and Han, 2004). Hence, given the available data, this study operationalizes asset specificity into two dimensions – physical and human asset specificity and examines the different modes of open innovation knowledge flows on the two types of asset specificity from the vendor perspective for the outsourced ITO projects. We

Figure 2 Logic behind the hypotheses

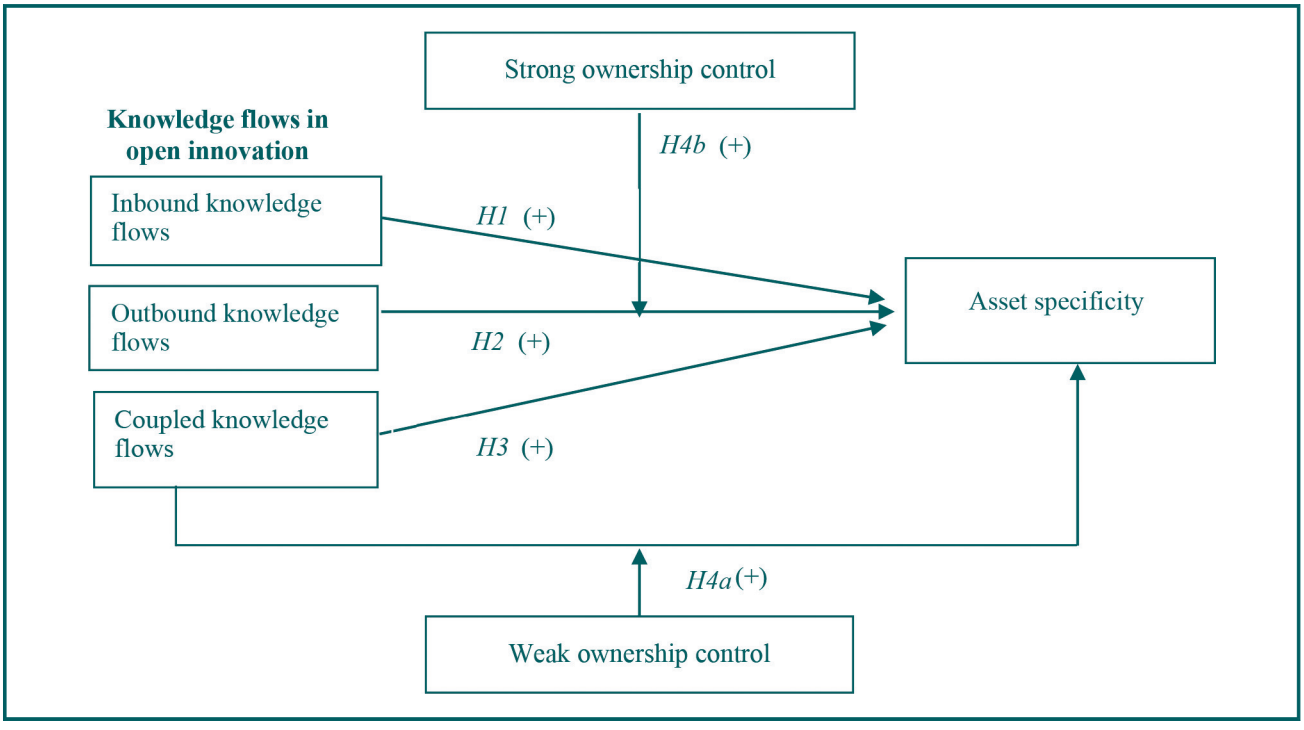


Table 1 Data distribution

2001–2006	*The no. of contracts* Transactions	*(%)*	*Value of contracts* Average value (Million RMB)	*% of total value*
Type I	243	36.05	32.31	85.92
Type II	431	63.95	2.98	14.08
2007–2011	The no. of contracts		Value of contracts	
	Transactions	(%)	Average value (Million RMB)	% of total value
Type I	172	10.15	32.49	79.39
Type II	1,523	89.85	0.95	20.61
2001–2011	The no. of contracts		Value of contracts	
	Transactions	(%)	Average value (Million RMB)	% of total value
Type I	415	17.52	32.38	83.08
Type II	1,954	82.48	1.40	16.92

Source: BMOTM

measure the degree of physical asset specificity using the contract value of the outsourced projects. The vendor needs to build asset specificity (or the sunk cost commitment) for R&D, which makes the technology transaction value go up. The technology transaction value represents the degree of asset specificity. This measurement is relatively more accurate, and in fact has been adopted by many studies (Lin and Fang, 2006; Li, 2009). On the other hand, this paper uses Wang *et al.*'s (2009) method that uses the number of cited patents of vendor firms to measure human asset specificity.

4.2.2 Independent variables: modes of open innovation knowledge flows. There are three types of ITO contracts in our dataset – technology development contracts, technical service

& technical consulting contracts and technology transfer contracts. In this paper, we assume that these multinational vendors are more competitive than the host country firms for both mature and unused technologies. Among the three types of ITO contracts, technology development contracts often seek to develop a technology that does not exist before and requires vendor firms to not only integrate their existing knowledge but also to develop new knowledge resources. Hence, the effects of coupled knowledge flows are most relevant for "technology development contracts." On the other hand, "technical service & technical consulting contracts" are featured as repeatedly using the mature technologies of vendor firms, and are based more on the integration of the knowledge resources among the vendors and then externalized to the clients. Hence, they are more related to the outbound knowledge flows. As it is difficult to distinguish whether the technology involved in the "technology transfer contracts" is mature or unused technology, the "technology transfer contracts" are not investigated in this study.

Given the above analysis, we use two dummy variables of *devjob* and *excjob* to represent the two modes of knowledge flows. The former represents coupled knowledge flows for "technology development contracts"; the latter stands for outbound knowledge flows for "technical service & technical consulting contracts." Therefore, due to the data availability, this study does not statistically test *H1* and it is left for future study.

4.2.3 Moderating variable: ownership control. Ownership control is an important means for MNCs to carry out their foreign operations (Hymer, 1976). For innovation outsourcing activities, in particular, concerns about knowledge leakage have been placed on the agenda (Williamson, 1991). Empirical studies have consistently shown that weak appropriability (high threat of knowledge leakage) has a negative relationship with innovation outsourcing (Stanko and Calantone, 2011). We hence use a binary dummy variable *foreignonly* as the proxy variable. When the vendors are foreign wholly-owned firms, it is valued as 1 indicating a strong degree of control; when the vendors are the joint ventures, it is valued as 0 indicating a weak degree of control.

4.2.4 Control variables. $Intime_{it}$ refers to the logarithm value of the duration of transactions. Time represents the number of days from signing the contract to completing the delivery. Here time is obviously closely related to asset specificity and needs to be considered as a control variable. $longpay_{it}$ represents a dummy variable indicating the behavior uncertainty for payment. The value of 1 indicates "installments or commission payments," and the value of 0 indicates "one-time payments." When the contract is a "one-time payment," vendors will determine the investments in asset specificity according to the contract value, and will generally not make a large adjustment. However, when the payment method is changeable, vendors' early commitments will help the continuation of the project. To achieve the expected performance, the vendor will accordingly increase the investment in asset specificity. Therefore, installment or commission payment facilitates an increase in the vendor's investments in asset specificity. $Infrequency_{it}$ is the logarithm value of transaction frequency, which means the annual number of repeated transactions between the same set of clients and vendors. When the transaction is very frequent, it may be that both parties of the contract tend to build a closer relationship, thereby increasing investments in asset specificity. This variable can thus affect the changes in ownership control. Moreover, because the samples are cross-sectional data, we need to consider the influence of time on the regression results. We then add a dummy variable of $year_{it}$ to the model.

Based on the above variables, we establish the regression model as below:

$$Assetspecificity_{it} = \beta_0 + \beta_1 devjob_{it} + \beta_2 excjob_{it} + \beta_3 X_{it} + year_{it} + \varepsilon_{it} \quad (1)$$

In this model, i and t indicate the transaction order and year, respectively. $Year_{it}$ is the year fixed effect, controlling transaction-wide shocks in a particular year. The vector X_{it} is a set of control variables, including $Intime_{it}$, $longpay_{it}$ and $Infrequency_{it}$. ε_{it} is the error term. We use

heteroscedasticity-consistent standard errors when applying the OLS method. The coefficients of β_1 and β_2 measures the effects of the "coupled" and "outbound" knowledge flows on asset specificity using variation over time.

5. Results

5.1 Descriptive statistics

Table 2 presents the descriptive statistics of all the variables used in this study. The average contract value of the outsourced projects is RMB 683m, which shows the average level of physical asset specificity. During the period of 2001–2011, the maximum cumulative number of cited patents is 1,434 times, and the average number is 16 times. Moreover, about 60% of ITO transactions are technology development contracts that are relevant to coupled knowledge flows. On the other hand, about 5% of ITO transactions are technical service & technical consulting contracts, which are relevant to "outbound" knowledge flows. Approximately 77% of transactions are installments or commission payments. In addition, on average the annual number of repeated transactions between the set of the same clients and vendors is 4.

5.2 The impact of knowledge flows on asset specificity

5.2.1 The impact of knowledge flows on physical asset specificity. As the data in this study are mixed cross-section data sets, there could exist the fixed effect of the individual heteroscedasticity. Hence, the heteroscedasticity test was conducted for both Model 1 and Model 2 (Lin and Fang, 2006; Yang, 2011; Zheng *et al.*, 2019). In Model 1, we include the independent variable of $devjob_{it}$ and control variables. In Model 2, we incorporate $excjob_{it}$ and control variables. The results for the two models are reported in Table 3.

The findings from the White test and the BP test suggest that there is heteroscedasticity between Model 1 and Model 2. Given the heteroscedasticity problem, instead of applying the OLS regression model, this study uses feasible weighted least squares (FWLS) to estimate Model 1 and Model 2. The regression results are shown in Table 4. The dependent variable for the test in Table 4 is logarithm of the contract value of ITO transactions, so the correlation coefficients indicate the effects of knowledge flows on physical asset specificity.

Table 2 Summary statistics

Variable	*Definition*	*Mean*	*Observations*
lnmoney	Physical asset specificity: the logarithm of the contract value of the outsourced projects	12.81 (2.08)	2,369
lnclaims	Human asset specificity: the logarithm of the number of cited patents	0.17 (0.93)	2,369
devjob	"Coupled" knowledge flows: a dummy variable (technology development contracts = 1, Otherwise = 0)	0.60 (0.49)	2,369
excjob	"Outbound" knowledge flows: a dummy variable (technical service & technical consulting contracts = 1, Otherwise = 0).	0.05 (0.23)	2,369
lntime	The logarithm of the duration of transactions	5.65 (1.11)	2,369
longpay	"Payment method" dummy variable (installment or commission payment = 1, one-time payment = 0)	0.77 (0.42)	2,369
lnfrequency	The logarithm of the annual number of repeated transactions between the same set of clients and vendors	0.88 (1.00)	2,369
year	Year dummy variable	2007.83 (2.58)	2,369

As shown in all the six columns, the coefficients of both *devjob* and *excjob* are positive and significant at 1% level. This means that both "coupled" and "outbound" knowledge flows can promote vendors' higher investments in physical asset specificity. Therefore, *H2* and *H3* are supported.

Moreover, this paper finds that there is no reverse causality between the independent variables of knowledge flows and the dependent variable of physical asset specificity. The type of technology development contracts determines the degree of vendors' asset specificity investments. In this respect, technology development contracts relevant to "coupled" knowledge flows require a higher degree of investment in physical asset specificity. Technical service and technical consulting contracts which are relevant to "outbound" knowledge resources require lower degree of investments in the physical asset specificity. However, when vendors have not signed a contract and are not certain about the type of target technology, they will not determine the amount of investment in asset specificity. Therefore, this paper suggests that there is no reverse causality between independent and dependent variables for the regression model.

In addition, the coefficients of payment, R&D time and transaction frequency are positive and statistically significant, thereby suggesting that "installment payment or commission payment" helps increase the vendor's investment in physical asset specificity. The longer the R&D time of the project, the more frequent transactions between the contractual parties, the more it will encourage vendors to increase the investment in the physical asset specificity.

5.2.2 The impacts of knowledge flows on human asset specificity. Table 5 shows the result of the White test and the BP test on human asset specificity. Similar to the test on physical asset specificity, we also use FWLS to test the estimated regression model. The results are shown in Table 6.

Table 3 Heteroscedasticity test (physical asset specificity)

	Chi-square value	p-*value*
Model 1		
White test	145.59	0.00
BP test	53.64	0.00
Model 2		
White test	193.01	0.00
BP test	53.20	0.00

Table 4 Baseline results (physical asset specificity)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Devjob	1.53*** (0.10)	1.57*** (0.08)			1.88*** (0.10)	1.67*** (0.08)
Excjob			1.42*** (0.37)	2.63*** (0.22)	2.62*** (0.44)	2.93*** (0.24)
Lntime		0.64*** (0.02)		0.83*** (0.02)		0.60*** (0.02)
Longpay		1.75*** (0.07)		1.77*** (0.08)		1.78*** (0.07)
Infrequency		0.05 (0.03)		0.19*** (0.04)		0.07** (0.03)
Year		−0.22*** (0.01)		−0.25*** (0.02)		−0.19*** (0.01)
Constant	11.89*** (0.05)	457.94*** (29.30)	12.73*** (0.04)	514.92*** (30.85)	11.54*** (0.05)	397.55*** (28.25)
Observations	2,369	2,369	2,369	2,369	2,369	2,369
F-value	233.93*** (0.00)	909.83*** (0.00)	14.84*** (0.00)	788.76*** (0.00)	181.02*** (0.00)	842.90*** (0.00)
R^2	0.0899	0.6581	0.0062	0.6253	0.1327	0.6816

Note: ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively

The dependent variable for the test in Table 6 is logarithm of the number of cited patents, so the correlation coefficients indicate the effects of knowledge flows on human asset specificity. In Column (1) to Column (3), the coefficients of *devjob* and *excjob* are both statistically significant and positive. This means that "coupled" and "outbound" knowledge flows can also encourage more investment in human asset specificity. The results in Column (3) show that if the ITO contracts are relevant to "coupled" knowledge flows, human asset specificity will increase by 0.15%; if the contractual transactions are relevant to outbound knowledge flows, human asset specificity will increase by 0.43%. Therefore, *H2* and *H3* are supported for human asset specificity as well.

5.3 The moderating effect of ownership control

5.3.1 The moderating effect on physical asset specificity. Based on the baseline results, this paper further tests the moderating effect of ownership control. Table 7 presents the results of moderating effects on the contractual transactions with weak and strong control, respectively. Tests in all columns of Table 7 include the three control variables illustrated before. Columns (1) to (3) show that when the control level of ownership is weak, the impact of both "coupled" and "outbound" knowledge flows on the investment of physical asset specificity is significant. Thus, *H4a* is supported. Columns (4) and (5) of Table 7 show that when the control level of ownership is strong, based on the FWLS model, the coefficient of "coupled" knowledge flows is not significant, but the coefficient of "outbound" knowledge flows is significant. However, when adding both dummy variables of *devjob* and *excjob* in Column (6), the coefficients of the two modes of knowledge flows are both significant. The regression results of "coupled" knowledge flows are unstable, but the effect of outbound knowledge flows is consistent.

The relative effects of "coupled" and "outbound" knowledge flows on the investment in physical asset specificity under strong ownership control are tested by the change in ΔR^2. $\Delta R_1^2 = \Delta R_{Column(6)}^2 - \Delta R_{Column(4)}^2 = 0.0849$ represents the increased investment in the

Table 5 Heteroscedasticity test (human asset specificity)

	Chi-square value	p-*value*
Model 1		
White test	170.87	0.00
BP test	79.24	0.00
Model 2		
White test	224.11	0.00
BP test	81.24	0.00

Table 6 Baseline results (human asset specificity)

	(1)	*(2)*	*(3)*
devjob	0.09** (0.04)		0.15*** (0.04)
excjob		0.29*** (0.10)	0.43*** (0.11)
Basic controls	Yes	Yes	Yes
Constant	87.55*** (14.68)	76.31*** (15.45)	63.92*** (15.52)
Observations	2,369	2,369	2,369
F value	15.53*** (0.00)	15.91*** (0.00)	16.11*** (0.00)
R^2	0.0318	0.0326	0.0393

Notes: *, ** and *** represent 10%, 5% and 1% significance levels, respectively. Figures in parentheses represent standard errors. This table reports baseline results for human asset specificity

Table 7 Moderating effect of ownership control on physical asset specificity

Ownership control		*Weak control*			*Strong control*	
			FWLS			
Model	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Devjob	1.75*** (0.09)		1.79*** (0.09)	−0.16 (0.18)		0.68*** (0.20)
Excjob		1.89*** (0.38)	2.23*** (0.39)		1.77*** (0.29)	2.45*** (0.34)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	472.04*** (31.69)	605.71*** (34.03)	450.05*** (31.50)	423.83*** (77.87)	323.46*** (77.75)	235.12*** (76.71)
Observations	1,941	1,941	1,941	428	428	428
F value	818.42*** (0.00)	648.76*** (0.00)	699.25*** (0.00)	22.61*** (0.00)	33.67*** (0.00)	29.53*** (0.00)
R^2	0.6789	0.6264	0.6845	0.2113	0.2852	0.2962

Notes: *, ** and *** represent 10%, 5% and 1% significance levels respectively. Figures in parentheses represent standard errors. The dependent variable is the logarithm of contract value of the outsourced projects. The results of all columns in Table 7 are estimated by using FWLS model at transaction level, including the control variables

physical asset specificity due to "outbound" knowledge flows under strong ownership control. $\Delta R_2^2 = \Delta R_{Column(6)}^2 - \Delta R_{Column(5)}^2 = 0.011$ represents the increased investment in the physical asset specificity brought by the "coupled" knowledge flows under strong ownership control. Under strong ownership control, ΔR_1^2 is larger than ΔR_2^2, which indicates that compared with the "coupled" knowledge flows, the "outbound" knowledge flows can promote more investment in asset specificity. Thus, *H4b* is partly supported.

5.3.2 The moderating effect on human asset specificity. To investigate the moderating effect on human asset specificity, we use the same method as Section 5.3.1 and divide the transactions into the following two groups: the weak control and strong control group. The results of applying the FWLS mode are shown in Table 8, in which all columns include three control variables. Columns (1) to (3) show that when the control level of ownership is weak, the impact of both "coupled" and "outbound" knowledge flows on the investment in human asset specificity is significant and positive. Thus, *H4a* is supported. In Columns (4) and (5), when the control level of ownership is strong, the coefficient of "coupled" knowledge flow is not significant, but the coefficient of "outbound" knowledge flow is significant. Therefore, under the strong ownership control, compared with the "coupled" knowledge flows, the "outbound" knowledge flows can promote more investment in asset specificity. In this case, *H4b* is partly justified.

6. Discussion

Under a closed innovation paradigm, knowledge flows are often restricted. As knowledge is considered to be a core resource, firms are willing to retain their core knowledge internally due to the fear of its leakage. Such limited knowledge flows further build up asset specificity and overlook external changes. This, in turn, propels firms to invest more in added inputs internally for continuous innovation and pressures them to increase their control over specific assets that provide added protection (Hymer, 1976; Williamson, 1985; Dunning, 2001; Hwang and Suh, 2015).

As such, the closed innovation paradigm deters firms from flexibly responding to market changes. It also leads to the biased accumulation of unused knowledge embedded in firms with great sunk cost, thereby exacerbating their financial performance (Zheng *et al.*, 2018). In this respect, the lens of open innovation theory will help provide a new perspective to examine the relationship between knowledge flows and asset specificity. On the one hand, with more frequent knowledge flows across firm boundaries, the impact of site-specificity will be reduced because of transparent information; the turnover of brand capital and dedicated asset specificity will increase, the value of depreciation will be accelerated and the marginal cost will be constantly decreasing. These effects indicate that the asset specificity will be more elastic and dynamic in the open innovation context. On the other

Table 8 Moderating effect of ownership control on human asset specificity

Ownership control		*Weak control*			*Strong control*	
			FWLS			
Model	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Devjob	0.09*** (0.02)		0.11*** (0.02)	−0.16 (0.15)		0.17 (0.15)
Excjob		0.03 (0.06)	0.13*** (0.06)		1.02*** (0.37)	1.19*** (0.39)
Controls variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−6.34*** (8.35)	−7.86*** (9.46)	−16.20*** (9.38)	286.26*** (48.03)	243.56*** (45.88)	222.09*** (48.09)
Observations	1,941	1,941	1,941	428	428	428
F-value	6.67*** (0.00)	2.86** (0.01)	6.37*** (0.00)	13.57*** (0.00)	14.38*** (0.00)	12.29*** (0.00)
R^2	0.0169	0.0073	0.0194	0.1385	0.1456	0.1490

Notes: *, ** and *** represent 10%, 5% and 1% significance levels respectively. Figures in parentheses represent standard errors. The dependent variable is the logarithm of the number of cited patents of vendors for all columns

hand, when faced with more demanding requirements from clients, as well as the need to update technology, vendors are encouraged to open their boundaries for closer interaction with clients. By coordinating and relocating their multifaceted asset specificity, vendors can improve their innovation performance.

Such impacts lead to significant changes with the "black box" of asset specificity under an open innovation paradigm. Therefore, this paper seeks to open the "black box," by constructing the asset specificity as the dependent variable and different modes of knowledge flows in open innovation as the independent variables.

Our empirical test reveals that both coupled and outbound knowledge flows encourage firms to engage in higher investments in physical or/and human asset specificities. This then supports the arguments of preceding studies that the open innovation process stimulates the absorptive capacity of firms that bridge international and external knowledge more effectively (Cohen and Levinthal, 1990; Zahra and George, 2002; Abdulkader *et al.*, 2020; Bogoviz, 2020).

Furthermore, the results show that outbound knowledge flows result in higher investments in asset specificity, but requires stronger innovation control compared to coupled knowledge flows. This is supported by the existing studies that commonly acknowledge that the most obvious issues regarding outbound knowledge flows is the risk of leaking valuable innovations to the competition and thereby losing their competitive advantages because of poor management and collaboration with external partners (Laursen and Salter, 2006a; Bereznoy *et al.*, 2021).

The results also show that both coupled and outbound knowledge flows imposed higher impacts on physical than they do on human asset specificity. According to Wang *et al.* (2019), physical asset specificity refers to tangible investment assets (tools, equipment and machinery), whereas human asset specificity refers to intangible investment assets (professional training and customizing workflows). Compared to physical asset specificity, human specificity is particularly influenced by cultural, institutional factors and trust between vendors and clients. Therefore, it may create difficulties for vendor MNCs to invest in human specificity rather than physical ones.

In addition, according to the literature (Ardito *et al.*, 2020), outbound knowledge flows are often linked with exploitative strategies and inbound flows are linked to explorative ones. Whereas many preceding studies (West and Bogers, 2014; West *et al.*, 2014; Shim *et al.*, 2019) mainly deal with inbound knowledge flows, this study adopted a more comprehensive approach by investigating both coupled and outbound flows, by examining the reverse onshore outsourcing activities. These vendor MNCs not only exploit their mature technologies for the successful commercialization of technologies in the market but also explore clients' knowledge, which are combined with their unused technologies to improve the performance of implementing outsourced projects (Zheng *et al.*, 2018).

Regarding the empirical test of this study, it has investigated the changes in the asset specificity from the vendor perspective, which is consistent with most of the existing studies (Heide and John, 1990, 1992; Bucklin and Sengupta, 1993; Ghani and Khan, 2004; De Vita *et al.*, 2010; Aral *et al.*, 2018; Suresh and Ravichandran, 2021). However, this paper is different from existing empirical studies on the suppliers' asset-specific investment due to the following reasons.

The preceding literature mostly limits their research context to a closed innovation paradigm (Hsieh *et al.*, 2016). Hence, in the research on the field of outsourcing, MNCs from developed countries are the clients of contractual transactions, and firms from developing countries are the vendors. In this respect, the key motivation of MNCs for outsourcing is to exploit their advantages and transfer non-core business activities to firms from developing countries. In exchange, clients in developed countries can gain two advantages from these firms: cost reduction advantages and manufacturing technology embedded in the final products. Hence, the uncertainty in the process of outsourcing mainly derives from the quality of the outsourced projects delivered by the vendor firms (uncertainty of product market, Chen, 2005).

By contrast, this paper investigates the reverse onshore outsourcing in the open innovation environment, where foreign MNCs in China are vendor firms and local firms are contract clients. From the perspective of multinational vendor firms, they provide technologies with ambidextrous features – both mature and unused technologies (Zheng *et al.*, 2018). Accordingly, in the process of transactions, the asset specificity is affected by the different degree of input combination of mature and unused technologies. Therefore, the uncertainty in the transaction mainly comes from the technology quality of the vendors (uncertainty of the factor market). The traditional offshore outsourcing activities mainly concern the mature technologies of vendor firms, which is rare for technological spillover and leakage by the vendors. However, the reverse onshore outsourcing activities examined by this paper involve more unused knowledge assets, thereby higher possibility of technology transfer and spillover effects. Unpacking the difference in technology nature and its relationship with asset specificity among vendor firms can thus be an important contribution of this paper.

Moreover, this study reveals both general and China-specific implications with regard to the ownership control in the innovation outsourcing activities. In the context of task uncertainty, if vendor MNCs aim to explore complicated knowledge or respond quickly to the needs of clients, weak control of ownership can promote the efficient knowledge flows within and outside the firm boundary. This can further help the understanding of resource allocation of MNCs along the value chain for R&D outsourcing activities in the fast-changing market.

On the other hand, given the growing number of MNCs entering the host market, this study found that strong ownership control positively moderates the relationship between the outbound knowledge flows and asset specificity. This reveals the particularity with the development level of R&D outsourcing in the host market. In other words, vendor MNCs may be unfamiliar with the local business environment. Taking China as an example, the demand of its client firms is relatively complex and local-oriented. Therefore, to respond to different requirements of local clients and reduce "cost of foreign liability" (Hymer, 1976), vendor MNCs have to integrate their internal resources through cautious control. This is influenced by the differences among the adaptability of MNCs to the local cultural environment. It is clear then that MNCs in China need to strengthen their control level to integrate internal resources for contractual businesses.

7. Conclusion

7.1 Key findings and theoretical contributions

The key findings of this paper can be summarized as follows. First, we find that different modes of knowledge flows under the open innovation paradigm have a positive impact on

the increase in asset specificity. Second, in the context of task uncertainty, weak ownership control positively moderates the relationship between coupled and outbound knowledge flows and asset specificity. Yet, strong ownership control moderates the relationship between the outbound knowledge flows and asset specificity.

The theoretical contributions of this paper are as follows. First, the three prominent theories (TCE, RBV and RET) in accordance with a closed innovation paradigm, regard asset specificity as an independent variable that exists as a "black box" with static nature. By contrast, this study opens the "black box" of asset specificity, which is treated as a dependent variable, by examining the modes of open innovation knowledge flows on asset specificity. From the perspective of open innovation, the degree of asset specificity can be influenced by the dynamic changes of firm boundaries in the process of knowledge flows.

Second, the three traditional theories view that the degree of asset specificity directly affects the changes of firm boundary, which, in turn, influences the governance modes of various transactions. They commonly hold that when the asset specificity increases, it often results in hierarchical organizational governance (strong ownership control). Yet, from the perspective of open innovation, when facing various modes of knowledge flows, the real meaning of ownership control lies in how to better promote the optimal efficiency of knowledge flows and obtaining its comparative advantages (Alchin, 1977). Therefore, our research results challenge the traditional one-way linear relationship between asset specificity and ownership control and found the complex influencing mechanism behind the relationship between asset specificity and ownership control. Not only asset specificity can influence the degree of ownership control, but also the control degree can affect asset specificity through its moderating effects on knowledge flows.

7.2 Practical implications

The research results of this paper provide practical implications for both firms and policymakers as follows. First, for innovation outsourcing, it is a new phenomenon that MNCs from developed countries act as vendor firms for clients from developing countries such as China. This paper examines the outsourcing activities of vendor MNCs using the lens of open innovation theory, and finds that when firms seek to maximize the efficiency of knowledge flows, they will increase the investment in asset specificity for both coupled and outbound knowledge flows. This study thus challenges the previous view that asset specificity and opportunism are connected (Williamson, 1985). From the perspective of efficiency of knowledge flows, it provides meaningful implications for vendor MNCs in developing countries. As such, this paper provides implications for policymakers to attract overseas R&D investment and establish global innovation centers.

Second, when encouraging MNCs in China to carry out R&D activities, further policy and institutional support is needed to encourage the spill-over effects of knowledge and technology, which has been consistent with China's opening-up policies. Since China joined the WTO in 2001, it has gradually loosened its policy controls to promote open innovation at both country and firm level. However, to adapt to the new era of innovation-oriented development, China needs further institutional development, such as intellectual property rights, to facilitate the knowledge transfer and exchanges between local clients and foreign vendors.

Third, regarding the reciprocity of the influences of asset specificity on knowledge flows, we argue that under a closed innovation environment, the more asset specificity constitutes a higher transaction cost for firms to open their boundaries. Hence, asset specificity imposes a trapped or lock-in effect for knowledge flows. Although many Japanese electronics giants such as Sony, Panasonic and Sharp held a dominant position in the market up to the early twenty-first century, they experienced difficulties in corporate transformation in the current digital era, a time when there were significant changes in the market. On the one hand, in an

open innovation environment, with frequent knowledge flows beyond firm boundary, the asset specificity is relaxed. For example, the competitiveness and sustainability of platform-based ecosystem depends on how diverse players are compatible and complementary with each other, thereby encouraging knowledge sharing and creation. On the other hand, the changing client demand and unused technologies of vendor MNCs help strengthen their commitments to the asset specificity, which promotes the dynamic capability of vendor MNCs for exchanging knowledge resources beyond the firm boundary.

7.3 Research limitation and future study

Despite its many advances, this study has some limitations. First, due to data availability, this study examines two dimensions of asset specificity (physical and human) and thus suggests further investigation into other dimensions, such as site, brand name capital and time asset specificity which have become increasingly important in an open innovation paradigm. Second, this study uses data from vendor MNCs in Beijing to test the hypotheses for ITO activities. Future research can expand the samples to other geographic regions of China such as Shanghai and Guangzhou and other emerging countries such as India, thereby generalizing the findings of this study. Third, this paper mainly investigates the time period from 2001 to 2011. Future research can update the database using more recent data, which will help obtain more comprehensive research results.

Note

1. This paper commemorates Oliver E. Williamson, who won the 2009 Nobel Prize in Economics.

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