Inter-firm Collaboration in New Product Development in Chinese Pharmaceutical Companies

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ABSTRACT

High-tech firms increasingly rely on inter-firm collaboration (IFC) in new product development (NPD). Whilst there is a growing research interest in exploring the economic rationale of IFC through the transaction cost economics (TCE) and the resource synergy of IFC through the resource-based view of the firm (RBV), little attention has been given to the institution-based view (IBV) that also has important implications for firms' choice of IFC. In particular, how national institutional environment affects IFC in the NPD process remains under-researched. This study aims to contribute to the literature by extending our understanding of the role of IFC in firms' NPD process, taking into account transactional, resource and institutional factors. Based on a case study of two firms: a state-owned and a private pharmaceutical firm in China, our research identifies three key forms of IFC, which are dynamic at different stages of NPD and contingent upon an array of institutional, resource and transactional rationales underpinning firms' choice of different forms of IFC. Our study is the first one that investigates the role of IFC in the NPD process bringing together the IBV, RBV and TCE perspectives.

Key words: inter-firm collaboration, new product development, Chinese pharmaceutical companies, resource-based view, institution-based view, and transaction cost economies.

Introduction

Firms are increasingly under pressure to enhance both efficiency and flexibility in new product development (NPD). Fast technological changes and shortened product life cycles drive firms to search for resource synergy through inter-firm collaboration (IFC), such as informal cooperation, licensing and strategic alliances (Kanter, 1994; Santoro & McGill, 2005; Wolter & Veloso, 2008). IFC allows firms to coordinate resources and engage in inter-organisational learning (Child, Faulkner & Tallman, 2005; Mowery, Oxley & Silverman, 1996; Nonaka & Nishiguchi, 2001). This helps to reduce uncertainty, mitigate risks in pursuing breakthrough innovations, and speed up NPD (Hoskisson et al., 2000; Peng & Heath, 1996).

Despite a growing research interest in exploring the economic rationale of IFC through the transaction cost economics (TCE) and the resource synergy of IFC through the resource-based view of the firm (RBV), the institution-based view (IBV) that also has important implications for firms' choice of IFC is under-researched. IBV is especially relevant in emerging market economies, such as China, where the institutional environment is dynamic and often undermines innovation that requires long-term commitment within firms (Ahn & York, 2011; MacMillan, 2007; Peng & Heath, 1996). IFC, as informal substitutes for formal institutional support (Hoskisson et al, 2000; Peng, Wang & Jiang, 2008), enables firms to pool resources and share risks, helping to overcome institutional constrains. In other words, IFC can be viewed as a constellation of collaborative actions giving rise to heterogeneous responses to the institutional environment. Given its relevance, scholars have urged to bring institutional factors to the forefront in research on firms' strategic choice in emerging markets (Ahn & York, 2011; Meyer et al. 2009; Peng, Wang and Jiang, 2008). This leads to our research question: what role does IFC play in the NPD process in Chinese pharmaceutical firms, taking into account the RBV, TCE, and IBV perspectives?

We aim to address this question by exploring how firms leverage different forms of IFC in the key stages of NPD. Firms' decisions on IFC involve weighing out the potential of value creation against the potential costs associated with different forms of IFC (Thompson, 2003), on which RBV and TCE offer contrasting insights. The RBV, taking a strategic stance, emphasises unique resources in IFC; value creation arises from accessing, mobilising and synergising unique resources embedded in collaborative partners (Barney, 1991, 2001; Phlippen, 2008; Smith, Vasudevan & Tanniru, 1996). Value creation can emerge not only from complementary or supplementary resources embedded in collaborative partners, but most importantly, from the collaborative process, in particular, the interaction among NPD teams. Conversely, TCE suggests that transaction costs (such as administrative costs and operational risks) are key to understand IFC (Silverman, Nickerson & Freeman, 1997; Williamson, 1985, 2002), and that IFC must be regulated with an appropriate structure to ensure that value creation outweighs transaction costs.

Although RBV and TCE offer insights on transactional and resource factors shaping IFC, they overlook institutional contexts where collaborations take place (March, 2005; Li & Peng, 2008). TCE focuses on micro-analytical aspects (e.g. opportunism and bounded rationality), overlooking the macro-level institutions (e.g. country-level legal and regulatory framework). Conversely, RBV focuses on firm-specific resources, neglecting the fact that formal and informal institutions, in which firms operate, may affect resource development, allocation and acquisition (Ahn & York, 2011; Bruton & Ahlstrom, 2003; Meyer et al., 2009). Prior research stresses that national institutional environment exerts substantial impacts on how firms associate with external bodies (Li & Peng, 2008), and in emerging economies institutional instability even gives rise to inter-firm collaborations (De Clercq, Danis & Dakhli, 2010). Therefore, research is required to integrate IBV with TCE and RBV to move from micro to macro factors, and from context-free to context-embedded factors in understanding

IFC as a social-economic phenomenon to overcome institutional barriers in emerging economies (Hoskisson et al., 2000; Peng, Wang & Jiang, 2008).

Positioned at the intersection between RBV, TCE and IBV, this study aims to contribute to the understanding of the role of IFC in firms' NPD process, taking into account transactional, resource and institutional factors. Moreover, this study is positioned in a unique institutional setting of the Chinese pharmaceutical industry. Although the Chinese government has promulgated industrial policies and offered financial subsidies to encourage collaboration between research institutes, businesses and public services (Zhang, Cooke and Wu, 2011), Chinese pharmaceutical firms are still lagging behind in NPD, compared with their international counterparts (Roijakkers & Hagedoorn, 2006). Within this industry setting, we draw empirical evidence from a case study of two pharmaceutical firms: a state-owned company and a private enterprise in Beijing, China. The state-owned company and the private firm enterprise provide contrasting institutional contexts in which firm's NPD takes place. Their different ownership also means differences in endowed resources and governing structure, providing contrasting situations that enrich our understanding of the roles played by resource and transactional factors in the NPD process. Therefore, our intersectional theoretical positioning combined with the unique research context provides insights on the NPD process in Chinese pharmaceutical firms, and the role of IFC in the interaction between Chinese pharmaceutical firms and their institutional environment in the NPD process.

Theoretical Background

Inter-firm collaboration from the resource-based view

From the RBV perspective, IFC enables access to and deployment of resources embedded in different firms (Makadok, 2001). RBV argues that the existence of any forms of organisation depends on its possession of valuable, rare, hard-to-imitate and immobile resources (Barney,

1991, 1999). Unique, sticky and embedded (tacit) resources are fundamental to firms' competitive advantage (Barney, 1991; Phlippen, 2008; Smith, Vasudevan, & Tanniru, 1996). Embedded resources cannot be easily acquired or mobilized through market mechanisms (Madhok, 1997; Madhok & Tallman, 1998; Teece & Pisano, 1994). Although embedded resources can be acquired through ownership transfer, the potential of associated value creation may be undermined or lost, especially when such resources are developed over time (Amit & Schoemaker, 1993). This is because the acquisition of such resources involves 'learning by doing', observation and intensive communication (Tsoukas, 2003). It requires individuals from different organizations to engage in shared practice where strong operational integration exists between both parties (Fineman, 2003; Fox, 2000; Li *et al.*, 2014).

Collaborative partners often possess different embedded resources. The value creation potential of IFC is realized only if such differences are exploited for mutual gain (Kim & Finkelstein, 2009). Resource complementarity or supplementarity is at the heart of realizing IFC's potential. Resource complementarity means that firms are able to create competitive advantage by eliminating deficiencies in their resource portfolio (Lambe, Spekman, & Hunt, 2002). Resource supplementarity means that firms can achieve economies of scale and/or scope by integrating resources and capabilities (Harrison, Hoskisson, & Ireland, 2001), not only for cost control but also for value creation. IFC can build on the synergy of complementary and supplementary resources, leading to sustainable competitive advantage (Espino-Rodriguez & Padron-Robaina, 2006). Therefore, IFC offers firms an alternative to build on their own competences by utilising partners for critical skills that firms cannot execute, or to exploit opportunities that they do not have sufficient resources to devote to.

Inter-firm collaboration from the transaction cost economics perspective

TCE sees IFC as a way in which firms relate to other economic entities (Silverman, Nickerson, & Freeman, 1997; Williamson, 1985). The effectiveness of IFC is moderated by three key transaction cost based factors. First, asset specificity (Williamson, 1983), that is, the investment made to an asset that is specific to a given transaction and therefore not deployable by other transactions (Williamson, 1985). IFC means that firms will designate investment in human capital, physical assets, time and co-ordination, specialised knowledge to the collaborative relationship (De Vita, Tekaya, & Wang, 2011). Such designated investment is specific to the collaboration, resulting in high switching costs if one partner is to be replaced (Williamson, 1981). In the case of high asset specificity, firms benefit from formalising and internalising the relationship to mitigate the hazard of opportunistic behaviour.

Second, uncertainty also has significant impacts on IFC. Uncertainty derives not only from opportunism but also bounded rationality - firms' constrained capacity to access and process available information (Simon, 1997). As firms are not able to write contracts that cover all possible contingencies (Powell, 1990), risks and costs are involved in making specialised investment decisions based on limited available information (Williamson, 1985). High uncertainty of transaction outcome implies complexity and high cost to contract and to enforce contracts (Thompson *et al.*, 1991), leading firms to turn to highly integrated or internalised governance forms (Williamson, 1975).

Third, IFC is also affected by the frequency of transactions, which can range from occasional to recurrent (Williamson, 1979). Due to high set-up costs, firms favour recurrent transactions that may lead to long-term collaborations instead of one-off contracts to regulate IFC, although bilateral governance structures often give way to unified ones as uncertainty increases in recurrent transactions (Williamson, 1981).

Despite its relevance, TCE ignores that transactions and transferability of resources are

often restrained by the organisational context as suggested by the RBV (Zander & Kogut, 1995) and the wider institutional context as suggested by the IBV. Williamson (1991) himself comments that fast changing markets create additional contextual concerns, which are not considered by TCE. The value of resources cannot be judged in a vacuum and must be considered in the context where the resources are used (Katila & Shane, 2005). In addition, both TCE and RBV emerged from the developed countries. Caution should be paid when applying TCE and RBV in developing countries, such as China, where the national institutional environment is significantly different from the West (Li & Peng, 2008). Therefore, IBV is a worthwhile perspective to take into account when analysing IFC.

National institutions and NPD in the Chinese pharmaceutical industry

National institutional environment serves as a framework to define, limit and regulate business interactions in a society (North 1990). Competition within industries and among firms is governed by formal (e.g. laws and regulations) and informal (culture and ethical norms) institutions (Peng, Wang, & Jiang, 2008). National institutional environment also creates a platform for all firms to play the game following the same rule. Firms' decisions are constrained or facilitated by the complicated interaction of formal and informal institutions. For example, Mahlich (2010) finds that, with the market deregulation and the removal of entry barrier in the pharmaceutical industry in Japan during the 1980s and 1990s, under great pressure challenged by foreign firms, Japanese firms were forced to adjust their business models toward more intensified in-house R&D. While Su, Tsang and Peng (2009) reveal that non-Western country specific institutional features in Taiwan affect the innovation pattern of its biotechnology industry. Taiwanese firms are stronger in process innovation (routine management) but weaker in product innovation (discovery) than firms in the US. In Malaysia, Ahn and York (2011) suggest that government's coordination in helping set up alliances to

channel in critical knowledge is more effective in developing its biotechnology industry than other institutional policies, e.g. tax incentives. This indicates that institutions matter.

The pharmaceutical industry in China experienced significant regulatory changes in accordance with China's economic reform. On 1st January 1993, the major amendments to the Patent Law came into effect in China, marking a historical transformation for the Chinese pharmaceutical industry (SIPO, 2011). Until 1993, only the pharmaceutical methods were protected. The 1993 amendments stipulate that the pharmaceutical products, methods and usage could be all patented, endowing inventors with true rights (Hill & Judith, 1993). These terms mean that Chinese pharmaceutical firms could no longer produce drugs patented by foreign companies after 1993. This leaves Chinese pharmaceutical firms with three choices for business development: to manufacture generic drugs once their patents expire; to purchase the intellectual property right of a patent drug, or to invest in developing innovative drugs (Cao, 2004).

Although drug development in China follows a four-phase process similar to that in the Western countries: laboratory test (Phase I), animal test (Phase II), clinical trials (Phase III) and post marketing surveillance (Phase IV) (CDER, 1998; Dimasi, Hansen & Grabowski, 2003; FDA, 1998; SFDA, 2005), pharmaceutical firms are currently subject to a series of monitoring and certification. For example, pharmaceutical firms must obtain four certificates from the State Food & Drug Administration (SFDA, 2005): the first one before doing Animal Test (Phase II); the second at the end of the pre-clinical test (Phase I&II); the third one when the NPD completes Phase III; and the fourth one, Certificate of Good Manufacturing Practice, before carrying out Phase IV. Only with the four certificates, Chinese pharmaceutical firms could start Phase IV.

The above regulatory changes accompanied by a long regulatory approval cycle and strong competition from international pharmaceutical companies place an intense pressure on

Chinese pharmaceutical firms. In addition, the long NPD process and tremendous resources required for NPD in the pharmaceutical industry mean that hardly any single firm has all the necessary capabilities to single-handedly pursue NPD (Liebestkind et al., 1996; Rothaermel & Deeds, 2004; Van de Vrande, Vanhaverbeke & Duysters, 2009). IFC offers an alternative route to NPD (Ahn & York, 2011; Freeman, 1991; Kogut, 2000; Liebeskind et al., 1996; Oliver, 2004; Powell 1996; Rothaermel & Deeds, 2004).

Integrating RBV, TCE and IBV

Prior research has discussed the need for different types of IFC. For example, Liebeskind et al. (1996) reveal that trustworthy informal IFC between individual employees and external scientists at universities and research institutions acts as the main boundary-spanning governance form facilitating the NPD process whereas formal IFC is uncommon at new biotechnology firms. Informal IFC offers flexibility to switch from one source of knowledge to another without incurring costs, helps increase the scope of organisational learning, and hence facilitates the scientific growth of the organisation (Liebeskind et al., 1996; Su, Tsang & Peng, 2009). This is echoed by Oliver (2004) and Rothaermel and Deeds (2004), who find that at the early 'research' stage of NPD in the biotechnology industry, firms indeed prefer to employ informal exchanges, a collaborative or explorative form of relationship, to screen and search for new knowledge; in the later 'development' stage of NPD, firms switch to formal contracts, a competitive or exploitative form of relationship, to capture value from knowledge. However, prior research has not explained how resource, transaction and institution based factors interact in firms' IFC. This study addresses this research gap by integrating RBV, TCE and IBV.

In broad terms, existing literature acknowledges that RBV complements TCE (Combs & Ketchen, 1999; Madhok, 2002; Mclvor, 2009). Although TCE takes transaction as the unit

of analysis while RBV examines resources, transactions and resources are not separable in business practice. When firms transact through exchanges, they transact resources (Madhok, 2002). Firms can be perceived as an avoider of negative opportunism but also a bundle of valuable strategic resources that create competitive advantage (Mclvor, 2009). In IFC firms can manage opportunistic behaviour through building trust between partners (Child, Faulkner & Tallman, 2005). While firms may engage in IFC to minimize the cost of governing the exchange activities (Madhok, 2002), they may also seek complementary resources rather than an efficient response to the exchange conditions (Combs & Ketchen, 1999; Madhok, 2002).

Existing literature also suggests that IBV complements TCE and RBV (Li & Peng, 2008; Meyer et al., 2009; North, 1990; Peng, Wang, & Jiang, 2008). Both TCE and RBV are criticized as context-free and US-centric theories (March, 2005; Li & Peng, 2008). TCE focuses on micro-analytical aspects, e.g. opportunism, but overlooks macro-level national institutions that affect transaction costs (North, 1990; Peng, Wang, & Jiang, 2008). For example, a weak institutional environment results in a lack of transparent information and augments information asymmetries, which increases risks and costs associated with partner selection (Meyer, 2001; Meyer *et al*., 2009). On the other hand, RBV highlights firm-level resources, but neglects institutional factors that affect firms' access to resources through market mechanisms (Ahn & York, 2011; Bruton & Ahlstrom, 2003). For instance, in developed countries where institutional environment supports market, firms can bid for resources, while in developing countries immature institutional environment may create barriers for firms to access resources through market exchanges (Meyer *et al*., 2009). Hence, firm-specific resources also reflect formal or informal constrains or enablers of a particular institutional setting that firms confront (Ahn & York, 2011; Peng, 2002).

Embedded in the institutional setting, firms are rewarded to conform to institutional requirements by achieving increased legitimacy, institutional recognition and support, and

survival capabilities. Firms that have a high level of institutional support for resources can attain competitive advantage through possessing 'institution-based resources' (Tokaranyaset, 2013) or 'institutional capital' (Oliver, 1997), in the forms of social (embedded in network), political (connection with governments) and reputational (reduce information asymmetry between firms and stakeholders) capital (Peng, Lee & Wang, 2005). Building on Dosi (1994), Williamson (1999) acknowledges that firms' boundary spanning activities must be understood by incorporating not only the TCE but other elements, such as learning, path-dependency, selection, technological opportunities, and complementary assets. Therefore, an integrative approach incorporating both micro and macro levels as well as context-free (TCE and RBV) and context-embedded (IBV) elements is needed to conduct research in China to reflect on its unique institutional setting (Li & Peng, 2008).

Research Methods

We adopted a qualitative case study research strategy (Yin, 2009) to allow us to focus on our key objective - to investigate the role played by IFC in the NPD process taking into account TCE, RBV and IBV in Chinese pharmaceutical firms. Complexity in China's institutional setting requires in-depth, qualitative investigation to gain insights with empirical substance and potentials for theorisation (Ghauri, Gronhaug & Kristianslund, 1995; Strauss & Corbin, 1998). In particular, we draw on Yin's (2009) "two-case" case study design, because analytical conclusions independently emerging from the two cases are more powerful than a single case study alone (Yin, 2009). Despite this, we are fully aware that findings from two cases, whilst useful to reveal insights of the role of IFC in NPD in Chinese pharmaceutical firms, may not be generalizable to other firms or research contexts.

Case selection and data collection

We followed Buck's (2011) guidelines for case selection. Gaining research access in China is challenging (Zhao et al. 2006), especially to pharmaceutical firms, due to sensitivity and confidentiality issues (Hirsch, 1995). Even when the initial access is granted, continued access that offers the researcher long enough time to interact with the interviewees in order to collect relevant, sufficient and reliable data cannot be guaranteed (Gummesson, 2000). The use of personal contacts and social networks is found to be an effective way to gain full cooperative access to Chinese firms (Liang & Lu, 2006).

We adopted a two-stage case selection process to overcome these challenges to conduct the case study in 2008 and 2009, then kept up to date with the recent NPD development of the two firms till the end of 2014 based on secondary data (e.g. the company websites, annual reports and other trade publications). We started with an informal sampling selection with these broad selection criteria: high-tech enterprises operating in pharmaceutical sector located in Beijing where there is a density of high-tech firms (Yam *et al*., 2004). We then applied the following criteria to screen firms in the first stage: (a) as the focus of this study is based on the NPD process (CDER, 1998; FDA, Food & Drug Administration, 1998; SFDA, 2005), firms that only produce generic drugs, and traditional Chinese medicine are excluded; (b) since a complete NPD process in the pharmaceutical industry takes a long time (PhRMA, 2013), firms included in this study must have operated for at least 10 years. Based on these criteria, we approached firms recommended by personal contacts and by cold calls, resulting in four selected firms.

In the second stage, we applied theoretical sampling and identified two firms (labelled as Pharmastate and Diagno in Table 1) from the four initial cases, based on theoretical not statistical reasons (Eisenhardt, 1989). Therefore, the unit of analysis is firm. Our rationales are: (a) as this study considers institutional environment, we chose two firms from the same

pharmaceutical industry to hold industry constant. Further, the choice of a state-owned firm (Pharmastate) and a private enterprise (Diagno) helped reveal the dynamics of institutional environment within the pharmaceutical industry; (b) the different governance structures in state-owned and private enterprises provided contrasting insights on endowed resources and organisational context, helping with the understanding of transaction and resource based factors in the NPD process; (c) both firms invested in NPD intensively. Pharmastate was one of top five pharmaceutical firms in China in terms of investment in NPD and sales, while Diagno was the leading firm in Hepatitis B research in China. Pharmastate developed more than 10 patented products, and Diagno had two patented products. Moreover, the two firms selected were willingness to take part and hence our continued access was granted. Therefore, our two cases - one state-owned and one private in the same industry and location were purposely chosen to reduce extraneous variation and focus on our research objective (Eisenhardt, 1989; Pettigrew, 1988).

To collect relevant and in-depth data, we used purposive sampling (Lincoln & Guba, 1985) to identify and select key informants who were most knowledgeable about NPD (Saunders *et al*., 2009). Informants that we selected covered the key roles in the R&D Department (Diagno) and the Research Centre (Pharmastate) - the heart of NPD within the two case study firms. In Diagno, the R&D Manager had worked there since its conception. In Pharmastate, the Manager of Administration responsible for coordinating all the NPD activities internally and externally at the Research Centre had worked for the firm for about 16 years, and the Manager of Information Management responsible for evaluating NPD projects, had worked at Pharmastate for 14 years. We also selected other key persons who had knowledge about the NPD and management, such as General Manager, Founder, and Manager of Production. We conducted five (including 2 follow-up) interviews with selected informants in Diagno and three (including one follow-up) in Pharmastate. All interviews were

conducted by the authors face-to-face on the respective sites of the firms. Multiple researchers allowed the case to be viewed from different perspectives, which enhanced reliability of the findings (Eisenhardt, 1989). Once we conducted five interviews with Diagno and three interviews with Pharmastate, additional insights from further interviews were marginal, indicating a point of diminishing returns (Strauss & Corbin, 1998). This indicated that the number of interviews conducted in each firm was sufficient to reveal the NPD process. Therefore, interviews were stopped at this point when incremental learning was minimal and no further considerable insights were gained; theoretical saturation was reached (Eisenhardt, 1989; Glaser &Strauss, 1967).

The interviews were semi-structured covering two broad dimensions - the two-way interaction between national institutions and firms, that is, the influence of national institutional environment on firms' choice of IFC and firms' response to institutional opportunities and threats. The interview questions included: a. institutional opportunities and threats; b. the nature of IFC and stages of NPD; c. the key modes of IFC employed at each NPD stage; and d). the rationales of decisions on selecting the modes of IFC at different NPD stages. Each interview lasted from one to one and a half hours. All the interviews were recorded and transcribed for data coding and analysis. Where available, secondary data, such as information on company websites, were gathered. Data collected from different informants and from different sources were triangulated to increase the internal reliability of the research findings.

Insert Table 1 here

Data analysis

We followed the three key steps of analysing case study data recommended by Eisenhardt

(1989), to understand firms' choice of IFC in the NPD process, as well as institution, resource and transaction based factors. First, we conducted within-case analysis, by drawing a timeline of four key stages of NPD, and then zoomed into each stage to identify IFC used to conduct NPD. Second, we conducted cross-case analysis to compare not only similarities, but also differences between the two cases in order to capture the interaction between the firms and the national institutional environment, and to understand the dynamics involved in shaping firms' choice of IFC. Third, we incorporated the themes emerged from the cross-case analysis to build theory of the influence of transactional, resource and institutional factors on firms' decisions on IFC. In particular, we identified three IFC modes, as summarised in Tables 2, 3 and 4. We adopted a case-oriented approach to cross-case analysis that allows, or even emphasises diversity in the selection of cases (George & Bennett, 2005; Przeworksi & Teune, 1982) to elicit both similarities and differences between cases, as opposed to a variable-oriented approach in the quest for controlled comparison to discover causal association.

Insert Tables 2, 3 and 4 here

Case Background

Case 1: Pharmastate. Originating as a military medical centre in 1937, Pharmastate became a state-owned pharmaceutical company in 1954 and was publicly listed in 1997. Located in Beijing and neighbouring with universities and research institutes, Pharmastate enjoyed the location advantage to access research resources, outputs and advanced knowledge related to NPD. Pharmastate focused on the 'development' of drugs, that is, converting semi-finished new products into marketable products. Its own research centre served product development for all its subsidiary manufacturers, covering three key product lines: large infusion,

cardiovascular medicine, and hypoglycaemic medicine. The research centre's key responsibility was to provide market-ready drugs for the subsidiaries. The speed of commercialisation of new drugs was vital for Pharmastate's survival.

Case 2: Diagno. Unlike Pharmastate, Diagno focuses on 'research' of new drugs, providing liver disease diagnosis and treatments. Founded in 1994, Diagno was a private enterprise located in Beijing. The Founder was an expert in infectious disease, being the first person who proposed immunotherapy in China that marked a departure from the universal but less effective treatment for liver disease. The Founder developed a new diagnosis method and personalised treatment targeting patients on whom conventional treatment was ineffective. Diago's first patent was a new therapy, including two drugs and a vaccine for Hepatitis B. Diagno experienced a very difficult start-up period, and even rented labs to do experiments. After more than ten years' development, Diagno built own research labs and moved from outsourcing research to in-house R&D.

Research Findings

Personal-network initiated collaboration: Phases I&II.

We found that collaboration was informal and fluid at the initial stages of NPD (Phase I&II) when firms focused on exploring new product ideas. In both cases, managers and researchers exploited personal networks with doctors and scientists at hospitals and research institutes. However, Pharmastate and Diagno used their informal and personal networks for different purposes due to their contrasting NPD focuses. Pharmastate focused on fast development and marketisation of new drugs, while Diagno specialised in cutting edge live disease research (Table 2). Pharmastate considered that personal networks not only offered trustworthy channels to identify chemical compounds with commercial potential, but also helped to identify semi-complete new products that were available for purchase or licensing to

significantly shorten NPD turnaround time. '*We rarely start from lab research to screen potential drug entries. We normally step in from pre-clinical trial stage, namely, others have developed a new product entry, and we then do clinical trials together. Sometimes we take over and start from animal test (Phase II). Even so, the investment required has been considerable*' (Information Departmental Manager, Pharmastate).

In contrast, Diagno employed personal networks to gain forefront knowledge and technology in the field. '*In one of the conferences in the US, during the coffee break, a leading international expert on cancer approached me as we adopted the same approach to treat cancer and Hepatitis - improving the immune system, but he developed a new drug with much advanced technology than mine. He invited me to collaborate with him by testing his innovative medicine on Hepatitis... I brought them [his innovative medicine] back to China and completed this research project in a Hepatitis research centre in Qinhuangdao, Hebei province, where I had personal contacts: my previous teacher, a leading person in Hepatitis who was responsible for Hepatitis research in Asian Pacific, invited me to collaborate with him in Qinhuangdao; the head of Qinhuangdao Municipal Bureau of Health invited me to help establish Hepatitis research centre and we became good friends.'* This collaborative research as well as other similar collaborations through personal networks helped Diagno overcome resource constraints in its Phases I & II research in its early days. With the accumulated income generated through these collaborations, Diagno bought a new building and moved its research from a rented basement to own labs after two years in operation.

Moreover, Pharmastate and Diagno considered the boundary of IFC differently. Pharmastate found that collaborative relationships through personal networks could expedite the new product filtering process compared with in-house R&D, and also reduce the administrative outlay associated with in-house R&D. '*These scientists are national experts and they work in the prestigious Academy of Science and Technology. It will cost us a fortune*

to even hire one of them, let alone a whole team.' (Manager of Administrative Dept., Pharmastate). In contrast, Diagno used personal relationships with doctors and scientists to form an ad-hoc advisory board that served as an extended R&D function of the firm. '*Friendship [-based] relations are critical because they are the origin of innovation, the exchanges with these experts both home and abroad kept our research forefront, not in a closed way.'* (Founder of Diagno).

In both cases, contracts were seldom used to specify the responsibilities of collaborative partners given the informal nature of collaboration. The role of the 'external experts' was ambiguously defined to allow flexibility in the collaborative relationship. Interestingly, trust-based relationships built on personal networks enabled firms to be the first to gain access to reliable and critical new product information at not only the research forefront, but also the market forefront. On the market side, firms worked closely with medical practitioners to identify new product and market gaps. Practising doctors were particularly informative about new product gaps, supply and demand gap of certain products, and products that were well received and had high market growth potentials.

IFC at the initial stages of NPD was by no means random, and the search for collaborative partners did not rely entirely on personal connections. Institutional factors were found indispensible in shaping firms' choice of IFC in the NPD process. First, strategic priorities were different in Pharmastate and Diagno, due to their different ownership and management. Diagno, as a private enterprise where the Founder was a leading doctor in the field and focused on R&D as the source of competitiveness and survivability, was willing to invest in research in its early days. Pharmastate, as a state-owned enterprise where the CEO was assigned by the Chinese Communist Party with fixed terms (3-5 years), was unwilling to invest in basic research that required long-term commitment and involved greater uncertainties. Pharmastate's priority was to commercialise innovation and increase sales

within the manager's tenure. Short-term performance was paramount for Pharmastate, and its decision on NPD was made on political or nonmarket motivations. Therefore, institutional factors influenced managerial perception of transaction costs and organisational goals and resource allocation.

Second, the Chinese government encouraged collaboration between pharmaceutical companies and universities to expedite the commercialisation of scientific research. Located in Beijing concentrated with renowned universities and research institutes, Pharmastate and Diagno had geographical advantage to collaborate with universities and research institutes.

Finally, after China joined the WTO in 2001, it was under increasing pressure to enforce the new Patent Law introduced in 1993, responding to the need for knowledge protection among foreign pharmaceutical companies entering the Chinese market. This also motivated Chinese pharmaceutical firms to seek IFC to speed up NPD. '*Foreign Pharmaceutical companies are years ahead of us in terms of new drugs developed. If we start by investing in basic research, we may never be able to compete with these companies. We have to speed-up the process and pair with research institutes, who can assist us to understand current trends [of medical development] and sometimes to predict the next generation of new medicines'* (Manager of Administrative Department, Pharmastate).

Arms-length collaboration: Phase III.

The clinical trial stage (Phase III) of NPD involved a higher level of specific assets in IFC due to firm's early commitment, exposing to greater hazards of opportunistic behaviour as the NPD becomes more tangible than that in the pre-clinical stage (Phases I & II). Therefore, an informal and ad-hoc collaborative partnership was not suitable. Both Pharmastate and Diagno had contractual relationships in place with hospitals as the major form of IFC. Additionally, Pharmastate licensed in semi-finished research output with high commercialisation potential,

whereas Diagno licensed out its in-house research output to generate extra income.

Phase III required a great deal of resources and capabilities. Pharmaceutical companies working with hospitals would gain access to resources, including doctors and patients, for clinical trials. '*It costs about RMB50 million to do clinical trials to develop one of our vaccines into a drug. It is impossible for us to do it ourselves without collaborating with a hospital. It requires at least 200 samples, and we have to trace each patient for about two years to look at the effect of the vaccine on the immune system. Sometimes, the patients stop to come as they feel a positive effect after 1 year, and leaving us an unfinished case. It hence increases the cost if we want to continue to trace*' (Manager of R&D Department, Diagno). In addition, scientists at hospitals were also keen to advance their research to enhance their career reputation, and knowledge gained through collaboration with firms for new discoveries at the operational level can be directly fed back into their on-going R&D, which could not be obtained from market. Both pharmaceutical firms and doctors and scientists at the hospital could access to complementary resources and capabilities.

However, given the critical and confidential NPD information involved in the clinical trial stage, formal contract-based arm's length form of IFC was preferred to set out responsibilities and legal terms of collaboration. Both Pharmastate and Diagno reported that a long-term arm's length collaboration helped to maintain open access to critical on-site data, encourage intensive interaction between collaborative partners and make timely adjustments to the new product over an extended period of time. Therefore, a close work relationship and frequent contacts with experts in hospitals allowed Chinese pharmaceutical firms to observe and learn from the collaboration. Such close and frequent contacts also facilitated sharing of tacit knowledge. '*We have to cooperate with hospitals as we have to know what is exactly happening when the product is being tested, and we need first-hand materials. We monitor the process together with doctors there, discuss and work on problems. Sometimes we need to*

bring these problems back and think how to solve them, and then go back to the hospital for several times (General Manager, Diagno)'.

Institutional factors moderated IFC at the clinical trial stage. Unlike clinical trial in developed countries where pharmaceutical firms or sponsors determine the locations of the trials (FDA, 2014), the Chinese government announced a list of organisations qualified for conducting clinical trials. This meant that clinical trials of new drugs were highly concentrated among a small number of hospitals. By engaging in a legal contractual relationship, collaborative partners were obliged to protect information. In addition, pharmaceutical firms had to abide by the SFTA's regulation to provide clinical data from a recognised hospital if they wanted a new drug to be approved.

***Lead operator centred collaboration: dual or triple trajectories in Phase IV*.**

Once a clinical trial has been successfully completed, firms can obtain a new drug certificate and a drug manufacturing certificate. With the two certificates as well as the other two obtained from Phases I and II, firms' NPD moves to the final stage - manufacturing and marketing. This stage is characterised by high asset specificity due to firms' earlier commitment, the greater innovation certainty as NPD approaches to completion, and the need for different resources and capabilities for production and marketing. Both Pharmastate and Diagno internalised core production and outsourced peripheral activities. They acted as lead operators - a central hub hosting multiple forms of IFC. Pharmastate was careful when collaborating with partners. '*If a new product contains confidential information and is crucial to the firm, we will do it in-house, as the costs of knowledge leaking through IFC might be much higher than we do it by ourselves; or we may break it down into small pieces until making it impossible for others to interpret our NPD, we will ask others to do the most difficult and costly part, and then we collect and integrate them to continue the rest of*

research' (Manager of Information Dept., Pharmastate). Similarly, Diagno was capable of in-house production, and outsourced only peripheral activities with low value creation potential by using one-off contract based collaboration.

Lead operator centred IFC allows firms to focus on core competencies, and at the same time, fully exploits internal and external resources. As a lead operator, firms are in control of allocating and deploying resources rationally. '*We normally carry out the core part of the production and outsource the rest. For example, if we think that we need to recruit expert people and invest in new equipment, which may not be used in the future after the completion of manufacturing this product, we will seek to cooperate with others who are experienced in doing that with higher efficiency and lower costs than us'* (Manager of Information Department, Pharmastate).

Once again, institutional factors influenced the firms' choice of IFC. Due to its state ownership, Pharmastate enjoyed more advantages than Diagno. First, contrary to the practice in the developed countries where market mechanisms support voluntary exchanges and firms can acquire critical resources through friendly or hostile bid, investment funds in China were controlled and allocated by the government (Bruton & Ahlstrom, 2003). The venture capital industry was underdeveloped. Hence, the majority of funds were invested in state-owned enterprises rather than in private enterprises. Therefore, the national institutional environment in China enabled Pharmastate to access financial resources for NPD, but constrained Diagno that struggled to raise funds for research, e.g. Diagno even sourced in non-core research (skin cosmetics) to generate extra income to re-invest in the core research.

Second, in a market where accurate market information is not always readily available, Pharmastate benefited from its endowed 'non-market forms of capital' (its good political relationship with governments and its reputation) (Peng, Lee, & Wang, 2005: 624) and its drugs were enlisted as government subsidised drug in all state-owned hospitals. In contrast,

Diagno had to spend more efforts and costs to market their new products.

Finally, the legislative and administrative power of the Chinese state to protect intellectual property was insufficient to deter opportunistic behaviour (Teece, 1986). In fact, interviewees in both firms concurred that in-house production was preferred at this stage. Overall, interviewees expressed that Chinese pharmaceutical firms preferred to develop their own patent drugs in an increasingly regulated pharmaceutical industry in China, as it was considered the only way to increase their competitiveness. For example, the number of patent drugs in Pharmastate reached 13 in 2006, whereas Diagno was seeking potential partners to invest in its own hospitals and factories to conduct all R&D activities in-house.

Discussion

Prior literature on IFC concentrates on the TCE and the RBV perspectives, and overlooks national context where collaborations take place. By incorporating the RBV, TCE and IBV, this research contributes to the strategic management literature by enhancing our understanding of the nature of IFC and its role in the interaction between Chinese pharmaceutical firms and their institutional environment in the NPD process, based on a case study of two Chinese pharmaceutical firms. In particular, our study has two theoretical implications.

First, our findings show that three key forms of IFCs are pertinent to NPD: p*ersonal-network initiated collaboration* at Phases I&II, *arm's length collaboration* at Phase III and *lead-operator-centred collaboration* at Phase IV. In addition to the three key forms of IFC, licensing in, as a supplementary form, can be used at different stages of NPD to purchase in semi-finished research outputs with high commercialisation potential, especially by the state-owned firm with resource advantage. The existing literature (Koza & Lewin, 1998; Oliver, 2004; Rothaermel & Deeds, 2004) generally states that informal explorative forms of

IFC are employed at the early stage of NPD while formal exploitative forms of IFC are preferred in the later stage of NPD (Afuah, 2001; Van de Vrande et al., 2009). Our findings support this, but we have gone a step further by capturing what and how a particular form of IFC is employed at different stages of NPD and by revealing a dynamic and contingent nature of IFC, rather than a static view at one point. Therefore, the key forms of IFC identified in this study deepen our understanding of the role of IFC and how firms can employ different forms of IFC to overcome institutional constraints on NPD in the pharmaceutical industry. It also offers practical insights for pharmaceutical firms in choosing modes of IFC in NPD.

Second, our findings support that institutional factors should be given more attention in research (Peng, Jiang & Wang, 2008; Meyer et al., 2009), as they interact with transaction and resource based factors in firms' strategic choices, especially in emerging markets. By drawing on TCE, RBV and IBV, our study unveils the nature of each form of IFC and the underlying logic of the shift from one to another along the NPD phases - this was a missing link in the existing literature (Madhavan & Grover, 1998; Liebeskind et al., 1996; Oliver, 2004; Rothaermel & Deeds, 2004). In particular, our study discusses the two-way interaction between national institutions and firms - the influence of national institutions on firms' choice of IFC and firms' response to institutional opportunities and threats, based on a case study of two firms with different ownership structures. To some extent the institutional context in China is more advantageous to state-owned firms than private firms (Oiver, 1997; Peng, Lee and Wang, 2005; Tokaranyaset, 2013). State-owned firms' historical connections with the State (e.g. Pharmastate was developed from the military medical centre, and had CEOs assigned by the State), public reputation, social and political capital help them overcome certain barriers to NPD, for example, through access to financial resources (e.g. government sponsored university-firm collaborative research, investment funds, and venture capital) and distribution channels (e.g. drugs to be included in government funded drug selling list in

hospitals). These factors also allow state-owned firms to be kept abreast of scientific discoveries, new technologies, and collaborative and investment opportunities, as well as helping to reduce NPD risks and costs. In contrast, in a context where the venture capital industry is underdeveloped and accurate market information is not readily available, private firms have to find their own ways to raise research funds, and spend money to search information and to promote its NPD outputs. Therefore, the national institutional environment in China favours state-owned firms to acquire critical resources. In sum, the national institutional environment can facilitate or hinder firms in resource acquisition and influence transaction costs. Hence, an integration of the TCE, RBV and IBV is meaningful to help us understand firms' rationales of choosing and shifting forms of IFC in the NPD process.

At the early stage of NPD (Phases I & II), personal-network initiated collaborations allow informal and trust-based interactions, and responsibilities of partners to be ambiguously defined. This form of IFC entails economic efficiency in terms of little administrative and switching cost according to the TCE. Resources offered by collaborative partners are knowledge-based, highly personal or firm-specific, and path-dependent. Replacement and substitution of such embedded resource profiles are difficult to achieve through market exchanges and costly to develop in-house from the RBV perspective. However, our between-case analysis shows that, although the two firms both adopted personal-network initiated collaborations at the early stages of NPD, they were driven by different strategic priorities, which TCE and RBV fail to capture. While the state-owned firm proactively sought IFC in order to avoid doing Phases I & II stages in-house, the private firm explored IFC in order to strengthen its core research and expecting to do it in-house completely.

Different from the firms in the developed countries where firms' governance structure is self-defined, managers in the state-owned firms in China are assigned by the government with fixed terms (an institutional factor according to the IBV). Therefore, managers in state-owned

firms are less willing to invest in basic research which is resource-demanding, time-consuming, and with high uncertainties than the private firm. Instead, they focus on profit maximisation through speeding up NPD commercialisation. In addition, the location convenience by neighbouring with universities and research institutions, and the government’s call for collaboration between firms and research institutions in NPD stimulates firms to explore the various personal collaborations with universities and research organisations, from both TCE and RBV perspectives. The above evidence proves that the context where the transactions are conducted and resources are exchanged determines how and why IFC is employed by Chinese pharmaceutical firms to pursue the early stages of NPD. Therefore, the RBV, TCE and IBV must be taken into account to understand the intricacies of IFC.

When NPD moves to the clinical trial stage (Phase III), firms refine the collaborative boundaries by replacing the personal-network initiated collaboration with a long-term agreement-based arm's length collaboration. As the value of NPD becomes more certain, the incentive for knowledge appropriation increases. Both state-owned and private firms turn to the same mode of IFC: arm's length formal agreement, a governance providing mechanisms of knowledge protection compared with informal personal-network initiated collaborations. In long-term agreement-based arm's length collaboration, from the TCE perspective, partners' responsibilities and legal consequences of breaching the contract are defined, and a long-term engagement also discourages opportunism of collaborative partners (Powell, 1990). Besides, both the state-owned and private firms are short of critical resources for conducting NPD, such as doctors with expertise knowledge, patients as trial participants, and physical facilities, when it moves to the clinical trial stage. Therefore, the success of NPD at this stage is dependent on a combination of firms' intellectual resources of NPD and collaborative partners' clinical resources. More importantly, by exploiting complementary resources in joint and

integrated operations, an agreement-based form of collaboration allows firms to closely observe, communicate with, and learn from doctors at collaborative partners. Such practice is conducive to sharing tacit knowledge often required for developing and enhancing in-house R&D, an important aspect highlighted by RBV.

Firms' choice of arm's length contract-based collaboration is not only a balance between resource and transactional factors, but also a regulatory requirement in the pharmaceutical industry in China. Different from that in developed countries where pharmaceutical firms or sponsors have the freedom to choose the site (hospitals or research centres) for clinical trials (FDA, 2014), in China pharmaceutical firms are forced to choose from a list of government nominated hospitals where clinical data can be gathered, as part of requirements for new drug approval. This suggests that national institutions can constrain resource allocation and acquisition, implying that resources and national institutions are not isolated, but interact each other (Meyer at al 2009), highlighting the interaction between IBV and RBV.

In final Phase IV, firms' effort shifts from research to development and their collaboration boundary is also redefined. Contrary to some existing literature that indicates firms will inevitably internalise collaborative relationships (Olive, 2004; Oxley & Sampson, 2004), our findings show firms position as a lead-operator-centre in IFC. With the two case study firms, both ownership and ad-hoc project-based contracts are simultaneously employed. The TCE provides partial explanation to this phenomenon. The NPD at this stage contains the highest level of specific asset resulting from early commitment. The uncertainty is also high because the technical newness induces misappropriation (Liebeskind *et al*., 1996). Even legal contracting may not be sufficient to prevent misappropriation (Liebeskind *et al*., 1996), especially in an environment, such as China, where intellectual property is insufficiently protected (Meyer, 2008) (highlighting the interaction of IBV and TCE). To build stronger

knowledge protection, firms internalise collaboration to protect their technological knowledge against threats of opportunistic behaviour associated with the collaborative partnership (Griffith, Harmancioglu & Droge, 2009; Rothaermel & Deeds, 2004) (stressing the interaction between IBV, RBV and TCE).

However, TCE ignores that not all specific assets necessary for the NPD in Phase IV fall in firms' core competences and could be developed in-house competitively. Those that have low value creation and do not require specific investment are outsourced to sub-contractors who can do it with higher efficiency and lower costs through *one-off contracts*. To contrast with the ownership governance form, one-off contracts shield the IFC by specifying the legal consequences of breaching the terms of collaboration. The combination of in-house and outsourcing NPD is echoed by Leiblein and Miller (2003) in the semiconductor industry where greater uncertainty only leads to integration when the transaction involves high value of asset specificity; those with low value of asset specificity are likely being outsourced. Additionally, a third form of IFC is found in our case study: non-core research is sourced in to generate sufficient income to re-invest in the core research by the private enterprise. The above provides evidence of the interaction between IBV, RBV and TCE.

Contrary to TCE's claim that firms follow a governance continuum moving from market towards integrated governance with reduced number of IFCs (Williamson, 1999), our findings suggest that pharmaceutical firms, as they progress through the NPD stages, internalise the core part of NPD at the final stage but maintain different modes of IFC (Powell, 1996; Roijakkers & Hagedoorn, 2006). The dynamic choice of IFC enables the Chinese pharmaceutical firms to break through certain institutional barriers and overcome their inherited vulnerabilities (Wei, 2008) to pursue innovative activities.

Insert Figure 1 here

Conclusions

This study firstly identifies three key forms of IFC employed at different stages of NPD, and secondly investigates the institution, transaction and resource-based rationales underpinning firms' choice of different forms of IFC. Each form of IFC has its distinctive features and the optimal choice is made based on its effectiveness and efficiency in breaking down institutional barriers to NPD, gaining resource advantage, and mitigating transaction costs. Thirdly, firms' choice of IFC is dynamic and contingent upon the interaction of institution, resource and transaction based factors at play, and multiple forms of IFC may be employed to maximise the benefits of IFC. Our findings contribute to knowledge on IFC in the NPD process by cross-fertilising the IBV, RBV, and TCE perspectives in an under-researched emerging market economy.

Despite our contribution, our study has limitations. Our findings are supported by data from two cases. While the purposely selected two cases offer useful and relevant evidence on how IFC enables NPD in Chinese pharmaceutical firms, our findings may not be generalizable to other firms or in different research contexts. Future research is recommended to extend our study to other firms in similar or different industry and institutional settings. Moreover, the long period of drug development means that it is difficult to trace the whole NPD process of a new drug in a longitudinal study. Our findings are drawn from interview data from the most appropriate informants who were most knowledgeable about the NPD process in the respective firms, despite being a cross-sectional study. Finally, the confidential nature of drug research creates barriers to research access to the most valuable part of NPD. To address this, we built trust with the participants in the case study firms, approached the NPD process from the views of different functional divisions, and also incorporated secondary data to triangulate the findings. Nevertheless, there is a scope for longitudinal and

more in-depth research to further unpack the roles of institutional, resource and transactional factors in firms' choice of IFC in the NPD process.

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Table 1 The summary of case studies

		Case 1 Pharmastate	Case 2 Diagno
Industry sector		Pharmaceutical	Biopharmaceutical
Main business activities		Synthetic drugs	Diagnostic agents, Treatment therapies, Bio-tech drugs
Incorporation		1937	1994
Ownership		Publicly listed company (50% state ownership)	Independent, private
No. of employees		12,120*	50 *
Sales turnover		RMB¥4.28 billion*	RMB¥20 million*
Industry position		Mass market leader	Niche market dominator
R&D Indicators	**R&D intensity** (R&D spending /sales turnover)	2.5% *	50% * ^
	No. of R&D staff	300 (2.4%)*	10 (20%)*
	No. of Patents	12	2
	No. of radically new products	2	4
	No. of incrementally new products	10	1
	Age of bestselling product	42	11
	Age of newest products	3	2
Marketing	**Marketing intensity**	22%+	30%+
	No. of marketing staff (ratio)	N/A	15 (30%)
	Target Markets	Domestic, except for Large infusion (10% overseas) Endocrine (5% overseas)	Domestic
	Distribution chanel	Specialised distribution firm within the corporate group	Hospitals
Interviewées		• Manager of Administration, Research Centre • Manager of Information Management, Research Centre • Manager of Administration, Research Centre	• Manager of R&D Department (1st interview); • Manager of R&D Department (2nd follow-up interview) • Manager of Production Department • President (founder) (1st interview) • General Manager

* as in 2014 ; + average in 2014. Marketing intensity = spending in marketing / sales turnover%; ^ R&D spending Includes expenditure on equipment, payment for out-sourced research, rent of research facilities and HR outlay of the R&D staff.

Table 2. IFC at Initiation Stage of NPD: I & II

Themes \ Cases		Case 1 Pharmastate	Case 2 Diagno
Interaction between TCE, RBV and IBV	**Formal state approval** (IBV)	Approval when moving from Lab Test (I) to Animal Test (II) (Certificate 1)	
	Institutional constraints (IBV- TCE -RBV)	Inefficient institutions in China: • augment information asymmetry, high costs in searching for information • increase difficulties in access key resources through market • lead to high potential opportunism and higher partner-related risks	
		• CEO: fixed term of office (3-5 years) • State pressure on performance within the short term of office • Non-market motivation: quick profit, unwilling to invest in basic research	• Difficulty in securing funds from state • Venture capital industry is immature, controlled and arranged by the state • Unaffordable in-house scientists
	Institution-based risks (IBV-TCE-RBV)	• Entry of well-established foreign MNCs • Renewed Patent Law (strict regulation on generic drug manufacturing)	
		• CEO: weak means of managing firms • Short term of office augmented the perceived investment risks in basic research	Challengeable survivability
	Institution-based resource endowment (IBV-TCE-RBV)	Preferential policies: encouraging university-firm linked research	
		• **Political**: ➢ State-assigned CEO, connection with government ➢ State-sponsored university-firm collaborative projects • **Reputational**: ➢ Originated from a military medical centre ➢ Public reputation ➢ One of top five in pharmaceutical industry in terms of R&D investment	• **Freedom** and **self-determination** in NPD • **Self-developed reputation:** Owners with expertise well known in specialized area • **Self-developed network** with other hospitals and research institutes
IFC	**Objectives of IFC**	**Product-focused**: • Identify and **explore** potential drug candidates ready to do Clinical Trials to **shorten** NPD process • Identify and quickly **filter** out compounds with the biggest commercial potential	**Partner-focused**: • Identify and **exploit** partnerships with trustworthy individuals and firms to generate income to **invest in** basic research • Identify and exploit partnerships with individuals or firms to enhance cutting edge research **competence** and **position** in the field
	Collaborative Partners	Research institutes, universities, pharmaceutical firms	Individuals and research institutes with shared research interests
	Forms of IFC	Approached through **personal networks**	Built upon **personal networks**
		Licensing-in	

Table 3. IFC at the Clinical Trial Stage: Phase III

Themes \ Cases		Case 1 Pharmastate	Case 2 Diagno
Interaction between TCE, RBV and IBV	**Formal state approval** (IBV)	Certificate 2 and 3	
	Institutional constraints (IBV -TCE -RBV)	Government determines which hospitals are qualified to provide Clinical Trials	
		Limited numbers of hospitals available to choose to do Clinical Trials for a specific drug, increased risks in proceeding NPD	
			Relative weaker position in the relationship with the hospitals compared with big pharmaceutical firms
	Institution-based risks (IBV-TCE-RBV)	No legislation to protect intellectual property at this stage	
		High level of specific assets involved, exposing to greater hazards of opportunistic behavior than Phase I&II	
		High likelihood of information leakage to key competitors (from domestic and foreign market) during Clinical Trials	• Possible information leakage to competitors • Limited past experiences from the hospital side • Government dictated resources ignored highly specialized areas, increased risks in doing Clinical Trials
	Institution-based resource endowment (IBV -TCE -RBV)	• Clear regulations on doing Clinical Trails • Information of qualified hospitals to do Clinical Trials is relatively open	
		• **Financial**: State allocated funds reduce financial burden on investment in Clinical Trials with tremendous resources needed • **Political & reputational:** ➢Government connection and established reputation enhance trust and made it easy to sign collaborative contracts with hospitals ➢Well informed by new discoveries and semi-finished research outputs through political and social network	• **State-owned** hospitals or research institutes **short** of expertise knowledge in doing clinical trials on liver diseases, opportunities for exploitation • Leading company in the field, **limited** number of **competitors** from both home and abroad
IFC	**Objectives of IFC**	Focus shifted from 'what to develop' to 'how to develop a NP successfully'	
		From informal trust-based to formal contract-based	
		Partners are bonded by legal obligations	
		From short-term to long-term relationship	
		Obtain data for product validation	
		Learning from intensive cooperation with doctors in hospitals	
	Collaborative Partners	Hospitals authorized by the state	
		A wide range of hospitals	A small number of hospitals
	Forms of IFC	Arm's length collaboration, formal contract	
		Licensing -in	Licensing -out

Table 4. IFC at the Product Commercialisation Stage: Phase IV

Themes \ Cases		Case 1 Pharmastate	Case 2 Diagno
Interaction between TCE, RBV and IBV	**Formal state approval** (IBV)	Certificate 4	
	Institutional constraints (IBV-TCE -RBV)	• Untransparent information increases complexity in distribution and sales • Increased competition on patent drug development forces firms to keep core part of NPD in-house and outsource peripheral activities to create more research capacities	
		• State pressure on quick commercialization • Weak capabilities in marketing and sales compared with foreign competitors	• Limited distribution channels • Limited funding for production and marketing
	Institution-based risks (IBV-TCE-RBV)	• Intellectual property is insufficiently protected, increases opportunistic behavior • Technical newness induces misappropriation	
	Institution-based resource endowment (IBV-TCE-RBV)	State policies encourage commercialization	
		• **Political**: Political connections help get drugs to be included in the 'List of Prescriptive Medicines Approved for National Insurance Coverage', sold in all state-owned hospitals, reduced uncertainty and costs • **Financial** State allocated funds offers opportunities to acquire drug manufacturers national-wide along pipe-lines of products to enhance commercialization process • **Reputational**: Well-established public reputation reduces information asymmetry between firms and consumers and market research costs	• Self-determined NPD offers Diagno freedom to source in non-core NP to generate **extra** income to reinvest in core research • Self-developed in-house research expertise opens windows to potential private investors (establishing own hospitals on liver diseases
IFC	**Objectives of IFC**	• Shift from "developing NP' to 'commercializing the research outputs' • Outsource peripheral activities to create capacities on core research(internalize through ownership to protect tacit technological knowledge) • Explore and exploit internal and external resources to speed up commercialization process and reduce costs	
			Sourcing-in profitable non-core research outputs to generate extra income to reinvest in core research
	Collaborative Partners	Small manufacturers for manufacturing peripheral products	
			Non-core research project contractors
	Forms of Collaboration	Lead-operator-centered collaboration	

Figure 1. The influence of Institutions on the Chinese Pharmaceutical Firms' Choice of IFC