R&D Investment, FDI and Technology-Sourcing Firms

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Abstract: Adopting a micro-level perspective to study the relationships between R&D investment and technology-sourcing FDI is an emerging research field in international economics and development economics. Based on relevant theories, we build a two stage game of technology-sourcing firms in which firms, customers, government participate. Comparing with traditional technology-exploitation FDI, technology-sourcing FDI could achieve better economic efficiency and social welfare under certain conditions. In conclusion, we make policy implication: it is rational for government to foster some firms to conduct technology-sourcing FDI which has a strong effect on domestic economy.

Keywords: technology-sourcing firms, R&D investment, social welfare

I. Introduction

One especially curious characteristic of China's recently new trend is a surge in its outward foreign direct investment (FDI) volume since 2003. This means that China has become a new FDI player in the world. The phenomenon itself may be an eye-catching headline for newspapers and is considered as a sign of stronger economic power---It could be interpreted as Chinese firms' rising status after years of receiving FDI. Some other scholars adopt a conservative perspective on this topic. They view Chinese outward FDI as a high like hood of capital escaping. Besides, more and more scholars are exploring the relationship between outward FDI and its impact on home country. This includes the various dimensions of argument from the home countries. E.g. the relationship between outward FDI and unemployment rate (Skaksen and Sorensen, 2001); the relationship between outward FDI and wage rate (Naylor and Santoni, 2003; Lommerud et al, 2003); downstream-chain enterprises investing overseas and its impact on domestic consumer surplus effect (Leahy and Montagna, 2000); based on the above research, Junichiro Ishida (2008) consider a two stage game including the bargaining power of unions, the duopoly market structure. He demonstrates the domestic products price will rise as the bargaining power of unions and decrease consumer surplus. Thus, outward FDI will be a negative impact on home country.

Based on existing research, we construct a firm level game model with Government's participation, consumer surplus and outward FDI. But there are a few differences from

model with developed countries. First, developing country lacks union's bargaining power compared to developed countries. Second, as a new outward FDI player, it is plausible to classify FDI to study the impact on the domestic economy. In this paper, a two-stage game model starting from the consumer utility function is set to maximize the benefits of government and firms. On the first stage, government decides the best subsidies or related policies efforts. On the second stage, firms decide outward FDI to maximize their profits. The core of this model is to establish two types of FDI in the profit function as two types of FDI have different production costs.

According to this model, we prove that firms are likely to invest more when investment environment is more liberal and government policies are more favorable. This is in line with our common sense. Second, from the long-term perspective view, technology-sourcing FDI is more beneficial to domestic economy given sufficient absorptive capacity and transmission capacity.

II. The Theoretical Frame for Two Types of FDI

According to the existing relevant theory, outward FDI could be divided into two types--Technical Sourcing Foreign Direct Investment (TS-FDI) and technology exploration Foreign Direct Investment (TE-FDI). Traditional foreign investment (TE-FDI) theory emphasizes the company's own core competence as a reason for foreign investment. Enterprises with advanced technology invest abroad to combine product factors such as low-cost raw materials, labor. However, TS-FDI is a non-traditional type of FDI which is difficult to explain by the traditional theory. Firms playing TS-FDI do not have technical advantages compared to counter partners in developed countries. We can hardly find any evidence that TS-FDI players trying to seek low cost resources, instead, they are sourcing kind of technology. Foreign Direct Investment in developing countries can be traced to 1980, and many scholars attribute this to the fast development of information networks. Firms see outward FDI as a strategy to obtain investment technology spillovers, production innovation and a way to improve their own competitiveness.

Empirical studies find evidence on motives of TS-FDI. For example, James H. love constructs an index of RAT to identify a potential industry that is likely to perform TS-FDI. If RAT index is less than 1 in home and more than 1 outside,

we infer the industry is relatively weak in terms of R & D activity. Playing TS-FDI is likely to happen in such situation. While if domestic RAT is more than 1 and foreign RAT is less than 1, then we support this type as traditional FDI motives. To further determine the type of FDI in a sector, we use a quantitative model developed by Japanese scholars Kogut:

$$FDI = b_0 + b_1 (R \& DSUM) + b_1 (R \& DDIF) + b_2 (TAR) + U$$

where $R \& DSUM$ refers to sum of R&D implied by RAT index and $R \& DDIF$ refers to the difference of that. TS-FDI is likely to happen when estimation results find the coefficients of the two variables are positive.

As motive of TS-FDI is to seek advanced technology overseas to improve production efficiency, empirical research began to test the actual effect of conducting such type of FDI. The main measurement of technology spillovers is total factor productivity (TFP). Through empirical study, some scholars (Jaffe, trajtenberg, henderson, 1993; keller, 2002; hompson, fox-kean, 2005) confirm outward FDI access to technology. They find firms are beneficial to technology spillovers while become an outward FDI player. However, using company panel data, Braconier (2001) find no evidence of technical spillover effect or innovation improvements through such FDI.

Empirical results find conflicting conclusions in terms of technology spillovers of TS-FDI. Kokko et al (1996) believe that absorptive capacity of the enterprises themselves plays a key role in TS-FDI. If technology gap is too big to absorb the technology spillovers for TS-FDI firms, they may eventually push out of the market. Borenszten (1998) find such threshold effect –firms need to hold a sufficient absorptive capacity to acquire technology spillovers. In addition to the absorptive capacity, chances are that there is a lag effect of technology spillover. In the short term, technology spillovers have not yet been revealed. Considering the stage of china TS-FDI and availability of data, we discuss TS-FDI compared to TE-FDI in terms of its impact on economy.

This paper assumes that from long term perspective, TS-FDI firms acquire the technology spillovers and its total factor productivity is increasing, thus decreasing unit cost and further expanding production. The main reason is that taking long-term factors into account, rational government will give t subsidies o potential business with high absorptive capacity to acquire such technology spillovers.

Turning to TE-FDI, it is a traditional FDI performed by firms with advantages in technology. Its players search lower cost of factors such as wage rate and raw materials to expand production. So TE-FDI also reduces the marginal cost of production. As a result, the two types of FDI could reduce the marginal cost. TE-FDI technology spillovers are obtained through its R & D activities, organizational innovation, and production innovation. These technology spillovers can be passed to its established domestic firms so that firms around the world can reduce the marginal cost.

However, firms performing TE-FDI can only reduce its marginal cost in branch because of it cheaper labor cost and raw materials. Due to high transportation cost, these factors can not easily be transported to domestic firms. In this way, two types of FDI will generate two different types of profit function.

Second, we consider the role of government in the model. A major role of government is to maximize social welfare. The Government will choose a policy to support firms to expand global markets and enhance firms' competitiveness. That is to say, the state can either support the TS-FDI or TE-FDI firms.

Finally, we have to consider investment environment. From the general understanding, the more relaxed environment for investment, the higher of FDI volume. But this is only our common sense without presumption. Our model will test such inference.

Ⅲ. Two-Stage Game Model of FDI

On demand side, we assume that each state makes A and B products, A Company makes A produces and B Company makes B produces, individual consumer utility can be written as:

$$U_i = a q_{AH} + a q_{BH} - \left(\frac{q_{AH}^2}{2} - \frac{q_{BH}^2}{2} + k * q_{AH} q_{BH} \right)$$

（1）

q_{AH} is representative of consumption made in home country.

q_B refers to consumption of product B. equation (1) is a standard utility function where k refers to the degree of difference of the two products. K ranges from 0 to 1. On extreme condition, k is equal to 0 which means two total different products. Therefore, the consumer utility function could be simplified as:

$$U_i = a q_{AH} + a q_{BH} - \left(\frac{q_{AH}^2}{2} - \frac{q_{BH}^2}{2} \right)$$

We can infer consumer surplus:

$$cs = u_i - p_{AH} q_{AH} - p_{BH} q_{BH} = \frac{1}{2} \left(q_{AH}^2 + q_{BH}^2 \right)$$

According to rational principles of consumer choice, maximizing consumer surplus means $\frac{\partial cs}{\partial q_{AH}} = \frac{\partial cs}{\partial q_{BH}} = 0$.

Then, consumers' demand function can be written as:

$$P_{AH} = a - q_{AH}$$

Similarly, foreign demand function can be written as:

$$P_{AF} = a - q_{AF}$$

Supply side

We must consider the costs of foreign investment including cost caused by management in different cultures. Assume such cost equals to t and is an exogenous variable. We use t to measure the investment environment.

Second, we consider different effects on production efficiency when conduct TS-FDI and TE-FDI. As above analysis, we know that the two types of FDI generate different production functions. Profits function of TS-FDI can be written as:

$$\pi = \left[p_{AH} - (c - x) \right] q_{AH} + \left[p_{AF} - (c - x) - t \right] q_{AF} - x^2 - f \quad (2)$$

Where s refers to subsides, and Profits function of TE-FDI can be written as:

$$\pi = \left(p_{AH} - c \right) q_{AH} + \left[p_{AF} - (c - x) - t \right] q_{AF} - x^2 - f + sx \quad (3)$$

We use x as marginal cost reduced by FDI and f stands for the fixed cost of running a firm and the welfare will be:

$$W_i = cs + \pi - sx \quad (4)$$

And consumer surplus will be:

$$cs = u_i - p_{AH} q_{AH} - p_{BH} q_{BH} = \frac{1}{2} \left(q_{AH}^2 + q_{BH}^2 \right) \quad (5)$$

First, we discuss TS-FDI firms. In line with profit maximization principle $\frac{\partial \pi}{\partial q_{AH}} = \frac{\partial \pi}{\partial q_{AF}} = 0$, we can see the optimal output in home country and abroad will be:

$$q_{AH} = \frac{a - (c - x)}{2} \quad ; \quad q_{AF} = \frac{a - t - (c - x)}{2} \quad (6)$$

When $\frac{\partial \pi}{\partial x} = 0$, combine (2):

$$x = \frac{q_{AH} + q_{AF} + s}{2} \quad (7)$$

combine （6） and （7）:

$$q_{AH} = (a - c) + \frac{s}{2} - \frac{t}{4} \quad ; \quad q_{AF} = (a - c) + \frac{s}{2} - \frac{3t}{4} \quad (8)$$

$$x = (a - c) + s - \frac{t}{2} \quad ;$$

$$FDI = \left[(a - c) + s - \frac{t}{2} \right]^2 + f \quad (9)$$

Proposition 1: loose investment environment induce more TS-FDI volume.

From (8) and (9), we find that enterprises will invest less when foreign policy on FDI is not friend, which is consistent with our common sense.

Proposition 2: the production volume is reduced as TS-FDI firms facing a tight police abroad.

To our surprise, the domestic production is negative with t. Reasonable explanation is that marginal cost is rising due to low level R & D and less technology spillovers.

(8), (9) are the result of the second stage game. Through backward induction, how will government decide the ideal subsidies to support domestic firms play TS-FDI? According to formula (4), we know that maximizing the national welfare needs to meet:

$$\frac{\partial W}{\partial s} = \frac{\partial \pi - sx + cs}{\partial s} = 0$$

The national government and relevant organization have adopted policies and measures to encourage firms conducting FDI. For example, the Canadian Trade Commissioner Service (Canadian Trade Commissioner Service) and Japan External Trade Organization (JETRO) provide sound information to support the external expansion of firms. SOFI from Switzerland, founded in 1997, provides a range of services to facilitate foreign investment enterprises in foreign country. Some countries such as Singapore, Korea, and Mexico establish "comfort zone" ("comfort zones") for foreign investment. So we can see:

$$\frac{\partial cs}{\partial s} = \frac{q_{AH}}{2} > 0 \quad (11)$$

Combine （10）, （11）, （6）, （7）, （8）, （9）:

$$s^e = \frac{4(a - c) - t}{6} \quad (12)$$

combine （8） and （9）:

$$q_{AH}^e = \frac{4(a - c) - t}{3} \quad ; \quad q_{AF}^e = \frac{8(a - c) - 5t}{6} \quad ; \quad (13)$$

$$x^e = \frac{5(a-c)-2t}{3} \quad ;$$

$$FDI^e = (x^e)^2 + f = \left(\frac{5(a-c)-2t}{3}\right)^2 + f$$

（１４）

The profit wills be :

$$\pi^e = \frac{2(a-c)[34(a-c)-29t]+17t^2}{36} - f$$

（１５）

Thus, we can see that the rational Government could support TS-FDI. Similarly, we can infer TE-FDI:

$$q_{AH} = \frac{a-c}{2} \quad ; \quad q_{AF} = \frac{a-c-t+x}{2} \quad ; \quad x = \frac{q_{AF}+s}{2}$$

（１６）

$$s^e = \frac{2(a-c-t)}{5} \quad ;$$

（１７）

$$q^e_{AH} = \frac{a-c}{2} \quad ; \quad q^e_{AF} = \frac{4(a-c-t)}{5} \quad ;$$

（１８）

$$x^e = \frac{3(a-c-t)}{5} \quad ; \quad FDI^e = \left[\frac{3(a-c-t)}{5}\right]^2 + f$$

（１９）

$$\pi^e = \frac{(a-c)^2}{4} + \frac{7(a-c-t)^2}{25} - f$$

（２０）

In order to compare two types of FDI, we will do subtraction: (12) - (17); (13) - (18); (14) - (19); (15) - (20). It is evident that TE-FDI firms have more profits and national welfare as well as more production. Thus, rational government gives more subsidies to support TS-FDI.

Ⅳ. Conclusions and Policy Suggestions

In this paper, we construct a two-stage game model based on Maximization of country's welfare and firm's profit. Comparing TS-FDI with TE-FDI, we are able to find TS-FDI is more beneficial to economic efficiency and social welfare. Our conclusion is that TS-FDI outweighs TE-FDI in terms of social welfare and economic efficiency given sufficient international technology spillovers. Rational government needs to support TS-FDI firms.

However, this conclusion is based on three important conditions. First, we assume that firms conducting TS-FDI have sufficient absorption capacity to acquire technology spillovers in the international market. Unfortunately, if firms do not demonstrate certain absorption capacity to acquire the technology spillovers, subsides will be wasteful. Second, we discuss the above topic from a long term perspective view and assume no lag effect of such technology spillovers. Third, actually, firms could send their flags over the world. Technology spillovers acquired by one branch can be transferred to another. Thus, global R & D activities induce a greater economic effect of TS-FDI. However, if there are inter-firm barriers to such technology transfer, firms conducting TS-FDI will not better off.

Turning to TE-FDI, in short term, it may be a better way than TS-FDI to generate profits due to cheap raw materials and wages. Therefore, we suggest the government consider the long term effect of TS-FDI and short term effect of TE-FDI. The strategic TS-FDI firms with sufficient absorption capability are entitled to have more favorable polices.

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