Intellectual Property Rights Protection, Complexity and Multinational Firms

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7 May 2013

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May 7, 2013

(CENET working paper, First Draft: May 2013)

Abstract

This paper examines theoretically the impact of host intellectual property rights (IPR) protection and complexity on MNEs' investment decision to the South in order to explain why large amount of foreign direct investment (FDI) flows to low IPR protecting China and other emerging economies. There are two key assumptions, imitation cost are positively related to complexity and imitation cost is higher when imitating a product designed only for foreign market than those for host market. In the model, a strengthening of IPR protection in the South raises an MNE's profit and stimulates inward FDI and licensing simultaneously, and stronger IPR protection will also induce more higher complexity production transfered to the South. Furthermore, as cost-oriented FDI is less sensitive to host IPR protection, developing host countries with low IPR protection can attract relatively more cost-oriented FDI. The model implies that strengthening of IPR protection can help emerging economies attract more complex and market-oriented FDI.

Key words: Intellectual Property Rights, Licensing, Imitation, Multinational Enterprise, Foreign Direct Investment

JEL Code: F21, F23, O33, O34

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1 Introduction

Two features of the process of globalization in the last few decades are most remarkable, one is the growing fragmentation of production and the other the expansion of multinational firms' organization on a global scale. Firms allocate their operation worldwide to exploit cross-country differences in production costs or access foreign market. Existing literature shows that market size, labor cost, infrastructure, trade barrier, market structure, institutional quality and other local advantages of host country are key determinations of a multinational firm (MNE) investing abroad. One important institutional dimension is intellectual property rights (IPR) protection, which may have strong impact on firm's overseas investment decision, firm performance, technology transfer and host country industrial development (Branstetter *et al.*, 2005[2]; Khoury and Peng, 2011[18]; Branstetter *et al.,* 2011[4]; Smith, 2001[29]; Helpman, 1993[15] and Javorcik, 2004[17]).

In last two decades, a large amount of foreign direct investment (FDI) flowed into emerging and developing economies. As shown in Figure 1, only 25 percent of FDI in average flowed to developing economies in 1970s and 1980s, this figure is up to 32.5 in 1990s and the first decade of the 21th century. Over 20% in of these FDI in last two decades flowed to China, one of the largest emerging market in the world. In 2011, about 124 billion US dollars of FDI flowed into China, 44% of all flowed into BRICS economies (Brazil, Russia, India, China and South Africa) (see Figure 2). From early 1990s, firms in developing economies paid a large amount of royalty and license fee to foreign firms. Figure 3 shows the royalty and license fees paid by BRICS firms. Chinese firms are most outstanding, they paid more than 13 billion current US dollars in 2009, much more than the sum of the other four economies (less than 12.3 billion US dollars).

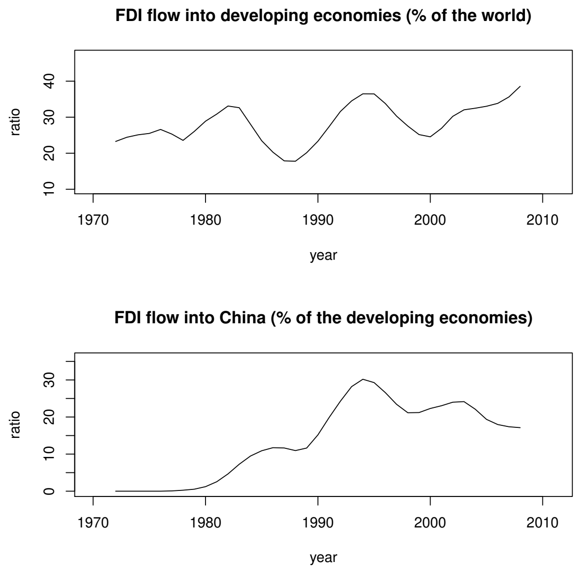

Figure 1: FDI flowed into developing economies

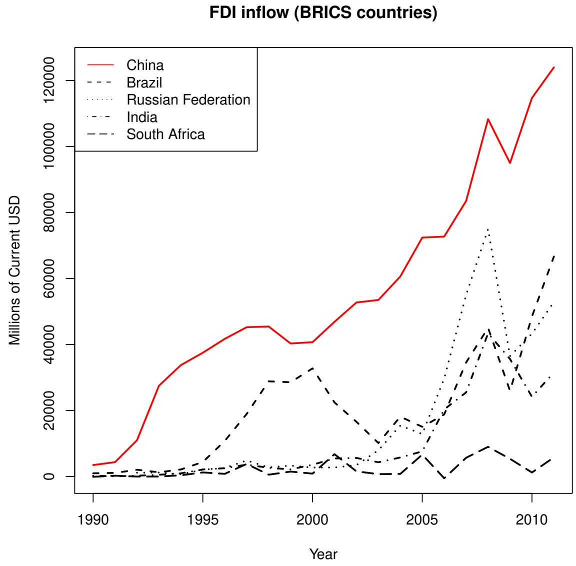

Figure 2: FDI flowed into BRICs economies

Taking low labor cost and large emerging market into account, it is still confusing to see large amount of FDI flowing into the emerging economies, especially China, while the IPR protection remains very weak there. The effect of IPR protection on FDI are widely discussed theoretically and empirically. Javorcik (2004)[17] finds that a weak IPR regime deters foreign investment in high technology sectors where intellectual property rights play an important role. It also shifts the focus of FDI projects from manufacturing to distribution. Theoretically, the relationship between IPR protection and FDI is quite ambiguous. On the one hand, a weak IPR protection increases the probability of imitation, which makes a host country a less attractive location for foreign investors. On the other hand, strong protection may shift the preference of multinational corporations from FDI towards licensing. So the effect of IPR protection on FDI flow maybe determined by the substitution effect between FDI and licensing. Using an aggregate data set of 50 countries, Smith (2001)[29] finds that the effect of IPR on licensing is larger than those on export and FDI, but Puttitanun (2007)[28] using a larger disaggregated industry level dataset (provided by the Bureau of Economic Analysis, BEA) concludes that an increase in IPR results in a higher probability of FDI than does licensing. Also, the importance of IPR protection varies between industries. Using survey data, Mansfield (1994[19], 1995[20]) finds that the concern about the IPR regime also depends on the purpose of an investment project, being the highest in the case of R&D facilities and the lowest for projects focusing exclusively on sales and distribution. Nunnenkamp and Spatz (2003)[27] also finds that FDI depends on industry as well as host-country characteristics and stronger IPR protection tends to induce high-quality FDI.

New technologies can be divided into two groups by their legal status, technical secrets (know-hows) and patents. Within license relationship, the licensor must disclose his technical secrets to the licensee, so the later is the most potential imitator. Ethier and Markusen (1996) and Markusen (2001) adopted a two-stage framework assuming that an MNE hires a local agent in host country, which learns the technology in the first period and can defect to start a rival firm in the second period. The MNE can similarly dismiss the agent at the beginning of the second period and hire a new agent. But for patents, the imitator may be a third party. Firms are required technical disclosure when applying patents, so the third party outside a licensing relationship can learn the technology by reading patent literature. In this paper, I focus on the case of patent imitation in host country, assuming that when an MNE enters the host country by means of either direct investment or licensing, there is a potential third party imitator. IPR protection is modeled simply as the scale of punishment imposed on the third party imitator.

As far as I know, the existing literature have two major shortcomings. **On the one hand, few of the literature above explore the impact of complexity on the relationship between IPR protection and FDI**. Theoreticly, complexity may take effect by means of imitation cost: higher complexity means higher imitation cost. Mansfield (1994, 1995) show that the concern about the IPR regime depends on the purpose of an investment project. Obviously, investments in manufacturing components and complete products (where about 80 percent of survey respondents were concerned about IPR protection) are much more complex than sales and distribution outlets (where the percentage is only about 20).

On the other hand, few of the literature above explore the impact of MNEs' investment motivation on this relationship. There is significant difference between cost-oriented and market-oriented FDI. For cost-oriented one, the MNEs are seeking low productive cost in host country. The R&D stage is put in home country in which high skill R&D staff are available and R&D activities are more close to their customers, and manufacturing and assembling stage in low-cost host country. So MNEs have to determine the way they obtain products from host country: direct invest and then obtain by intra-firm trade or import from independent exporter (the licensee) from host country by arm's-length trade. For market-oriented FDI, more R&D activities are put in host country where they are close to local customers. Given the cost advantage of host country, MNEs also have to determine the way they access host market: investing directly in host country and then produce goods locally or licensing to a host partner.

Motived by above literature and facts, this paper investigates following questions theoretically: (i) how indutrial characteristics, especially the complexity of production, impact the effect of IPR protection on MNEs' investment decision; (ii) is there any difference between the reflection of market-oriented and cost-oriented direct investment decision against host IPR protection; (iii) how the other institutional elements, contracting institutions for example, effect the MNEs entry mode choice between FDI and licensing. The model developed in this study is based on many relating theoretical studies. Antràs and Helpman (2006)[1] developed a headquarter services-intermediate input model to study the impact of contractual frictions on MNE's outsourcing or vertical integration choice. Based on a simplified Antràs and Helpman (2006) model, Carluccio and Fally (2012)[5] incorporated capital market frictions on the supplier's side, and analyzed MNE's global sourcing activety under imperfect capital markets. Based on their work, complexity is embodied into the model of this paper, showing that strengthening of host IPR protection can induce larger amount of higher complexity and market-oriented MNEs' investment.

The rest of the paper is organized as follows: Section 2 describes the basic model; Section 3 discusses the impact of IPR protection, complexity, competitiveness and motivation of investment on imitation and MNEs' welfare; Section 4 concludes.

2 Framework

Consider a world comprised of three regions: the developed North H (home country of MNE), the developing South (potential host country) S, and the third developed country T. Labor cost is higher in the North and the third country than that in the South. IPR protection is strong in the North and the third country, but weak in the South. Consumers of each country consuming a set of varieties prefer diversified and highly complex goods. There are many producers in each country. Firms from the North can sell goods in home market and/or in foreign market, transportation cost is set to be zero, but firms from the South and the third country are assumed to sell only in local market.

To sell goods in foreign market, firm J from the North can either: (i) invest and performing production directly in the South or license his patent to a local firm to sale goods in host market, in this case, the MNE is performing *market-oriented* internationalization; or (ii) invest and performing production directly in the South but sales goods produced to the third country T, and in this case, the MNE is performing *cost-oriented* internationalization to take advantage of low labor cost in the South. And in each case, there is a potential imitator in the host country (noting that the IPR protection is weak in host country). In this section, complexity is incorporated into utility and production function, so that I can analyze its impact on MNE's FDI decision-making later.

2.1 Consumption

Consumers prefer diversified consumption. Their preferences are identical and a representative consumer chooses instantaneous expenditure $E(\tau)$ to maximize utility at time t:

$$U = \int_t^\infty e^{-\rho(\tau - t)} \log D(\tau) d\tau$$

subject to the intertemporal budget constraint

$$\int_t^\infty e^{-r(\tau - t)} E(\tau) d\tau = \int_t^\infty e^{-r(\tau - t)} I(\tau) d\tau + A(t)$$

for all t, where ρ denotes the rate of time preference; r the nominal interest rate; $I(\tau)$ instantaneous income; and $A(t)$ the current value of assets. The instantaneous utility $D(\tau)$ is given by

$$D(\tau) = D\left[\left(\int_0^n \theta(j)^\alpha q(j)^\alpha dj\right)\right]^{\frac{1}{\alpha}} \tag{1}$$

where $q(j)$ is the consumption of good j, n the number of varieties available and $0 < \alpha < 1$ a measure of substitutability, $\theta(j)$ reflects the complexity of good j[1]. The consumer has "taste for variety" in that he or she prefers to consume a diversified bundle of goods, and also prefers higher complexity goods[2].

Under the above assumption, the comsumer's optimization problem can be broken down into two stages. First, he chooses how to allocate a given spending level across all available goods. Second, he chooses the optimal time path of spending. The elasticity of substitution between any two varieties j_1 and j_2 is

$$\sigma_{1,2} = \frac{1}{1-\alpha} - \frac{d\ln\left[\theta(j_2)/\theta(j_1)\right]}{d\ln\left[p(j_1)/p(j_2)\right]}$$

Each firm can choose its investment level in R&D to achieve a certain complexity level and maximize its profit. Given symmetrical firms, firms will choose a same R&D and complexity level, *i.e.* for any two varieties j_1 and j_2, $\theta(j_1) = \theta(j_2)$, and this will introduce a constant elasticity of substitution, so formula (1) becomes a CES utility function, and the elasticity of substitution is then $\sigma = \frac{1}{1-\alpha}$. Given consumer's total expenditure E, the demand for any good j is

$$q(j) = \frac{Ep(j)^{-\sigma}}{\theta(j)P^{1-\sigma}} \tag{2}$$

where $p(j)$ is the price of good j and P a price index such that

$$P = \left[\int_0^n \theta(j)^{-1} p(j)^{1-\sigma} dj\right]^{\frac{1}{1-\sigma}} \tag{3}$$

Formula (3) shows that given a large amount of diversified products, a single producer's pricing strategy has approximately no effect on the common price index P, so $A = \frac{E}{\theta(j)P^{1-\sigma}}$ can be regarded as constant. But if there are only a small number of varieties, a single producer's strategy has significent impact on P. For simplicity, n is regarded large enough and the case of small number of varieties will be discussed later.

2.2 Production

Assuming that a firm produces and sales only one variety. The final goods are made of intermediate goods. Producing one unit of final good needs one unit of intermediate good and no other inputs needed, *i.e.* $q(j) = m(j)$. The firm needs to undertake a continuum of tasks (normalized to one) to produce the intermediate good. Each task can be taken to be the production of a single component or procedure of the intermediate good. Tasks are distributed evenly in $[0, 1]$. Following Carluccio (2012)[5], the production technology is assumed to be represented by a CES function where tasks are imperfectly substitutable. To be more precisely

[1] The complexity of good is defined as the fraction of complex tasks input in production, see subsection 2.2.

[2] For the popose of simplicity, suppose that all varieties have the same price p and are therefore consumed in equal amounts q, the utility function can be recalled as $U = n^{\frac{1}{\rho}}(\theta q)$, we can see that utility is increasing in n and θ.

$$q(j) = m(j) = \left(\int_0^1 k_i^{\alpha'} di \right)^{\frac{1}{\alpha'}} \tag{4}$$

where k_i denotes the tasks input in producing intermediate goods, $\frac{1}{1-\alpha'}$ is referred to the elasticity of substitution. For the sake of argument, assuming that the elasticity of substitution between tasks is the same as it is between final goods ($\alpha = \alpha'$), producing a simple linear form for the value of total sales.

There are two types of tasks: basic and complex ones. A task is regarded as basic one when it is performed using public technology, for a single firm, the cost of basic task is given due to competitive market. Contrary to basic tasks, complex tasks are specific and are performed using exclusive technology[3], *i.e.* patents and know-hows. Performing complex tasks needs exclusive equipment and skill, so the cost of complex task is higher than basic one, and the total cost arises as the complexity increases. Let θ denote the fraction of complex tasks required during production. θ can be regarded as a parameter of *good complexity*[4]. Total cost of intermediate good is then

$$TC = C_f + m(j)c + \gamma\theta(j)m(j)c = C_f + [1 + \gamma\theta(j)]m(j)c \tag{5}$$

where C_f is fixed cost, c the unit cost of tasks, $\gamma\theta(j)c$ the marginal cost related to exclusive technology (*complexity specific cost* hereinafter), and γ ($\gamma > 0$) reflects positive correlation between complexity and unit cost. Cost function (5) shows that firms benefit from economies of scale.

2.3 Cross-border License and Direct Investment

To sell his product in the South market, a North firm J have many alternative ways, including exporting, establishing joint venture with local partners, establishing wholly owned subsidiaries and licensing to local partners. Dunning's eclectic OLI framework shows that firm choice among several internationalization mode, including exporting, licensing, and direct investment, is determined by firms advantages pattern of ownership, location and internalization. There has been rich literature documenting MNEs' choice between exporting and FDI, Melitz (2003)[26] argues that only the firms with high productivity can export, Helpman, Melitz and Yeaple (2004)[16] extended his work to show that only the firms with highest productivity can sell products in host market *via* FDI, firm with higher productivity can export, and low productivity firm can only serve home market. For sake of argument, I only consider two of these MNEs' entering mode, license and direct investment.

[3]Carluccio (2012) regards complex tasks specific and cannot be fully described in a contract in order to link characteristics of production with imcomplete contracts.

[4]Here complexity in production induces better customer experience, (see utility function (1)), so consumers is willing to pay higher price for more complex goods, but higher complexity induces higher cost. So firms must consider the trade-off between high cost and high price.

2.3.1 Cross-border License

Two important dimensions of local institutions, contracting institution and (intellectual) property rights protection, both can effect MNE's operation. In vertical relationship, incomplete contacts are usually caused by relationship-specific investment and contractibility of tasks[5]. Contracting issues between licenser and licensee are usually related to information asymmetry and moral hazard caused by it. As discussed by Markusen (1995)[22], the potential licensee has superior information, usually about how the product will sell in its local market. The licensor can mitigate contractual hazards by payment structure (Cebrián, 2009[6]) and supervision activities. When information asymmetry and low penalty exists, the licensee will be tempted to abuse patent technology to maximize his own profit, for example, the licensee can state that not all of the products produced under license are sold out in order to lessen royalty fee he should pay. The proportion that the licensee is willing to hide can be seen as a parameter of contracting institution quality[6]. So improvement of contracting institution may raise the licenser's (the MNE's) income and profit.

Consider the case that there is no potential imitator but a weak contracting institution in the South country. When firm J enters the host market by licensing his patent to a local partner S (the licensee), he firstly bargain over the division of the revenue with potential local partner[7]. Let β denote the fraction the licensor obtains and $(1-\beta)$ the licensee obtains. Given weak contracting institution in the host country and opportunism on the licensee's side, the local partner has motivation to hide a fraction of $(1-h)$ he produced. Due to information asymmetry and low deterrent of the court, local partner is more opportunistic than ones in MNE's home country, in which the contractual institution is assumed perfect. So the local partner can declare that the quantity produced is only a fraction of h, and the other $(1-h)$ is lost, he would only pay royalty for the remaining h. The local partner determines the optimal output quantity to maximize his profit:

$$\Pi_S = (1-\beta h)R - (1+\gamma\theta)qc$$

where R denotes total sales revenue, c_f the fixed cost (assume that it is equal to the cost that production performed in home country by firm J himself), Given the CES demand, the local partner's optimal supply is

$$q_S^* = \frac{A}{\theta}\left(\frac{(1+\gamma\theta)c}{\alpha(1-\beta h)}\right)^{-\sigma} \tag{6}$$

Plug formula (6) into (2), we can get the optimal price charged by local licensee and maximized profit

[5] Antràs and Helpman (2006) studies the effects of changes in the quality of contracting institutions on the relative prevalence of integration and outsourcing.

[6] In existing literature, there are different definations on contractual institution. Antràs and Helpman (2006) regards it as the fraction of contractible produciong activities, Markusen (2001)[23] measure the contract enforcement as the scale of a penalty that the defecting party must pay.

[7] Royalties are typically agreed upon as a percentage of gross or net revenues derived from the use of intellectual property or a fixed price per unit sold of an item of such. None of these measures can completely remove local partner's opportunism behavior.

of him:

$$p^* = \frac{(1+\gamma\theta)c}{\alpha(1-\beta h)} \tag{7}$$

$$\Pi_S^* = (1-\alpha)(1-\beta h)\frac{A}{\theta}\left(\frac{(1+\gamma\theta)c}{\alpha(1-\beta h)}\right)^{1-\sigma} - C_f \tag{8}$$

Firm J's profit under license $\Pi_{J,L} = \beta h R$ is then

$$\Pi_{J,L}^* = \beta h\frac{A}{\theta}\left(\frac{(1+\gamma\theta)c}{\alpha(1-\beta h)}\right)^{1-\sigma} \tag{9}$$

Formula (6) to (9) shows that strengthening of local contracting institution (the decline of hidden fraction $(1-h)$) will make the local producer supply less in order to maximize his own profit. But is effect on firm J's profit is not clear. On the one hand, it raise the fraction the MNE get from unit output, on the other hand, it reduces the volume the licensee produces. the final result is determined by the net effect of these two aspects.

2.3.2 Direct Investment

Instead of entering the foreign market by licensing, firm J can invest directly in host country and serve local market directly. Generally, MNE can either establish a joint venture with local partner or establish a wholly owned enterprise. The controlling power of MNEs differs across these entering modes. An MNE has full control on solely owned foreign subsidiary but have least control in licensing, while joint venture is of compromising control. In this paper, only the extreme cases, i.e., licensing and solely owned foreign subsidiary (FDI hereinafter) are discussed. When an MNE enter host market by direct investment, it can be seen as he "buys" a local partner in host country. As shown in Grossman and Hart (1986)[12] and Hart and Moore (1990)[14], integration does not eliminate the opportunistic behavior of the local partner. For the sake of simplicity, it is assumed that the subsidiary can only produce a fraction $\delta \in (0,1)$ of the amount of $q(j)$ produced in the case that the local partner fully cooperates. The MNE determines it's optimal investment to maximize his profit $E(\Pi_{J,V}) = \beta_D R - [c_f + (1+\gamma\theta)\, q(j)c]$, where $\beta_D = \delta^\alpha + \beta(1-\delta^\alpha) > \beta$. The optimal price charged by the MNE and his optimal supply are

$$p_{J,D}^* = \frac{(1+\gamma\theta)\, c}{\alpha\beta_D} \tag{10}$$

$$q_{J,D}^* = \frac{A}{\theta}\left(\frac{(1+\gamma\theta)\, c}{\alpha\beta_D}\right)^{-\sigma} \tag{11}$$

respectively. Firm J's profit under FDI $\Pi_{J,D} = \beta_D R - (1+\gamma\theta)qc$ is then

$$\Pi_{J,D}^* = (1-\alpha)\beta_D\frac{A}{\theta}\left(\frac{(1+\gamma\theta)c}{\alpha\beta_D}\right)^{1-\sigma} - C_f \tag{12}$$

3 IPR Protection and Imitation

Ethier and Markusen (1996)[9] and Markusen (2001)[24] document a highly simple two-period model in which the MNE wishes exploit a technology in a foreign market by licensing a local partner or by setting up a subsidiary. The licensee masters the technology in the first period and can defect to start a rival firm in the second period. The MNE can also defect to license a third partner. But the imitator of know-hows and patents may be different, because know-hows are technological secrets, commonly one can not know it before entering a licensing agreement with the inventor, a patent is a set of exclusive rights granted by a sovereign state to an inventor or their assignee for a limited period of time, in exchange for the public disclosure of the invention. One can get to know how to manufacture using a patented technology, but not being permitted to do so before licensed by the owner of the patent. So an potential imitator of patents may be the licensee or a third person. In this paper, I will focus on the case of a third person, i.e., the potential imitator sets up a rival firm.

The way that IPR protection affect MNE's operation is that strenghening of IPR protection decrease imitation in host country. In Grossman and Helpman (1991)[10], imitation is taken as a costly activity[8]. Mansfield, *et al.* (1981)[21] shows that in a sample of firms in four industries, average imitation costs totaled some 65 percent of innovation costs and imitation time equaled about 70 percent of innovation time (see also Maskus (2000)[25]). Branstetter *et al.* (2007)[3], following Grossman and Helpman (1991), has the same assumption. In reality, imitation is not only costly, but also is related to industrial characteristics. Maskus (2000)[25] points out that imitation cost is not symmetric across industries. Patent protection is seen more critical for inventions in pharmaceuticals, agricultural and industrial chemicals and biotechnology, because these industries embody high costs of R&D but imitation costs are very low, competitors can easily determine the molecular composition of pharmaceutical compounds or the genetic makeup of biotechnological inventions. In this study, imitation cost is assumed to be endogenously determined by complexity, *i.e.*, it is a fraction of original *complexity specific cost*, and the fraction varies across industries.

3.1 Complexity Ceiling of Imitation

Assuming that there is a potential imitator in host country when firm J enters the South market either by means of licensing or direct investment. The imitation cost is in the same form of *complexity specific cost*, but is much lower, namely a $\eta_1(j) \in (0, 1]$ fraction of it and $\eta_1(j)$ reflects the difficulty of imitation[9]. Unlike Grossman and Helpman (1991)[11] and Branstetter *et al.*,[3], in which imitation cost is endogenously determined by capital accumulation and quantity produced in host country (in order to analyze knowledge spillovers for the South), imitation cost here is assumed to be endogenously determined by complexity.

[8] Helpman (1993) noted that "...imitation is an economic activity much the same as innovation; it requires resources and it responds to economic incentives...".

[9] The variety index j will be omitted hereinafter.

Not all imitation activity is profitable, the imitator responds to IPR protection judicature in host country. Two fundamental dimension of this judicature is *probability of punishment* and the *scale of penalty*. More precisely, assuming that the imitator will be punished for infringement at the probability of $\epsilon \in (0, 1]$. If $\epsilon = 1$, any infringement will be punished. When the imitator is punished, he will be charged a penalty of $\phi q(j)c$, *i.e.* a fraction of his variable cost. So $\Phi = \epsilon\phi$ can be regarded as a parameter of IPR protection intensity, higher Φ means stronger IPR protection. All penalties are assumed to be paid to the court, so they can not be taken as potential income for an MNE[10].

Total cost and profit function of an imitator I is then $TC_I = C_f + (1 + \eta_1(j)\gamma\theta + \Phi)\, qc$ and $\Pi_I = R - [C_f + (1 + \eta_1\gamma\theta + \Phi)\, qc]$. Resolving the imitator's optimizing problem, we can get the imitator's optimal price and optimal supply

$$p_I^* = \frac{(1 + \eta_1\gamma\theta + \Phi)\, c}{\alpha} \tag{13}$$

$$q_I^* = \frac{A}{\theta}\left(\frac{(1 + \eta_1\gamma\theta + \Phi)\, c}{\alpha}\right)^{-\sigma} \tag{14}$$

respectively. Note that $-\sigma = -\frac{1}{1-\alpha} < 0$, so the optimized supply of imitator declines in the IPR protection index Φ.

Proposition 1. *Strengthening of IPR protection and increasing of complexity will decrease imitator's expected profit and inhibit imitaton in host country.*

Proof. Plug the imitator's optimal price and optimal supply into his profit function, we can get the imitator's expected pofit

$$E(\Pi_I^*) = \frac{(1-\alpha)A}{\theta}\left(\frac{(1 + \Phi + \eta_1\gamma\theta)\, c}{\alpha}\right)^{1-\sigma} - c_f \tag{15}$$

Make derivation to formula (16) yields:

$$\frac{\partial E(\Pi_I^*)}{\partial \Phi} = -A\left(\frac{(1 + \Phi + \eta_1\gamma\theta)\, c}{\alpha}\right)^{-\sigma}$$

and

$$\frac{\partial E(\Pi_I^*)}{\partial \theta} = -A\frac{\eta_1\gamma\theta\left(\frac{(1+\Phi+\eta_1\gamma\theta)c}{\alpha}\right)^{-\sigma} + \sigma^{-1}\left(\frac{(1+\Phi+\eta_1\gamma\theta)c}{\alpha}\right)^{1-\sigma}}{\theta^2}$$

Note that $\left(\frac{(1+\Phi+\eta_1\gamma\theta)c}{\alpha}\right) > 0$, so $\frac{\partial \Pi_I^*}{\partial \Phi} < 0$ and $\frac{\partial E(\Pi_I^*)}{\partial \theta} < 0$, $E(\Pi_I)$ declines in the IPR protection index Φ and complexity index θ, showing that strengthening of IPR protection and increasing of complexity will decrease imitator's expected profit. □

Proposition 2. *(Complexity Ceiling Effect) There exists a unique complexity threshold $\bar{\theta}$ above which,*

[10]In practice of IPR judicature, the complaint party may ask for penalties for compensation, but potential penalty income can hardly treated as (a part of) determination(s) for an MNE's entering stratagy.

a variety will not be imitated in the South. This threshold decreases as (1) host IPR protection being strengthened; and/or (2) the imitating difficulty (η_1) arising.

Proof. The condition of an imitator in host country enters the market is non-zero profit. Formula (12) implies that the imitation condition is

$$\bar{\theta} = \frac{\alpha c^{-1} \left(A^{-1}\sigma c_f\right)^{\frac{1}{1-\sigma}} - \Phi - 1}{\eta_1 \gamma} \tag{16}$$

This implies not only the unique complexity threshold exists, but also it decrease in IPR protection index Φ and imitation difficulty index η_1. so as the IPR protection is strengthen, only those less complex goods will be imitated in the South. □

When there are large number of varieties, the common price index P will not be affected by a single imitator's pricing strategy, the demand the firm J facing is then not affected by it (noting that $q(j) = \frac{Ep(j)^{-\sigma}}{\theta(j)P^{1-\sigma}} = Ap(j)^{1-\sigma}$, A is constant in case of large number of varieties). **Proposition 1.** and **Proposition 2.** indicate that given IPR protection index in host country, varieties of which complexity are above $\bar{\theta}$ will not be imitated, as Figure 3 shows.

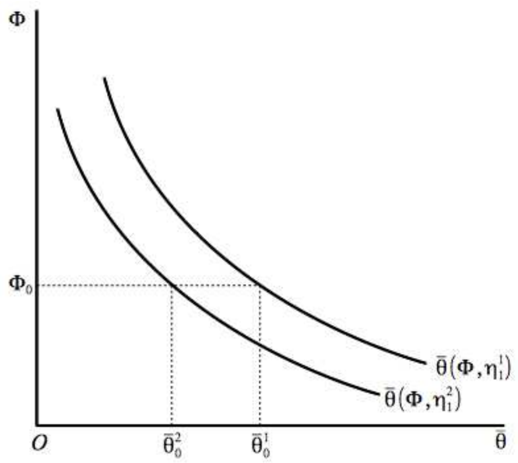

Figure 3: IPR Protection and Imitation Complexity Ceiling

Figure 3 also shows that when host IPR protection strengthened, this complexity threshold will be smaller, so that the number of varieties threatened by imitation will be smaller. This will encourage more MNEs allocate high complex production into host country. As the industry-vary imitating difficulty has impact on imitating cost, given IPR protection level, in industries with different imitating difficulty, the thresholds are also varies. Assuming that there are two industries, 1 and 2, and $\eta_1^1 < \eta_1^2$ (which means that imitating cost is higher in industry 1 than that in industry 2). Figure 3 shows that the threshold of industry 2 is lower that industry 1.

Obviously, given host IPR protection level, relative to those of lower complexity and lower imitation cost, varieties of higher complexity and higher imitation cost are unlikely to be imitated. What's more, stronger IPR protection can be seen as complement to low complexity and/or low imitation cost. As discussed by Maskus (2000), industries like pharmaceuticals, agricultural and industrial chemicals and biotechnology embody high costs of R&D, but competitors can easily get to know the molecular composition of pharmaceutical compounds or the genetic makeup of biotechnological inventions. So firms of these industries are very sensitive to host IPR protection when investing there. Strengthening of IPR protections can reduce the number of potential imitators, and make the host country more attractive to MNEs.

3.2 Impact of Competiveness

As mentioned above, the number of varieties, or competitiveness, matters. Given *large* amount of variaties, imitation has little effect on MNE's profit. In a more generalized case, considering a relatively *small* amount of variaties, in which imitation has impact on the MNE's profit by affecting the common price index P.

To intuitively illustrate the impact of competiveness on price index, I assume that there are very small difference among firms' productivity, and firms are descending arranged by productivity from 0 to n. So the prices charged by these firms are ascending arranged in (0,1). Price charged by the imitator is then assumed to be slightly lower than the firm which has the least productivity but is slightly higher than the firm which has the second least productivity. Now, it is easy to understand that the entrance of imitator (i) will crowd out the firm which has the lowest productivity. Let P the price index without imitation and P_i the price index with imitation. The differece betwenn P_i and P is

$$\Delta P = P_i - P = \left[\int_0^{n-1} \theta^{-1} p(j)^{1-\sigma} dj + \theta^{-1} p(i)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} - \left[\int_0^{n} \theta^{-1} p(j)^{1-\sigma} dj\right]^{\frac{1}{1-\sigma}} \tag{17}$$

As the price charged by the imitator is much lower, $p(i) < p(n)$, it is intuitive that P_i is lower that P. The entrance of imitator lower the common price index. Note that the MNE's profit either in case of licensing or FDI decreases in P (see formula (12) and (15)), **so the entrance of local imitator makes the MNE worse off**. As shown in formula (9), local imitator will charge higher price when IPR protection strengthened, so strengthening of IPR protection increase MNE's profit.

Proposition 3. *In the case of small number of variety, strengthening of IPR protection makes the MNE better-off in general, but MNEs producing medium complexity variety benefit most.*

Proof. Plug $A = \frac{E}{\theta P^{1-\sigma}}$ into MNE's profit equation under license (formula (9)), we can get

$$\Pi^*_{J,L} = \frac{Eh\beta}{\theta^2 P^{1-\sigma}} \left(\frac{(1+\gamma\theta)c}{\alpha(1-\beta h)}\right)^{1-\sigma} \tag{18}$$

Formula (9) shows that the MNE's profit is strictly decreasing in common price index P. Formula (18) implies that the entrance of an imitator induces lower P, so strengthening of IPR protection will make MNEs better-off by remove threat of imitation or lower price charged by potential imitator.

Figure 4 demonstrates the patterns of effect of IPR protection on MNE's profit. At beginning, IPR protection index of host country is Φ_0 and the complexity threshold of imitation is then $\bar{\theta}_0$. MNEs with complexity arranging from 0 to $\bar{\theta}_0$ are threatened by imitation, but those with complexity above $\bar{\theta}_0$ have enough immunity from imitation.

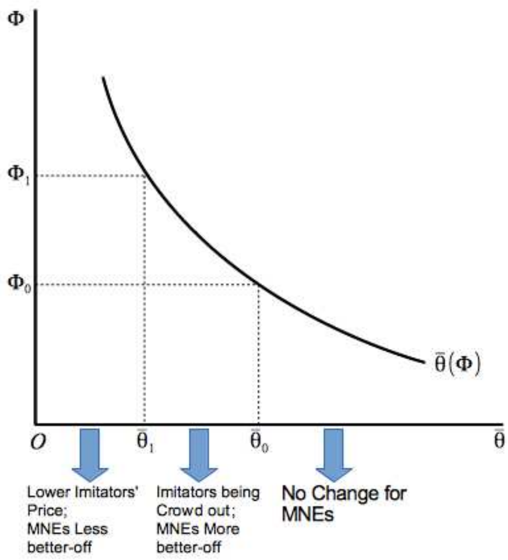

Figure 4: Effect of IPR Protection on MNE's Profit

As IPR protection strengthened, i.e., $\Phi_0 \to \Phi_1$, the complexity threshold of imitation goes down to $\bar{\theta}_1$. MNEs with complexity above $\bar{\theta}_0$ still have immunity from imitation. There is no change for these MNEs. MNEs with complexity arranging from $\bar{\theta}_1$ to $\bar{\theta}_0$ will be better-off since the imitators have been removed by strengthened IPR protection. MNEs with complexity arranging from 0 to $\bar{\theta}_1$ will be better-off as well, but not so notable as those arranging $\bar{\theta}_1$ to $\bar{\theta}_0$. Because, imitation is till possible, in spite of lower prices charged by imitators and a higher common price index P. $\square$

3.3 Cost-Oriented FDI and Processing Trade

Instead of entering the host country for access local market (market-oriented FDI), some multinational firms enter host country to ultralize local abundant labor force and export products to home or third foreign markets. In other words, the produts produced in host country are not designed for local market. Two terms are related to this sort of strategy: export-platform FDI and processing trade. *Export-platform FDI* is generally defined as investment and production in a host country where the output is largely sold in third markets, not the parent or host-country markets. An MNE enter the host country for abundant and low-wage labor, so it is *cost-oriented FDI*. For example, US firms investment in Ireland to serve the integrated EU and Ireland is chosen as the low-cost location, Mexico is also chosen as the low-cost location by EU firms to serve the integrated North American market. Econometric analysis of Hanson *et al.,* (2001)[13] suggests that export platform FDI is promoted by low host-country trade barriers and discouraged by large host-country markets[11]. *Processing trade* refers to the business activity of importing all or part of the raw and auxiliary materials, parts and components, accessories, and packaging materials from abroad in bond, and re-exporting the finished products after processing or assembly by enterprises within the mainland. It includes processing with supplied materials and processing with imported materials.

A common feature of export-platform FDI and processing trade is that the variaty produced in host country are not designed for local market, a host firm who imitates and sells this kind of variaty in the South has to burden extra cost to redesign for local customers. I assume the extra cost have same form with complexity specific cost and denoted by η_2. Consider a single kind of product u which the MNE produces in the South country and exported to the North. The imitator's profit is then

$$E(\hat{\Pi}_I^*) = \frac{(1-\alpha)A}{\theta}\left(\frac{[1+\Phi+(\eta_1+\eta_2)\gamma\theta]c}{\alpha}\right)^{1-\sigma} - c_f \tag{19}$$

and this profit is lower than that of a good designed for host country. In this case, the non-imitating threshold of complex will be lower, *i.e.* $\hat{\theta}(\Phi) < \bar{\theta}(\Phi)$, as shown in **Figure 5**.

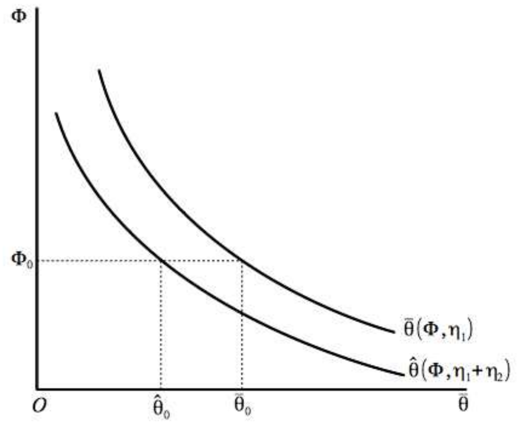

Figure 5: Imitation Ceiling for Cost-oriented Production

And the optimal price charged by the imitator is then

$$\hat{p}_I^* = \frac{[1+(\eta_1+\eta_2)\gamma\theta+\Phi]c}{\alpha} \tag{20}$$

and this price is higher than that of a good designed for host country. This will make the price index P higher, and the MNE's profit will be larger, so given the IPR protection intensity, the MNEs tend to put cost-oriented production to the South than that of market-oriented.

[11]See comprehensive theoretical analysis by Ekholm *et, al.* (2003)[8].

4 Concluding Remarks

As the fragmentation of production grows and MNEs global activities expended, large amount of FDI flowed to emerging markets. BRICs, especially China, are most important host countries. Two features are remarkable. On one hand, IPR protection remains very low in these host countries while existing literature show that IPR protection generally have positive effect on FDI inflow. On the other hand, remarkable fraction of investments exacuted by MNEs in emerging coutries are vertical integration: they are seeking abundent and low-wage labor instead of large local market, and generally operating in low complexity (and also low value-added) production processes. Existing literature has not given convincing theoretical explanation yet.

By inducing complexity into Dixit-Stiglitz (1977)[7] model with a CES production function (in order to allow a simultaneous consideration of effects of IPR protection and industrial characteristics), this paper theoreticly link IPR protection, complexity and MNE's FDI decision on firm-level. Key assumptions in this study are: (1) imitition is a costly activity and imitation costs vary across industries; (2) local imitator burden relatively higher imitation cost when imitating a product only designed for foreign market than the product designed for host market.

The first main conclusion is that strengthening of host IPR protection will make MNEs more willing to invest directly in host country or license his patent to local producer. Stronger IPR protection encourage FDI and licensing in two ways. *First* strengthening IPR protection increases MNE's potential penalty income as a compensation to local licensee's hidden behavior caused by weak contracting institution and outcome loss caused by local partner's opportunism behavior. *Second*, the entrance of imitator lower the common price index, makes the MNE worse off. Local imitator will charge higher price when IPR protection strengthened, so strengthening of IPR protection increase MNE's profit. This effect is stronger when the number of varieties is small.

The second main conclusion is that strengthening of host IPR protection will make MNEs invest in higher complexity sectors or license higher complexity patents to host partners. Imitation cost is assumed a fraction of "complexity specific cost", there is a complexity ceiling for a certain set of varieties. This means that there is a $\bar{\theta}$ above which a variety can not be imitated. This $\bar{\theta}$ declines as IPR protection intensity index Φ increase. So as the host country's IPR protection is strengthened, more imitation threats to high complexity but low imitation cost varieties are eliminated, and more MNEs producing these varieties will enter the host country.

The last conclusion is that cost-oriented FDI (or export-platform FDI) is less sensitive to host IPR protection than market oriented FDI. Varieties the MNE products by cost-oriented FDI are not designed for host market, so local imitator has to burden extra imitation cost to to redesign for local customers, and therefore charge a relatively higher price than varieties originally designed for local market, hurts to MNEs are also smaller. This may be the reason why low IPR protected emerging host countries received larger amount of foreign direct investment that performing processing trade and manufacturing products solely for exporting.

The conclusions above have explicit policy implications for China. China is one of the most largest FDI recipients in last twenty years. But it is frequently criticized that a large fraction of the foreign invested enterprises are performing processing trade or producing only for export. These products are less complexity and low value-added, the spill-over is also scare because the industrial linkage between these firms and local industries are weak. This study shows that enhance IPR protection can encourage market-oriented FDI and induce more MNEs producing high complexity varieties in China.

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