Ownership structure and new product development in transnational corporations in China *

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This paper examines the relationship between the ownership structure and new product development (NPD) at the affiliates of transnational corporations in China. Seven research hypotheses are tested on a panel data set covering 10,000 manufacturing firms with foreign involvement for the period 1998–2001. The results from probit and tobit models show that contractual joint ventures, equity joint ventures and joint stock enterprises are better organizational forms than wholly owned enterprises for increasing both the probability and intensity of NPD. We also find that ventures with OECD participation are more likely to be involved in NPD than those with participation by "overseas" Chinese TNCs.

Key words: TNCs, ownership structure, new product development, China

1. Introduction

Foreign affiliates of transnational corporations (TNCs) often succeed in developing new products and technologies faster than local firms, thus exerting competitive pressure and forcing local firms to imitate or innovate. This is one important reason why many developing countries are eager to attract foreign direct investment (FDI). Although a large number of studies have been carried out on the behaviour of TNCs, relatively little is known about the relationship between organizational and ownership arrangements of foreign affiliates and new product development (NPD) in the host country.

Since its adoption of economic reform and opening up to the outside world in the late 1970s, China has been enjoying remarkable economic growth. It is now among the world's top exporters and largest hosts of FDI, and as a result, China is sometimes labelled as the factory of the world. However, as Nolan (2005) argues, it is perhaps more accurate to describe China as "the workshop

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for the world", rather than "the workshop of the world". For example, about 60% of China's industrial exports are undertaken by affiliates of foreign TNCs during the period 1998–2004 (China Customs, 2005), and a large proportion of the remainder consist of industrial products that are either OEM manufactures or low value-added, low technology, non-branded goods for global firms. Nolan (2005) also observes that, while some leading TNCs are rapidly building their research bases in China, indigenous Chinese firms spend negligible amounts on R&D. Chinese firms seem to be still relying on the cheap labour force, pursing what Porter (1980) refers to as cost leadership rather than differentiation strategy. Thus, foreign affiliates seem to be playing an important role in R&D and resulting NPD in China.

Foreign affiliates in China show a very diverse spectrum of organizational forms and ownership arrangements. It is interesting and important to examine how these organizational and ownership arrangements are associated with NPD activities in these firms.

This paper attempts to synthesize the relevant FDI and NPD literature to study the linkage between the ownership structure of FDI and NPD activities. We examine NPD in terms of both the probability of a firm being a new product developer and the intensity of NPD activities at that firm. Probit and tobit techniques are used respectively to test the research hypotheses on a large panel data set consisting of more than 10,000 firms with foreign involvement in seven industries in China for the period 1998–2001.

The rest of this paper is organized as follows. The next section reviews the literature from which relevant hypotheses are developed. Section 3 describes the data, empirical models, variable measurements and estimation methods. Then, section 4 discusses the empirical results. Finally, section 5 summarizes the findings and discusses policy implications.

2. Literature review and hypothesis formation

2.1 Firm organization and NPD

It is widely recognized that innovation, technology enhancement and resulting NPD contribute significantly to business competitiveness (Cooper and Kleinschmidt, 1988; Johne and Snelson, 1990; Page, 1993; Littler et al., 1995; Collins, 2001; Martínez and Pérez, 2003; Ayag, 2005; Hamel and Prahalad, 2005; Mudambi et al., 2007; Christensen

et al., 2008). Accordingly, there has been tremendous interest in this subject (Danneels and Kleinschmidt, 2001), although the existing NPD literature tends to concentrate more on issues regarding firms operating within their home markets rather than TNCs' affiliates. One important stream of research in this area is the analysis of success factors for NPD (Montoya-Weiss and Calantone, 1994; Cooper and Kleinschmidt, 1995; Sun and Wing, 2005; Jin and Li, 2007).

In the NPD literature, a large number of factors have been identified as being critical for new product success. Cooper and Kleinschmidt (1995) identfiy the following four determinants of new product success: (1) organizational factors, such as the use of a cross-functional team, a positive culture and climate for NPD in general, such as teamwork, product champions and autonomy; (2) new product process activities, such as market orientation and predevelopment preparations; (3) new product strategy which specifies the development focus and formalizes the necessary organizational structure; and (4) senior management's involvement and corporate commitment. The relevance of these factors has been confirmed in various empirical studies, including for market orientation (Atuahene-Gima, 1995, 1996; Mishra et al., 1996), NPD climate, expertise and management involvement (Souder and Song, 1998), and marketing and technological fit of new products (Danneels and Kleinschmidt, 2001).

An organizational factors that has received considerable attention is inter-firm alliances (e.g. Li and Atuahence-Gima, 2002). Inter-firm alliances are thought to help firms develop new technology and improve technical skills (Cohen and Levinthal, 1990; Eisenhardt and Schoonhoven, 1996); gain access to the complementary resources required to develop and market new products, reduce new product risks and establish long-term market positions in unstable environments (Ozer, 1999); learn new management skills (Kraatz, 1998; Ahuja, 2000); and develop innovative products (Grenadier and Weiss, 1997).

Pursuing this line of resource-based reasoning, Hamel et al. (1989) argue that "it takes so much money to develop new products and to penetrate new markets that few companies can go it alone in every situation". Thus, for industry giants and ambitious start-ups alike, strategic partnerships have become central to competitive success in fast-changing global markets (Doz et al., 1998). Teece (1992) also contends that "when high technology activities are at issue, contractual agreements, alliances and joint ventures are likely to be superior to full-scale internal organization". This is because product innovation involves

a whole range of development and profitable commercialization of new technology, and one important approach to competitive innovation is "competing through collaboration" (Doz et al., 1998). Competitive renewal depends on building new process capabilities and winning new product and technology battles. Collaboration can be a low-cost strategy for doing both (Hamel et al., 1989). The ideas of Hamel et al. (1989), Teece (1992) and Doz et al. (1998) on inter-firm alliances for product innovation can be readily applied to the analysis of the relationship between foreign ownership structure and NPD.

Large TNCs with vast resources tend to succeed in developing new products and technologies faster than local firms, and hence they are an important source of technological change, especially in developing countries (de Mello, 1997; Li et al., 2001; Wang et al., 2004; Wei and Liu, 2006). FDI literature also examines the relationship between organizational arrangements of FDI and affiliate performance, measured by simple outcome-based financial indications such as profitability (Pan et al., 1999), survival based appraisal (Pan and Chi, 1999), and multi-dimensional measurements such as "satisfaction with performance" (Brouthers et al., 2000). However, to the best of our knowledge, little systematic empirical research has been undertaken on the relationship between organizational and ownership arrangements of FDI and NPD. In this study, we aim to fill this gap in the literature.

There are a number of organizational arrangements for foreign involvement in China: contractual joint ventures (CJVs); equity joint ventures (EJVs) or joint stock companies (JSC)[1] with Chinese companies; and wholly foreign-owned enterprises (WFOEs). A CJV is a non-equity based form of strategic alliance, and an EJV is an equity form of a

[1] An EJV is a limited liability company where resource commitment, profit distribution, risk sharing, and the control and management are based on equity shares between foreign and Chinese partners. In a CJV, each party's rights and obligations are set out in the contract, which may not be in proportion to the party's investment. A JSC may be established by means of promotion or public offer. This is equity based, with the minimum registered capital requirement for its establishment of $3.6 million, and the amount of foreign ownership of the company should exceed 25%. Obviously, a common feature of EJVs, CJVs, or JSCs is that they are all JVs as foreign investors only partially own the enterprises. However, these different types of JVs are involved in different ways of ownership and control strategies. Ownership and control are normally determined by equity shares in EJVs and JSCs but by contracts in CJVs. Moreover, an EJV normally involves a very limited number of partners, while a JSC may be owned by a number of people, although the equity share of the foreign partner(s) must be higher than 25% (*Source:* NPC, 1979, 1986, 1988; MOFTEC, 1995; Wei and Liu, 2001)

strategic alliance. A JSC is a limited liability company with issued share capital and was not approved until 1995. These alternative ownership arrangements represent different alliance strategies and have different implications for NPD. Given the technical capabilities, a foreign firm forming strategic alliances with local firms in the host country gains access to complementary strategic resources and will be more likely to succeed in NPD than a foreign firm that just "goes it alone". Thus, JVs should be in a better position than WFOEs in terms of NPD.

This line of analysis in the NPD literature is consistent with transaction cost theory in FDI literature. Hennart (1991) suggests that parent firms will choose JVs when they need complementary intermediate inputs whose purchase on the market would entail high transaction costs, and which would be costly to obtain through replication or full acquisition. Put another way, through forming alliances, a firm creates or gains access to resources and capabilities which complement its existing core competencies and captures the technological and marketing synergies offered by the partner firm in the host country (Dunning, 2001). As NPD often requires complementary R&D, manufacturing and marketing skills from other firms, JVs should be superior to WFOEs.

Combining the ideas from the resource-based theory and transaction cost theory, the following hypothesis can be formulated:

H1: An EJV/CJV/JSC has higher capability to develop new products than a WFOE.

The success of NPD activities partly depends on the qualities and complementarities of the strategic resources offered by foreign and local partners. As mentioned earlier, NPD requires a range of knowledge about appropriate technologies, effective manufacturing and marketing. As a consequence, companies, foreign or local, that possess better technological, manufacturing or managerial capabilities tend to make a more significant contribution to NPD.

There are two main types of foreign investors in China: "overseas" Chinese investors typically from Hong Kong (China), Macao (China) and Taiwan Province of China (denoted hereafter as HMT) and investors from the rest of the world, mainly from the OECD countries (denoted hereafter as OECD). HMT investors contributed more than 60% of the total number of FDI projects and nearly 60% of the total value of FDI inflows in China during the period 1998–2004 (National Bureau of Statistics of China, 2005). Although they contributed less than those from HMT in terms of the number of projects and value of investment,

OECD TNCs are usually believed to have higher technological and manufacturing capabilities (Yeung, 1997; Buckley et al., 2002; Wei and Liu, 2006). Thus, OECD investors tend to have a higher propensity to develop new products than HMT investors.

The capabilities and resources possessed by local firms also play an important role in NPD. Indigenous firms typically have better knowledge of local conditions regarding the availability of resources and skills of employees (e.g. Beamish, 1988; Wei et al., 2008). With the superior knowledge of local markets, consumer preferences and business practices, local partners can help TNCs, for example, in adopting technologies suitable for local conditions (Blomstrom and Sjoholm, 1999). This knowledge of local conditions and practices forms part of the set of complementary assets as defined in Teece (1992). In addition, in many cases, local partners can provide complementary technologies necessary for NPD. In recent years, strategic alliances – particularly those geared towards innovatory activities – have become an important component of corporate strategy. A firm may expand production and sales abroad in order not only to exploit its technology assets, but also to gain new resources to develop these assets (Caves, 1996). Several recent studies have shown that TNCs from all countries are increasingly reaching beyond their national boundaries to create or gain access to resources and capabilities that complement their existing core competencies (Dunning, 2001). Thus, the possession of complementary technologies and assets by local partners can contribute to the success of NPD.

For a JV, local Chinese partners can be categorized into four types: state-owned enterprises (SOEs), collectively owned enterprises (COEs), legal persons (LPs) and individual persons (IPs). SOEs are traditionally larger than COEs, and have long been supported by government policies for NPD. The legal person system arose from the recent corporatization of Chinese enterprises, especially large SOEs. In essence, what legal persons represent are limited liability corporations and these firms usually have both ample resources and incentives for product and process innovation. IPs are natural persons (i.e. single individuals) and were not allowed to form JVs with foreign investors until recently. Resources committed by IPs, in fact, are relatively small. Therefore, SOEs and LPs are expected to have more resources, technological and manufacturing capabilities than COEs and IPs. In JV-type organizations, capital participation by SOEs and LPs should be more positively associated with NPD than capital participation by COEs and IPs.

Therefore, our second and third hypotheses are as follows:

H2: OECD investors are more likely to conduct NPD than HMT investors.

H3: Capital participation by SOEs and LPs plays a more important role than capital participation by COEs and IPs in the NPD of JVs.

2.2 Firm resources and NPD

While the focus of this study is on the impact of foreign ownership on NPD, some other factors which are thought to have important influences on innovative capabilities are also included in our estimation models as control variables. As mentioned earlier, NPD involves the development and commercialization of new technology. Therefore, the stock of technological knowledge is an important factor in NPD. The higher the knowledge stock, the higher the firm's NPD capability. Therefore, the fourth hypothesis in this study is as follows:

H4: The firm's stock of technological knowledge is positively related to NPD.

Another possible factor is firm size. Schumpeter (1942) argues that large firm size is necessary to promote innovation for three reasons: only large firms can afford the cost of R&D programmes; large diversified firms can absorb failures by innovating across broad technological fronts; and firms need a degree of market control to reap the rewards of innovation. Since then, there have been a large number of studies on the relationship between firm size and NPD activities, but the results are inconclusive. This is perhaps because, as Teece (1992) argues, in some circumstances, cooperative agreements enable smaller firms to emulate many of the functional aspects of large integrated enterprises without encountering the problems associated with large size. This implies that firm size may not be important for NPD.

Although evidence is mixed, firm size has traditionally been considered as a possible determinant of NPD because large firm size often allows access to a wide range of strategic resources. Accordingly, the fifth hypothesis is:

H5: Firm size is positively related to NPD.

Location may be another factor that affects NPD, i.e. whether the firm is located in an urban or rural area. It is suggested that urban areas are characterized by high population density and a high concentration of professional and technical expertise. These are important strategic resources for NPD. The so-called urban or regional hierarchy model argues that urban environments have strong positive effects on product innovation (Roper, 2001).

In China, industrial and commercial activities have been concentrated in the coastal areas in recent decades. These regions have much better industrial bases and infrastructure and more qualified technical and managerial personnel than the inner regions. In addition, the Government of China has, until recently, actively encouraged inflows FDI to the coastal areas through preferential development policies. At the end of 2000, approximately 87% of the cumulative FDI was located in the coastal areas (Wei and Liu, 2001). The concentration of FDI and local industrial and commercial activities should provide agglomeration advantages in the coastal areas. Following the urban or regional model, we have the following hypothesis:

H6: Foreign-invested firms located in the coastal areas will perform better than those in the inner areas in terms of NPD.

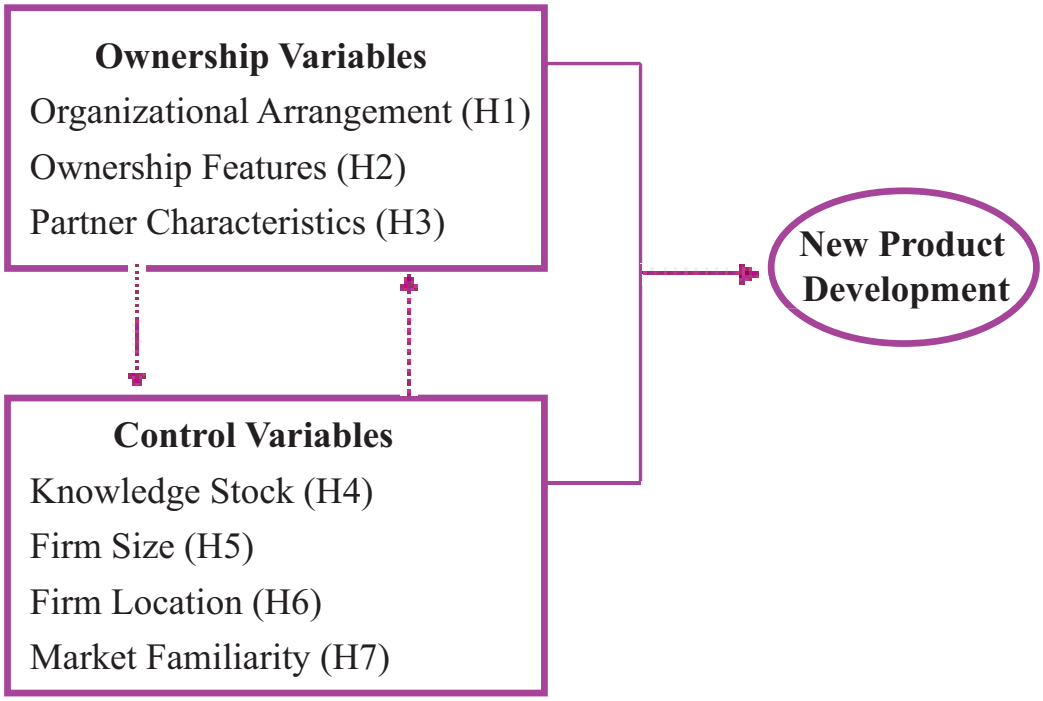
Another factor of interest is the linkage between the age of an affiliate in the host country and its NPD activities. Little discussion on this issue is found in the existing literature. On the one hand, it is likely that the longer an affiliate stays in the host country, the more familiar it becomes with the local market, and the more knowledge (including local knowledge) it can accumulates for NPD. We formulate the following hypothesis:

H7: The longer an affiliate stays in the host country, the more likely it becomes a new product developer.

The seven hypotheses can be represented in the following conceptual framework for our empirical investigation (figure 1). The relationship between foreign ownership structure and NPD is examined in three dimensions (H1–H3): the organizational forms (CJV, EJV, JSC and WFOE), the ownership characteristics (HMT and non-HMT investors) and the local Chinese partner features (SOE, COE, LP and IP). The resource variables discussed in H4–H7 are the control

variables. NPD is also believed to be influenced by the knowledge stock (H4), firm size (H5), firm location (H6) and market familiarity (H7). It should also be noted that some ownership and control variables may be related. For instance, if a foreign investor decides to choose JSC as the organizational arrangement, then this JSC must be relatively large as there is a minimum registered capital requirement of $3.6 million for such a company (MOFTEC, 1995).

Figure 1. Analytical Framework



3. Econometric models, data and methodology

To test the seven hypotheses contained in the analytical framework, the following three empirical models are established:

$$NPD_i = \alpha_0 + \alpha_1 ORD_i + \alpha_2 FOD_i + \alpha_3 KLG_i + \alpha_4 FS_i + \alpha_5 OT_i + \sum_{j=1}^{6} \alpha_{6j} IDD_{ij} + \alpha_7 RGD_i + u_{1i} \quad (1)$$

$$NPD_i = \beta_0 + \beta_1 LCR_i + \beta_2 FCR_i + \beta_3 KLG_i + \beta_4 FS_i + \beta_5 OT_i + \sum_{j=1}^{6} \beta_{6j} IDD_{ij} + \beta_7 RGD_i + u_{2i} \quad (2)$$

$$NPD_i = \gamma_0 + \gamma_1 LCR_i + \gamma_2 HMTR_i + \gamma_3 KLG_i + \gamma_4 FS_i + \gamma_5 OT_i + \sum_{j=1}^{6} \gamma_{6j} IDD_{ij} + \gamma_7 RGD_i + u_{3i} \quad (3)$$

Table 1 presents the definitions of the variables.

In equation (1), NPD_i is an indicator of NPD for firm *i*. NPD can be measured by various methods. For example, Cooper and Kleinschmidt

(1995) use ten different measures, including success rate, percent of sales, profitability relative to spending, technical success rating, sales impact, profit impact, success in meeting sales objectives, success in meeting profit objectives, profitability relative to competitors, and overall success. Given the nature of the current study and data availability, the percentage of sales represented by new products[2] introduced during the previous three years is adopted here.

Table 1. Variable definitions

Dependent variable	
NPD: two measures	
- probability of NPD	Binary variable (=1 if a firm carries out NPD, otherwise = 0.)
- intensity of NPD	Percentage of company sales represented by new products
Independent variables	
ORD	Organization dummy with four categories: WFOE, CJV, EJV and JSC.
FOD	Foreign dummy with two categories: OECD firm and HMT firm.
KLG	Knowledge variable: measured by a firm's R&D spending.
FS	Firm size
- FS1	Firm's total investment (i.e., the gross total of a firm's assets)
- FS2	Firm's total employment
OT	Firm's operating time: the time length of a firm has operated in China.
IDD	Industry dummy with seven categories: food processing and manufacturing, garment, machinery, pharmaceuticals, transport equipment, electrical goods and electronic goods.
RGD	Region dummy with two categories: coastal areas and inner areas.
LCR	Local capital ratios in a CJV, EJV or JSC.
FCR	Foreign capital ratio.

Source: Authors.

Following Roper (2001), we adopt two dummy variables to proxy for the *probability* and the *intensity* of NPD in foreign-invested firms in China. The probability that a foreign-invested firm would introduce new

[2] Although the wording varies slightly, there is a widely adopted official definition of a new product in China. For instance, the State Economic and Trade Commission (1997) and the Ministry of Science and Technology (2004), the central governmental organizations responsible for NPD, define that a new product is either a genuinely new product which is developed and manufactured using new technological principles and/or new design conception, or a significantly improved product whose functions have been substantially improved and/or expanded due to a breakthrough or significant improvement in the structure, materials or manufacturing technique. A new product must contribute to improvement in economic efficiency. A new product needs approval by the government authorities.

products is observed as the binary variable indicating that such a firm did (NPD = 1) or did not (NPD = 0) carry out NPD. The intensity (i.e. the actual percentage of company sales represented by new products) shows the ability of firm *i* to conduct NPD. The variable, *NPD*, will take on a positive value if this measure of ability is positive, and will take on a value of zero if this measure of ability is zero or negative.

ORD_i is an organization dummy with four categories: wholly foreign-owned enterprises (WFOE), contractual joint ventures (CJV), equity joint ventures (EJV) and joint stock enterprises (JSC). WFOE is treated as the base category in this study.

FOD_i is a "foreign" dummy with two categories. It is equal to 1 if firm *i* is an OECD firm, and equal to 0 if it is an HMT firm.

KLG_i is a knowledge variable and is measured by the ratio of intangible assets to total assets. Technological knowledge is one element of the set of intangible assets that can serve as a source of competitive advantage (Barney, 1991; Isobe et al., 2000). Ideally, a measure of R&D should be used to represent technological knowledge. However, the data used in this study contain no information on R&D, but instead include the total value of intangible assets, which we use as a proxy for R&D. The stock of knowledge that the firm possesses is measured by the ratio of intangible assets to total assets of firm *i*, and this follows the practice in other studies (see, for example, Liu et al., 2000). It must be noted, however, that intangible assets are a very rough proxy for knowledge stock since the term is usually defined to include unwritten-off goodwill, issue expenses, trade-marks and the value of publication rights and brands, among others. It is clear that not all the items covered by intangible assets directly contribute to the accumulation of relevant knowledge.

FS_i is firm size. In this study, two alternative measures are used to test the robustness of the models. Total investment (i.e., the gross total of a firm's assets), denoted as FS1 and total employment denoted as FS2.

OT_i is the operating time (i.e. the length of time in years) of foreign-invested firm *i* in China.

While our research question is about the characteristics of firms in determining the rate/extent of NPD, industrial and regional factors, such as the nature of industries (e.g. technology-intensity, export-oriented or import-substituting, stage of development) and the market structure firms face, are expected to affect NPD. Ideally, these variables should

be incorporated into our model. However, given our research focus and data limitations, we use the following two dummies to control for these industrial and regional variations. Specifically, *IDD* is an industry dummy with seven categories: food processing and manufacturing (base category), garment, machinery, pharmaceuticals, transport equipment, electrical goods, and electronic goods. Finally, RGD_i is a region dummy with 1 representing the coastal areas and 0 the inner areas to capture the stage of development.

As discussed in the preceding section, ORD_i , FOD_i , KLG_i , FS_i , OT_i and RGD_i are expected to have a positive impact on product innovation.

In equation (2), LCR_i represents the share of local capital in a CJV, EJV or JSC, indicating the degree of local participation in NPD. Local capital may be contributed by a state enterprise (SER), a collective enterprise (CER), a legal person (LPR) or an individual person (IPR). In most cases, there is only one local partner in a CJV or EJV. As mentioned before, the SER and LPR are expected to contribute more positively than the CER and LPR.

FCR_i is the foreign capital ratio. As discussed in the literature review, a positive relationship between NPD_i and FCR_i is expected.

In each foreign-invested firm, the shares of capital contributed by the local Chinese partner (LCR_i), the OECD investor (FCR_i) and the HMT investor (notated as $HMTR_i$) sum to 1. In the case of a WFOE, LCR_i is 0 and FCR_i (or $HMTR_i$) is 1. Given that $HMTR_i = 1 - LCR_i - FCR_i$, we can easily derive that γ_2, the coefficient on in (3), is equal to $= -\beta_2$. In addition, γ_3 to γ_7 in (3) are equal to β_3 to β_7 in (2), although γ_0 β_0 and γ_1 β_1.[3] As the impacts ofand, which are of particular interest to us, can be obtained from (2), the estimation of (3) is unnecessary and therefore not performed.

The data used for the current study are drawn from the *Annual Report of Industrial Enterprise Statistics* compiled by the State Statistical Bureau of China, covering more than 10,000 firms with foreign investment in seven industries for the period 1998–2001. Table 2 provides descriptive statistics on NPD by organizational form,

[3] Based on Equation (2) and the relationship that $FCR_i = (1 - LCR_i - HMTR_i)$, $NPD_i = \beta_0 + \beta_1 LCR_i + \beta_2 (1 - LCR_i - HMTR_i) + \beta_3 KLG_i + \beta_4 FS_i + \beta_5 OT_i + \beta_6 IDD + \beta_7 RGD_i + {}_{2i} = (\beta_0 + \beta_s) + (\beta_1 - \beta_2)LCR_i - \beta_2 HMTR_i + \beta_3 KLG_i + \beta_4 FS_i + \beta_5 OT_i + \beta_6 IDD + \beta_7 RGD_i + {}_{2i}$.

ownership structure, industry and region. In terms of organizational form, WFOEs, EJVs, CJVs and JSCs all involve the ownership and control by foreign partners. However, they are different in the degree of control, resource and risk involvement, and management structure, as specified by relevant laws and regulations in China (NPC, 1979, 1986, 1988; MOFTEC, 1995). From the table, we can see that, on average, JSCs had the highest level of NPD, followed by EJVs, CJVs and WFOEs. In terms of ownership structure, table 2 clearly shows that OECD TNCs performed better than HMT TNCs in terms of NPD. Table 2 also indicates that TNCs in pharmaceutical and electronic industries are more active in NPD that those in other industries, and that TNCs in inland China conduct more NPD than those in coastal areas.

Table 2. Product innovation by ownership structure, industry and region

	Total no. of firm	Firms carrying out NPD*		Firms' NPD intensity	
		No. of firms	% of firms	Mean	Std. Dev.
Full Sample	**10 671**	**1 561**	14.63	**0.046**	**0.191**
Organizational Form					
Contractual Joint Venture	973	102	10.48	0.026	0.137
Equity Joint Venture	6 134	1 118	18.23	0.061	0.219
Wholly Foreign-owned Enterprise	3 414	307	8.99	0.022	0.140
Joint-Stock Companies	129	30	23.26	0.083	0.240
Ownership					
HMT	5 519	640	11.60	0.037	0.170
OECD	5 152	921	17.88	0.058	0.215
Industry					
Food Processing	825	87	10.55	0.016	0.095
Garment	2 820	124	4.40	0.014	0.112
Pharmaceuticals	515	170	33.01	0.107	0.318
General Machinery	975	185	18.97	0.055	0.188
Transport Equipment	815	174	21.35	0.073	0.224
Electrical Equipment	1 911	395	20.67	0.082	0.253
Electronics Equipment	1 606	295	18.37	0.065	0.225
Region					
Coastal	8 507	1 063	12.50	0.040	0.182
Inland	2 164	498	23.01	0.068	0.223

Source: Authors.

Notes: *This includes the firms which carry our NPD for at least one year during the sample period.

The nature of the dependent variable dictates the appropriate estimation method. When the dependent variable is the probability of NPD, probit estimation is appropriate. When the dependent variable is the intensity of NPD, the data are left-censored at zero and the distribution of the sample is a mixture of discrete and continuous distributions. In this case, tobit or censored regression is suitable (Greene, 1997, p. 960).

To properly carry out probit and tobit estimations of equations (1) and (2), specification tests need to be carried out. The results suggest that the distribution is normal but heteroscedasticity is severe. We therefore use robust estimation to adjust the errors for hetroscedasticity. Another possible problem associated with the model is multicollinearity. We conducted several tests to detect multicollinearity. First we examined correlations (continuous variables) and associations (nominal variables) between independent variables and no pair of the independent variables is highly correlated. Further, we use the variance inflation factor (VIF) statistic to detect multicollinearity and the results suggest that there is no multicollinearity.[4]

4. Empirical Results

The estimation results for the seven hypotheses are summarized in table 3. Tables 4 and 6 report the estimation results of probit and tobit models respectively, with tables 5 and 7 providing the corresponding marginal effects.

Table 3. Estimation results of the hypotheses

Hypotheses	Results
H1: An EJV/CJV/JSC has higher capabilities to develop new products than a WFOE	Supported
H2: OECD investors are more likely to conduct NPD than overseas Chinese investors from HMT.	Supported
H3: Capital participation by SOEs and LPs plays a more important role than COEs and IPs,	Supported
H4: Stock of knowledge is positively related to NPD.	Inconclusive
H5: Firm size may be positively related to NPD.	Supported
H6: Foreign-invested firms located in the coastal areas are expected to perform better than those in the inner areas in terms of NPD.	Not supported
H7: The longer a affiliate stays in a host country, the more likely the affiliate will be a new product developer.	Not supported

Source: Authors.

The first two columns of table 4 reports the probit estimation results for equation (1), i.e. how the organizational form and ownership structure affect the probability that foreign-invested firms introduce new products. There are two specifications for equation (1). Specification I uses FS1 and specification II uses FS2 as the measure of firm size. The alternative measures are used to test the robustness of the model.

[4] Values of VIF larger than 10 are often regarded as suggesting multicollinearity. The results in this study are all smaller than 5.

To provide some interpretation of the estimated coefficients in table 4, we calculate the marginal effects of the variables on the probability of carrying out NPD. The values are small in magnitude because the likelihood of the firms in the sample carrying out NPD is low (14.63%, as seen in table 1).

Table 4. Probit results

	Equation 1		Equation 2	
cjv	0.374***	0.373***		
	(0.103)	(0.103)		
ejv	0.668***	0.755***		
	(0.063)	(0.063)		
jsc	0.626***	0.760***		
	(0.193)	(0.191)		
fod	0.092*	0.204***		
	(0.048)	(0.047)		
ser			1.264***	1.396***
			(0.122)	(0.121)
cer			0.736***	0.656***
			(0.121)	(0.120)
lpr			1.053***	1.176***
			(0.097)	(0.097)
ipr			0.499***	0.415**
			(0.165)	(0.164)
fcr			0.187***	0.361***
			(0.071)	(0.070)
klg	-0.283	0.707	-0.247	0.759*
	(0.462)	(0.447)	(0.464)	(0.448)
logfs1	0.445***		0.459***	
	(0.020)		(0.020)	
logfs2		0.473***		0.474***
		(0.025)		(0.025)
Operating time	0.000	2.01e-06	0.000	5.58e-07
	(0.000)	(0.000)	(0.000)	(0.000)
Garment	-0.082	-0.685***	-0.056	-0.663***
	(0.101)	(0.099)	(0.101)	(0.100)
Machinery	1.073***	1.002***	1.054***	0.987***
	(0.104)	(0.104)	(0.104)	(0.104)
Pharmacy	1.402***	1.466***	1.385***	1.458***
	(0.117)	(0.118)	(0.118)	(0.118)
Transport	0.818***	0.890***	0.821***	0.906***
	(0.109)	(0.109)	(0.109)	(0.108)
Electric	1.152***	1.061***	1.134***	1.027***
	(0.088)	(0.088)	(0.088)	(0.088)
Telecommunication	0.961***	0.879***	0.951***	0.863***
	(0.092)	(0.092)	(0.092)	(0.092)
Coastal	-0.604***	-0.620***	-0.548***	-0.566***
	(0.065)	(0.065)	(0.066)	(0.066)
Constant	-7.987***	-5.789***	-8.099***	-5.717***
	(0.244)	(0.170)	(0.246)	(0.169)

Source: Authors.

Notes: *** denotes significant at the level of 1%, ** at 5% and * at 10%.

From the first two columns of table 4, the coefficients on CJVs, EJVs and JSCs are all positive and statistically significant, showing that they are more likely to be new product developers than WFOEs. This is consistent with the descriptive statistics provided in table 2. More specifically, the marginal effects for CJVs, EJVs and JSCs suggest that the adoption of a CJV, EJV or JSC increases the probability that a foreign affiliate would introduce new products by 0.003 to 0.01 compared to the adoption of a WFOE. This lends support to hypothesis 1. Among the JV-type organizational forms, EJVs and JSCs are better than CJVs in terms of their probability of NPD, and this pattern is not influenced by the change in the measure of firm size, showing the stability of the model. It is not possible to say which form is more conducive to NPD between EJVs and JSCs, because EJVs seem to be slightly superior to JSCs when investment is used as a proxy for firm size, and the reverse is true when total employment is used. These results indicate that partial equity ownership is more appropriate than whole equity ownership or a contractual arrangement for increasing the probability of NPD, and are consistent with Hamel et al. (1989), Teece (1992) and Doz et al. (1998).

Table 4 also shows that OECD TNCs are more likely to introduce new products than HMT TNCs as the coefficients on "fod" are statistically significant in both specifications. As indicated by the marginal coefficients in table 5, OECD ownership increases the probability of NPD by around 0.006 compared with HMT ownership. Thus, hypothesis 2 is supported. Given higher technological and innovative capabilities, OECD TNCs have a higher propensity to become new product developers than HMT firms. Because of the close economic relationship, mainland China already has most goods that HMT firms have to offer. Put another way, it is much less likely that a company operating in HMT would have products that were not known on the Chinese mainland, which is probably another reason why investors from HMT are relatively less product innovative than those from the OECD countries.

The coefficients on KLG in the first two columns of table 4 are statistically insignificant, showing that the stock of knowledge may not be particularly important in increasing the probability that a TNC introduces new products. Of course, the insignificant coefficients on KLG may partly be due to the problem of using intangible assets as a proxy for R&D knowledge stock.

Firm size, measured either by total investment or total employment is always important for increasing the probability of NPD. Thus, hypothesis 5 is supported. The coefficients on the region dummy are

negative and statistically significant, suggesting that a foreign-invested firm's probability of becoming a new product developer is negatively affected by its location in the coastal areas. This result appears somewhat surprising. For this study, we defined the coastal areas to include Shandong, Jiangsu, Zhejiang, Fujian, Guangdong and Shanghai. Although much FDI in China is located in these areas, not all TNCs are proactively involved in NPD. In fact, many TNCs locate their labour-intensive activities in Guangdong, Zhejiang and Fujian Provinces. The majority of the TNCs' R&D centres in China are based in Beijing and Shanghai, as these two cities possess highly qualified human resources, well-developed infrastructure, a wide range of industries and high-tech parks, and mature local scientific communities including top-class universities and research institutes (Li and Zhong, 2003; China S&T Statistics, 2003; Gassma and Han, 2004). Other important cities such as Tianjin and Xi-An have also attracted much foreign R&D and NPD-related investment. Although Shanghai is traditionally included in the coastal areas, Beijing, Tianjin and Xi-An are not. Perhaps a much higher proportion of TNCs in some inner areas are involved in NPD than in some coastal areas, producing a negative coefficient on the region dummy. This result is consistent with the findings in table 2, which shows that, on average, firms in inland China conduct more NPD than those in coastal areas.

Table 5. Marginal effects of probit model

	Equation 1		Equation 2	
cjv	0.0039***	0.0041***		
ejv	0.0044***	0.0053***		
jsc	0.0105	0.0161		
fod	0.0060*	0.0015***		
ser			0.0084***	0.0099***
cer			0.0049***	0.0047***
lpr			0.0070***	0.0083***
ipr			0.0033***	0.0029**
fcr			0.0012***	0.0026***
klg	-0.0019	0.0050	-0.0016	0.0054
Logfs1	0.0029***		0.0031***	
logfs2		0.0033***		0.0034***
Operating time	0.0000	0.0000	0.0000	0.0000
garment	0.0005	-0.0034***	-0.0004***	-0.0034***
machinery	0.0285***	0.0252***	0.0271***	0.0245***
pharmacy	0.0621***	0.0721***	0.0598***	0.0716***
transport	0.0161***	0.0199***	0.0161***	0.0209***
electric	0.0273***	0.0235***	0.0262***	0.0220***
telecommunication	0.01967***	0.0168***	0.0190***	0.0164***
coastal	0.0074***	-0.0080***	-0.0063***	-0.0070***

Source: Authors.

Notes: *** denotes significance at the level of 1%, ** at 5% and * at 10%.

From table 4, the coefficients on operating time are statistically insignificant. This implies that hypothesis 7 is not supported. As discussed earlier, the counter argument to this hypothesis is that an established affiliate may no longer have strong incentives for NPD if there is a strong demand for its products. Our research suggests that the probability of a foreign affiliate becoming a new product developer is not influenced by how long it stays in that market.

The third and fourth columns of table 4 present the probit estimation results for equation (2), i.e. how local and foreign capital participation affects the probability that TNCs introduce new products. The positive and significant coefficients on ser, cer, lpr and ipr suggest that any form of local capital participation enhances the probability of NPD. Specifically, capital participation by state-owned enterprise (ser) produces the most important role in terms of its magnitude, followed by legal persons (lpr), collectively owned enterprises (cer) and finally individual persons (ipr). One very important finding from the third and fourth columns of table 4 is that capital participation by OECD investors significantly increases the probability that TNCs introduce new products in China.

From table 5, the marginal coefficients indicate that capital involvement by OECD investors is associated with a 0.006 rise in the probability of their firms being new product developers. As mentioned earlier, given the model specification, the coefficient on Chinese capital participation by HMT investors (HMTR) has the same magnitude but the opposite sign as that on capital participation by OECD investors (FCR). Thus, overseas Chinese capital participation is associated with a fall in the probability of their firms being new product developers.

The coefficient on the stock of knowledge is not significant in column 3, and is significant at the 10% level only in column 4 of table 4. Thus, the results are mixed on the role of knowledge stock in the probability of NPD in foreign-invested firms. As explained before, we believe that the insignificance of this variable in some cases may be due to measurement problems.

In addition, as in columns 1 and 2, the results from columns 3 and 4 of table 4 indicate that firm size increases the probability of NPD, while operating time has no impact on it. Furthermore, the coastal location seems to affect negatively the probability of foreign-invested firms being new product developers.

Overall, the main messages from the probit estimations in tables 4 and 5 are as follows. First, a TNC is more likely to be a new product developer if its equity is jointly rather than wholly owned, and if its partner is an OECD rather than an HMT investor. Second, the best Chinese partner for a TNC to be a new product developer is an SOE, followed by an LP, a COE and finally an IP.

Table 6 provides the tobit regression results for equation (1), i.e. how NPD intensity of a foreign-invested firm is affected by the organizational form and ownership structure. The positive and highly significant coefficients on CJVs, EJVs and JSCs suggest that NPD intensity in the JV-type firms is higher than WFOEs. In addition, there is clear evidence that OECD investors have a higher NPD intensity than HMT ones. Firm size, whether it is measured by total investment or employment, has a significantly positive impact on the extent of NPD activity. The coastal location negatively affects the extent of a foreign-invested firm's NPD activity. In addition, operating time is statistically insignificant. These results are consistent with those from the corresponding probit models in table 4, although the former is concerned with NPD intensity and the latter with NPD probability.

One difference between the tobit and probit estimation results is that, in the second column of table 6, the stock of knowledge is statistically significant for NPD intensity while it is not the case for NPD probability in the second column in table 4. Of course, we must bear in mind that intangible assets are a very rough proxy for knowledge stock, and the use of a better proxy such as R&D would probably offer more accurate empirical results.

The third and fourth columns of table 6 report the tobit results for equation (2), that is, how local and foreign capital participation affects the NPD intensity in foreign-invested firms. Similar to the results for the probit model (tables 4 and 5), the results from table 6 indicate that capital participation by state-owned enterprises (SER), legal persons (LPR) and collectively owned enterprises increases the extent of NPD activity in CJVs, EJVs or JSCs. Capital participation by individual persons produces a significantly positive impact in one (column 4) of the two estimations (columns 3 and 4). In addition, firm size, measured by either total investment or employment, has a significant positive effect on the intensity, and there seems to be a significant difference in average NPD intensity between the coastal and inner areas.

The significant coefficients on FCR indicate that capital participation by an OECD rather than an HMT investor is a significant

determinant of the firm's NPD intensity. Finally, the coefficient on klg is significant in the fourth column only. All these results are qualitatively the same as those obtained from the probit model, and the explanations of the probit results largely apply to the tobit results.

Table 6. Tobit results

	Equation 1		Equation 2	
cjv	0.010**	0.010**		
	(0.005)	(0.005)		
ejv	0.027***	0.030***		
	(0.003)	(0.003)		
jsc	0.020*	0.025**		
	(0.011)	(0.011)		
fod	0.007***	0.011***		
	(0.002)	(0.002)		
ser			0.043***	0.049***
			(0.007)	(0.007)
cer			0.021***	0.018***
			(0.006)	(0.006)
lpr			0.037***	0.041***
			(0.005)	(0.005)
ipr			0.015*	0.010
			(0.008)	(0.008)
fcr			0.007**	0.013***
			(0.003)	(0.003)
klg	0.028	0.068***	0.029	0.069***
	(0.025)	(0.025)	(0.025)	(0.025)
logfs1	0.022***		0.022***	
	(0.001)		(0.001)	
logfs2		0.016***		0.016***
		(0.001)		(0.001)
Operating time	4.12e-06	4.33e-06	3.16e-06	3.64e-06
	(0.000)	(0.000)	(0.000)	(0.000)
Garment	0.027***	0.001	0.027***	0.001
	(0.005)	(0.005)	(0.005)	(0.005)
Machinery	0.044***	0.041***	0.044***	0.041***
	(0.006)	(0.006)	(0.006)	(0.006)
Pharmacy	0.080***	0.084***	0.081***	0.085***
	(0.008)	(0.008)	(0.008)	(0.008)
Transport	0.044***	0.048***	0.044***	0.049***
	(0.006)	(0.006)	(0.006)	(0.006)
Electric	0.073***	0.069***	0.072***	0.068***
	(0.005)	(0.005)	(0.005)	(0.005)
Telecommunication	0.056***	0.052***	0.055***	0.052***
	(0.005)	(0.005)	(0.005)	(0.005)
Coastal	-0.021***	-0.022***	-0.020***	-0.021***
	(0.004)	(0.004)	(0.004)	(0.004)
Constant	-0.220***	-0.078***	-0.219***	-0.071***
	(0.013)	(0.009)	(0.013)	(0.009)

Source: Authors.

Notes: *** denotes significance at the level of 1%, ** at 5% and * at 10%.

Table 7 reports the marginal effects of the estimations provided in table 6. Again, we find that the values are small, which is not surprising because the average NPD intensity in the sample is 0.046 only (see table 1). The largest marginal effect in the table is from the variable "pharmacy", followed by electric, telecommunication, SER, LPR, machinery, and EJV. These results are consistent with the discussions above.

Table 7. Marginal effects of Tobit model

	Equation 1		Equation 2	
cjv	0.0104***	0.0098*		
ejv	0.0270***	0.0298***		
jsc	0.0195	0.0254*		
fod	0.0069***	0.0109***		
ser			0.0432***	0.0485***
cer			0.0212***	0.0184***
lpr			0.0374***	0.0405***
ipr			0.0147*	0.0103
fcr			0.0072**	0.0129***
klg	0.0282	0.0676***	0.0288	0.0686***
Logfs1	0.0217***		0.0222***	
logfs2		0.0164***		0.0164***
Operating time	0.0000	0.0000	0.0000	0.0000
Garment	0.0269***	0.0009	0.0274***	0.0009
Machinery	0.0439***	0.0412***	0.0439***	0.0414***
Pharmacy	0.0804***	0.0842***	0.0806***	0.0849***
Transport	0.0437***	0.0479***	0.0443***	0.0487***
Electric	0.0728***	0.0695***	0.0716***	0.0676***
Telecommunication	0.0556***	0.0524***	0.0549***	0.0516***
Coastal	-0.0211***	-0.0219***	-0.0204***	-0.0214***

Source: Authors.

Notes: *** denotes significance at the level of 1%, ** at 5% and * at 10%.

5. Conclusions

We believe this paper is one of the first systematic empirical studies of the relationship between foreign ownership structure and NPD. Seven hypotheses are derived from the literature and tested on a large firm-level panel data set. As NPD is examined in terms of both probability and intensity, the probit and tobit models are applied respectively.

The results summarized in table 3 show that contractual, and especially equity joint ventures and joint stock enterprises, are better organizational forms than wholly owned enterprises in terms of the probability of NPD. We argue that this is because strategic alliances typically provide access to complementary resources and enhance

successful NPD. OECD investors play a more important role than investors from HMT in raising both the probability and intensity of NPD, because the former generally have higher innovative capabilities than the latter and because it is much less likely that a company operating in HMT would have a portfolio of products that were not known on the Chinese mainland. Capital participation by SOEs and LPs plays a more important role than capital participation by COEs and IPs, because the former generally possess higher R&D and manufacturing capabilities. In addition, capital participation by OECD investors is positively associated with both the probability and extent of NPD, while capital participation by HMT investors is negatively associated with these two aspects. Firm size is important in enhancing the probability and intensity of NPD, as large firm size often implies that a large amount of strategic resources are available. The above evidence lends clear support to hypotheses 1, 2, 3 and 5.

The test results on hypothesis 4 is inconclusive as the coefficient on knowledge stock is significant in some model specifications while insignificant in others.

Evidence on hypothesis 6 is mixed with no clear results. While an overwhelming proportion of manufacturing FDI is located in the coastal areas, a higher percentage of TNCs in the inner areas are involved in NPD than in the coastal areas, producing a negative coefficient on the region dummy. Finally, there is no evidence to support hypothesis 7 that there is a positive relationship between NPD and the operation time of a foreign-invested firm in China.

We acknowledge that there are several limitations with this study. Firstly, our data set does not allow us to distinguish between a genuinely new product and a significantly improved product. As the relative importance of development activities for these two types of product differs, it is not ideal to lump them together. It would be very useful to conduct a survey to find out how different types of NPD are associated with different ownership and organizational arrangements of TNCs.[5] Furthermore, because of the lack of information on R&D, we have used intangible assets as a proxy for knowledge stock, and this prevents us from a more accurate assessment of the impact of knowledge stock.

[5] For instance, the survey by Yalcinkaya et al. (2007) distinguishes products that are new to the world, new to the market a firm serves, and new to the firm.

There are several important policy and managerial implications of the study. First, for the Government of China, international joint ventures (whether they are equity, contractual or joint stock enterprises) rather than WFOEs need to be encouraged in order to promote NPD in China. Knowledge accumulated in these NPD activities are likely to spill over to indigenous Chinese firms so that overall innovative capabilities of Chinese industries will increase. For TNCs, it is essential to develop and strengthen strategic alliances with indigenous firms in host countries so that local strategic resources can be accessed in order to perform NPD activities better.

Second, more FDI from the OECD countries should be particularly encouraged to promote NPD. This is very important in raising both the probability and intensity of introducing new products. However, this does not implies that FDI from HMT should not be welcomed. FDI from HMT investors is still important for the Chinese economy in terms of its contributions to employment and basic manufacturing and marketing knowledge spillovers. Nevertheless, if China aims to speed up its innovation and NPD, TNCs from OECD countries are likely to play a more important role in this process. Technological knowledge about NPD developed in these TNCs can not only directly benefit their affiliates in their NPD, but also spill over to indigenous firms, raising the overall innovative capabilities of that country.

Third, the finding that the coefficient on the stock of knowledge is not always significant suggests that possessing knowledge stock on its own does not lead to successful NPD. Perhaps this is because an appropriate business environment and incentives for NPD are not yet in place. Thus, Chinese policy makers may, for example, need to consider strengthening intellectual property right protection so that firms, whether foreign or local, would have strong incentives to conduct NPD and innovatory activities in general.

Fourth, as large firm size appears to help NPD, there is perhaps a case for encouraging mergers and acquisitions to promote innovation. A large proportion of firms in Chinese manufacturing are too small to benefit from scale economies; an example is that there are as many as 126 car manufacturers (not including car component manufacturers) (National Statistic Bureau, 2002). By increasing the size, firms would have more resources available for NPD.

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