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China's Outward Foreign Direct Investment:

A Country-level Empirical Analysis of OECD Country Determinants between 2003 and 2010

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Abstract

This thesis combines the gravity model with Dunning's four motivations and three control variables for Chinese outward Foreign Direct Investment (OFDI), and provides an empirical country level analysis on the determinants of Chinese OFDI in 34 OECD countries from 2003 to 2010. I find that resource-seeking motivation is a determinant of Chinese OFDI; the market-seeking motive is shown insignificant influence on Chinese OFDI; the strategic asset-seeking motivation of Chinese OFDI is not supported due to its unexpected negative sign. Moreover, the efficiency seeking motivation was not considered in previous studies due to low labor cost in China. In this thesis, by using real labor cost as a proxy, I prove that Chinese OFDI is not driven by efficiency seeking motive.

Key word: Chinese OFDI, OECD countries, China, gravity.

1. Introduction

Capital and investment movements are a basic aspect of globalization, foreign direct investment (FDI) is the most important category of capital and investment movements in the global economic activities (IMF, 2000).[1] Multinational enterprises (MNEs) are key players in globalised economies, and usually they take activities in more than one country (Barba Navaretti and Venables, 2004).

Global outward FDI (OFDI) fluctuated during the year 2003 to 2010, but Chinese OFDI saw a rapid growth from $2.85 billion (US) to $68.81 billion in the same period. China occupies 5.2 percent of the global OFDI flows and ranks 5th in the world in the year 2010 according to "2010 Statistical Bulletin of China's Outward Foreign Direct Investment". Chinese OFDI has reached commercially and geoeconomically significant levels and begun to challenge international investment norms and affect international relations (Rosen and Hanemann, 2009).

Chinese multinational enterprises (MNEs) could be pursuing multiple objectives by undertaking a FDI project. For example, in order to acquire and secure a continual supply of iron resources, China National Metal and Minerals Import & Export Corporation invests $180 million (US) in the Channar Mine in Australia (Deng, 2004). Haier Group Corporation sets up its manufacturing facilities in USA for the purpose of preserving its exports to the US market (Deng, 2004). To obtain advanced technology, Chery automobile does a series of technical cooperation with European firms (Zhang and Filippov, 2009).[2][3] On the one hand, Chinese MNEs provide fresh capital to host (receiving) countries and transfer the technologies for the development of home (sending) countries. On the other hand, political and financial support from Chinese state behind stated owned enterprises' OFDI, and there is an interaction

[1] IMF is the abbreviation for "International Monetary Fund"
[2] Haier group is a Chinese multinational consumer electronic and home appliances company of Qingdao in Shandong province. Haier brand had the world's largest market in white goods in 2011.
[3] Chery Automobile Co., Ltd is an Chinese automobile manufacturing company of Wuhu in Anhui province.

between policy and MNEs' activities (Barba Navaretti and Venables, 2004; Amighini, Rabellotti and Sanfilippo, 2011).

Dunnings's OLI framework is an attempt to explain why MNEs invest abroad: a firm occupies ownership, location or international advantages. These theories are concluded from empirical findings of North countries (such as US, UK and Japan), because these countries had large share of FDI in the world economy from 1960's to 1980's. As the time goes by, the reality is changing little by little. For example, Fosfuri and Motta (1999) argue that firms invest abroad may not rely on OLI advantages in the presence of spillover effect. Hennart (2012) finds that OLI model has problems to explain emerging MNEs' activities.

Dunning's four motivations (market-seeking, resource-seeking, efficiency-seeking and strategic asset-seeking) that derived from location advantages for FDI are popularly used in previous empirical studies on the determinants of Chinese OFDI (Buckley, et al., 2007; Cheung and Qian, 2009; Kolstad and Wiig, 2010; Zhang and Kevin, 2011; Amighini, Rabellotti and Sanfilippo, 2011). Some economists have already found the determinants of Chinese OFDI, for example, Buckley, et al. (2007) find market-seeking motivation is a determinant of Chinese OFDI. Amighini, Rabellotti and Sanfilippo (2011) show the strategic asset-seeking motive drives Chinese OFDI both in manufacturing and service sectors.

In this thesis, I combine the gravity model with four crucial (Dunning) motivations and three control variables for Chinese OFDI, and employ panel data including 34 OECD countries from 2003 to 2010 to do my empirical research on the host country determinants of Chinese OFDI. In contrast to previous studies on OECD countries, firstly, I find that resource-seeking motive drives Chinese OFDI, this result is in the opposite side of the studies by Buckley, et al. (2007) and Kolstad and wiig (2010). Secondly, the market-seeking motivation is found insignificant on Chinese OFDI; the similar result is also shown in the study by Buckley, et al. (2007). Thirdly, by using

the ratio of R&D expenditure to host countries' GDP as a proxy, I find a significant but unexpected negative effect of strategic asset seeking motivation, so the strategic asset seeking motivation of Chinese OFDI is not supported. Buckley, et al. (2007) show that strategic asset-seeking motive does not determine Chinese OFDI by using total patent registrations in host countries. Furthermore, previous economists (Buckley, et al., 2007; Kolstad and wiig, 2010; Amighini, Rabellotti and Sanfilippo, 2011) thought that there was no efficiency-seeking motive behind Chinese OFDI due to low labor cost in China. In this thesis, I use real unit labor cost as a proxy for efficiency-seeking motivation, and the variable receives a positive and insignificant coefficient, it proves that efficiency-seeking motivation is not a determinant of Chinese OFDI.

The thesis is designed as follows. Section 2 gives a brief description of heading theories that address on FDI, section 3 reviews previous empirical studies on Chinese OFDI, section 4 introduces the methodology and data issues, section 5 reports the econometric results, section 6 concludes my finding and further studies.

2. Theoretical background

A multinational enterprise (MNE) is an enterprise that engages in foreign direct investment (FDI) and owns or controls value-added activities in more than one country (Dunning and Lundan, 2008). In host countries, the entry of MNEs may change the average performance and behavior of local economies. Undertaking the Greenfield FDI, local economies benefit a lot. MNES are in general larger and more efficient than local firms, MNEs bring technologies, brands, and management skill and so on that is not available locally, and local firms will benefit from the spillover effect. MNEs pay higher wages and employ more skilled persons, they bring unemployed resources into use. However, Merger and acquisition (M&A) FDI transfers existing assets such as technologies and resources from local firms to MNEs, then it provide no long term benefits to local economies (Barba Navaretti and

Venables, 2004).

From home country perspective, it is on average good for the home activities as MNEs absorb foreign technologies from their foreign subsidiaries. But it will weaken domestic economies if invest in cheap labor countries, because of foreign outputs and employments do not substitute even against domestic ones (Barba Navaretti and Venables, 2004).

In the policy area, MNEs interact with policies. On the one hand, a range of policies provide the economic circumstance for MNEs such as taxation, trade policies, competition regulations, incentives for investments and so on. On the other hand, the economic integration and MNEs activities take changes on policy formation. (Barba Navaretti and Venables, 2004)

Why would a firm like to invest abroad? Dunning's Eclectic or OLI Paradigm (1981) show three main categories of advantages that encourage a firm to do the foreign investments: (1) A firm occupies the ownership specific advantages (O) such as the intangible asset advantages, including production technology, entrepreneurial skills and so on, these competitive advantages are assumed to increase the wealth-creating capability of the firm. (2) It is called internalization advantages (I) when firms are interested in adding value to their O advantages rather than to sell them, or their right of use. The greater net benefits of internalizing other countries' intermediate product markets, the more FDI will be done. (3) The uneven resources, capabilities and institutions are distributed across countries, these confer the competitive advantages. The more these location advantages (L) exist in a country, the more FDI will be located (Dunning, 1988; Dunning and Lundan, 2008). O and I advantages are firm specific advantages (FSAs), L advantages are country specific advantages (CSAs).

The above theories are based on empirical findings from developed countries and from 1960's to 1980's; recent empirical findings suggest that the reality is not that

simple. Firstly, In the presence of spillover effects, Fosfuri and Motta (1999) argue that the laggard firms are more likely to invest aboard than leading firms in order to acquire CSAs, leading firms may limit their multinationalization in the purpose of preserving its competitive advantages. They conclude that FDI may serve as a source of competitive advantages to firms.

Secondly, the increasing FDI from emerging countries was changing the structure of worldwide FDI in the early 2000's. Emerging and established MNEs have different characteristics, there are some arguments about using OLI model to explain emerging market multinationals (EMMs): (1) EMMs invest aboard are not based on FSAs but on CSAs, thus, the OLI model is ill advised (Rugman, 2009; Lessard and Lucea, 2009). Some Chinese MNEs have this characteristic (Rugman and Li, 2007). (2) The OLI model cannot explain EMMs as some of EMMs do not have FSAs, a special theory should be applied to analyze EMMs (Mathews, 2006). (3) EMMs have different FSAs compared with traditional FSAs by established MNEs (Zeng and Williamson, 2007; Hennart, 2012). Hennart (2012) argue that the assumption for location advantages is flawed, he points out that CSAs sometimes have local owners, and hence it is not freely available to all firms in the same location. The monopoly power in the CSAs enables firms to find their lacked FSAs, and then compete with MNEs.

The special of China

China takes the characteristics of EMMs and some of its special characteristics should be mentioned here: (1) Many Chinese MNEs are state-owned, these firms have available capitals that make them at below market rates leading to capital market imperfection (Buckley et al, 2007). In year 2010, Chinese state-owned enterprises (SOEs) occupy 66.2 percent of the stocks of Chinese OFDI according to "2010 Statistical Bulletin of China's Outward Foreign Direct Investment". Moreover, Morck, Yeung and Zhao (2008) show in their studies, the big four state banks (the bank of

China, industrial and commercial bank of China, China construction bank and Agriculture bank of China) in China were responsible for 75 percent of all commercial loans by the end of 2005, and SOEs accounted for 73 percent of the short-term loans from 2001 to 2004. SOEs can receive these loans because of preferential policies made by government and the banks' lack of competence in evaluating risks.

(2) Institutional factors take effects on Chinese OFDI. Government's role and intervention in China's economy is strong, Chinese OFDI is mostly affected by China's policies. For example, the 'go global' strategy and China's accession to WTO are directly increasing Chinese OFDI (details see section 4.2.1). Some Chinese OFDI decisions are driven by political objectives rather than in pursuit of profit-maximizing strategy (Kolstad and Wiig, 2010). Chinese OFDI in Africa and Southeast Asia are aimed at strengthening the relationships between China and these countries (Deng, 2004). For example, to develop the relationship between China and Africa, China has built over 100 schools, 30 hospitals, 30 anti-malaria centers and 20 agricultural technology demonstration centers for Africa, China has finished US $15 billion of preferential loans to Africa's commitment by the end of 2011 (Xin hua news).

(3) Chinese MNEs may have the Ownership advantages that allow them to operate certain types of activity in foreign countries more effectively than local firms and the MNEs from industrialized country (Buckley et al, 2007). With a population of 1.35 billion and a land area of 9.7 million square kilometers, these conditions qualify Chinese MNEs for some 'ownership advantages' including networking skills and interpersonal experiences.

(4) Chinese MNEs may also produce a different pattern of FDI from developed country MNEs (Buckley, et al., 2007; Amighini, Rabellotti and Sanfilippo, 2011). As Deng (2004) points out, OFDI from industrialized countries' MNEs (e.g., Japan, South Korea) has been driven by 'push' factors, including domestic market limitation,

labor shortage and escalating operating costs. In contrast, OFDI by Chinese MNEs has been determined by 'pull' factors, such as secure supplies of key natural resources, acquire advanced technologies and avoid host country trade barriers.

Though China may have some O advantages that engage Chinese MNEs invest abroad, these advantages are too weak. The imperfect market and institutional factors seem to have deep effects on Chinese OFDI, these facts suggest that use O and I advantages to explain Chinese OFDI are inappropriate. Moreover, the L advantages will show the factors that affect MNEs' choice of FDI, it will reveal the elements that attract Chinese MNEs. As a consequence, use the OLI model to explain Chinese OFDI relying on location advantages.

Based on the aspect of location advantages, Dunning suggests four motivations for FDI (Buckley, et al., 2007): (1) Market seeking FDI. The MNEs invest aboard may intend to protect existing markets, exploit or promote new markets (Dunning and Lundan, 2008).

(2) Resource seeking FDI. MNEs invest abroad to acquire specific resources with a higher quality at a lower real cost than it could be obtained in their home country (Dunning and Lundan, 2008).

(3) Efficiency seeking FDI. The efficiency-seeking FDI try to rationalize the structure of existed resource or market–based investments, then the investing firm can gain a common government on these projects (Dunning and Lundan, 2008). To rationalized specialization of products and processes, the location advantages should rely on host economies' product specialization and concentration, low labor costs and incentives to local production by host governments (Dunning, 1988).

(4) Strategic asset-seeking FDI. It is a subset of resource-seeking FDI (Buckley, et al., 2007). Strategic asset-seeking MNEs are engaging in acquiring the assets of foreign

corporations to sustain or advance their global competitiveness (Dunning and Lundan, 2008).

3. Empirical studies review

Previous studies on the determinants of Chinese OFDI are addressed on different levels: firm, industry and country level. In the case of Dunning's four motivations, the market-seeking and resource-seeking motivations are found as the determinants of Chinese OFDI in the different level of the studies. The efficiency-seeking motive determines Chinese OFDI is only shown in firm level study. The strategic asset-seeking motive drives Chinese OFDI appearing in firm and industry level studies but not in country level study. I will introduce the different level studies separately.

(1) Firm level studies. For example, Liu and Buck (2009) apply case study on two Chinese MNEs: Lenovo and BOE. They show the marketing-seeking motive drives Lenovo investing abroad, it searches new markets in the purpose of receiving further growth.[4][5] They find the two Chinese MNEs trying to seek low labor costs (efficiency-seeking) in other countries. They also show the strategic asset-seeking motive drives BOE's foreign investments, for example, in order to obtain advanced technology, human capital and experience in the worldwide LCD industry, BOE do several strategic alliances with Japanese and Korean firms.

By describing evidence, Deng (2004) show the resource-seeking motive drives some of the Chinese MNEs. For example, to meet China's rapidly growing demand for seafood, China Ocean Fishing Corporation sets up over 50 wholly owned subsidiaries, joint ventures and cooperative subsidiaries in almost 20 countries including US, Iran and West African countries.

[4] Lenovo is the largest personal computers manufacturer in Beijing, China.
[5] BOE Technology Group Co., Ltd is a supplier focusing on technologies, products and solutions in Beijing, China.

(2) An industry level study is done by Amighini, Rabellotti and Sanfilippo (2011); they study Chinese OFDI in 81 host countries and 29 industries from 2003 to 2008. The 81 host countries are divided into three groups: high income, upper-middle income and low and lower-middle income countries. The 29 industries are split into three groups: manufacturing, resource and service sector. Firstly, in high income countries, they find that the market-seeking motive drives Chinese OFDI in the manufacturing sector. Secondly, their results show the resource-seeking motive determines Chinese OFDI in resource intensive sectors. Thirdly, due to the high R&D and human capital endowments in high income countries, the strategic asset-seeking motivation is found as a determinant of Chinese OFDI both in manufacturing and service sectors. Moreover, the efficiency-seeking motivation is not considered in their study.

(3) Previous country level studies only showed market-seeking and resource-seeking motives determine Chinese OFDI in other countries, the efficiency-seeking motive was not addressed and the strategic-asset seeking motive was found insignificant. The details as follows:

Market-seeking motivation

The size of the market (GDP) is a fundamental factor that attracts MNEs' attention, and most FDI inflows seem to go to large markets (Barba Navaretti and Venables, 2004). Buckley, et al. (2007) study on 49 host countries that receipt Chinese OFDI during the time period 1991-2005, they find a positive and significant influence from host countries' GDP. Cheng and Ma (2007) show a positive relationship between host countries' GDP and Chinese OFDI by using panel data of 90 countries from 2003 to 2005. Kolstad and Wiig (2010) find Chinese OFDI is driven by host countries' GDP including 25 OECD countries from 2003 to 2006.

Another proxy for market size is per-capita GDP. It is recognized as an indicator of a

country's standard living, a higher standard living creates more market opportunities (Chakrabati, 2001). Zhang and Kevin (2011) use panel data including 23 host countries from 2003 to 2009, they find a positive and significant effect from host countries' PGDP.

Market growth (GDPG) takes the hypothesis that rapidly growing economies offer more opportunities for producing benefits rather than slowly growing economies (Lim, 1983; Buckley, et al., 2007). As a consequence, more FDI will be invested into the country with higher growth rate. Zhang and Kevin (2011) find host market growth drives Chinese OFDI.

Resource-seeking motivation

Resource-seeking motivation refers to find low factor cost across locations (Barba Navaretti and Venables, 2004; Dunning and Lundan, 2008). China is growing and subsequently needs a lot of primary resources to sustain its development (Cai, 1999). Kolstad and Wiig (2010) find that Chinese OFDI is attracted to the countries with large natural resources and poor institutions. By adding host countries' average wage to the proxy area, Cheung and Qian (2009) show a significant effect of resource-seeking motivation including 31 countries from 1991 to 2005.

Efficiency-seeking motivation

Some scholars argue that the efficiency-seeking FDI would occur when investors seek lower-cost locations for operations, particularly searching for lower-cost labor. Thus, much lower labor cost in host countries will attract more FDI. In the case of China, it's not explicitly considered for Chinese OFDI due to cheap labor (Cai, 1999; Buckley, et al., 2007).

Strategic asset-seeking motivation

Market access and competition, MNEs protect specific advantages in order to sustain or advance its global or regional competitive position by purchasing local firms,

capabilities (R&D, Knowledge, Human capital) or empting market entrance by competitors (Dunning and Lundan, 2008; Barba Navaretti and Venables, 2004). Buckley, et al. (2007) use total annual patent registrations in host country as a proxy for strategic asset-seeking motivation, they find a positive but insignificant relationship between Chinese OFDI and the strategic asset-seeking motivation.

4. Data and Methodology

4.1 Model specification

The basis for my empirical exercise is the gravity model, which is originally used in empirical investigations of determinants of bilateral trade. Tinbergen (1962) is the first economist that transfers the gravity equation to the empirical analysis of bilateral trade, he shows that exports are positively affected by income of the trading countries and are negatively affected by the distance between the countries. The basic theoretical model for trade between country $_i$ and country $_j$ takes the form of:

$$T_{ij} = G\frac{Y_i Y_j}{D_{ij}} \quad (1);$$

Where T_{ij} is the value of exports from country $_i$ to country $_j$; Y_i and Y_j are the national incomes of each country (measured by GDP); D_{ij} is the distance between country $_i$ and country $_j$; G is a constant; $\beta_0, \beta_1, \beta_2, \beta_3$ are the unknown parameters; ε_{ij} is the error term (Deardorff, 1995).

To estimate equation (1), the traditional method is taking logs of its both sides:

$$\ln T_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 D_{ij} + \varepsilon_{ij} \quad (2);$$ (Santos Silva and Tenreyro, 2006).

Some economists try to add the theoretical justifications to the model, for example, Linnemann (1966) adds population (it reflects country size and has negative impact) as a variable to the model. Anderson (1979) derives the gravity equations assuming

product differentiation and Cobb-Douglas preferences.[6][7] Bergstrand (1985) explores the theoretical determination of bilateral trade with price indices and monopolistic competition models, and Helpman (1987) develops the Bergstrand's work by the New Trade Theory.[8][9][10] Deardorff (1995) derives a gravity model from the Heckscher-Ohlin model.[11] Anderson and van Wincoop (2003) account for the endogenous change in price terms, they develop a method that estimates a theoretical gravity equation and calculates the comparative statics of trade frictions with multilateral resistance terms.

There is no similar paper such as Anderson and Van Wincoop (2003) do that provides a tractable model for FDI, but economists try to solve this problem such as Bergstrand and Egger (2007). They introduce the physical capital and suggest a third country to the standard 2*2*2 "knowledge-capital" model; they derive a formal N-country theoretical rationale for estimating gravity equations of bilateral FDI flows and foreign affiliate sales (FAS), in consistent with the estimation on bilateral trade.[12] Kleinert and Toubal (2010) derive a gravity equation from 3 different models for MNEs. Previous empirical studies have already showed gravity model also has power to explain patterns of FDI: Harry and John (1991) test taxes, tariffs and transfer pricing associated with the investments from US multinational corporations by a gravity model. Frankel (1997) uses gravity model to analyze the effect from free trade arrangements (FTA) on FDI. Eichengreen and Tong (2007) employ a gravity model to analyze bilateral FDI flows between 29 source and 63 destination countries over year 1988 to 2003, their results show some FDI flows to China also attracted FDI to other

[6] Product differentiation is a process of differencing a product from another; it is related to a competitive advantage of a product.
[7] Cobb-Douglas preferences: $U(x,y)=x^a y^b$.
[8] Price indices is a weighted average of prices for a given good or service in a given region during a given time, the notable price indices such as Consumer price index, Producer price index and GDP deflator.
[9] Monopolistic competition has 6 characteristics: Product differentiation, Many firms, Free entry and exit in the long run, Independent decision making, Market power, Imperfect information among buyers and sellers.
[10] New trade theory is a colletion of economic models in international trade which focuses on the role of returns to scale and network effects.
[11] Heckscher-Ohlin (H-O) model assume the only difference between countries was the relative abundances of labor and capital.
[12] 2*2*2 model: H-O model contains 2 countries, 2 commodities be produced, 2 relative abundance (labor and capital); this is 2 homogenous factors of production model is called 2*2*2 model.

Asian countries. Cheng and Ma (2010) analyze the size and the composition of Chinese OFDI in 2003 to 2005 by a gravity equation.

In this thesis, my focus is on host determinants, so I decide to only use the gravity variable of host countries' GDP. Then I combine the original gravity model (*OFDI*, *GDP*, *DT*) with Dunning's four motivations (*GDPG*, *RER*, *RULC*, *RDR*) for Chinese OFDI and three control variables (*IR*, *TR*, *OPN*) that may have impacts on Chinese OFDI, and then drive my model:

$$\ln OFDI_{it} = \beta_1 \ln GDPG_{it} + \beta_2 \ln RER_{it} + \beta_3 \ln RULC_{it} + \beta_4 \ln RDR_{it} + \beta_5 \ln GDP_{it} + \beta_6 \ln IR_{it} + \beta_7 \ln TR_{it} + \beta_8 \ln OPN_{it} + \beta_9 \ln DT_{it} + a + \varepsilon_{it};$$

4.2 Data issues

4.2.1 An overview of Chinese OFDI

Global outward foreign direct investment (OFDI) flows reached at $1,323 billion in 2010 (a 11% increase over 2009), which was 39 percent below the 2007 peak; but the OFDI flows from developing and transition economies reached record high of $388 billion in 2010 (a 21% increase over 2009), and their share in global OFDI flows reached 29 percent in 2010 (UNCTAD, 2011).

Chinese OFDI was virtually nonexistent on the eve of the economic reforms beginning in 1978 (Rosen and Hanemann, 2009), it was insignificant during the period 1991 to 2004 and got a dramatic growth from 2005 to 2010 (As shown in figure 1.2). In general, we identify 3 stages to Chinese OFDI: (1) The first stage is from 1982 to 1991. China's threshold to global investment is the 'Open door' policy in late-1970s, many Chinese companies began to explore world market with scarce investment. (2) The second stage is from 1992 to 2000. In the beginning of 1990s, Chinese OFDI reached at 1 billion US dollars and fluctuated from 1 to 4 billion in the late-1990s after Deng Xiaoping's tour in the south of China. (3) The third stage is

from 2001 to the present. And China's accession to World Trade Organization (WTO) accelerated its investment overseas (Zhang and Kevin, 2011). By the year 2010, China's OFDI reached historical high of $68.81 billion、the stock of Chinese OFDI is up to $317.21 billion、about 13000 Chinese enterprises have invested abroad and the investments distributed in 178 countries (statistical data from Ministry of Commerce of the People's Republic of China). Figure 4.1 shows the top 20 home economies of Global OFDI flows in 2009 and 2010,

Where do the most of Chinese OFDI go? By the year 2010, Asia and Latin America are the most concentrated areas that store Chinese OFDI; Table 4.2 gives the distribution of Chinese OFDI stock in every areas of the world. By the year 2010, Chinese OFDI has distributed in 178 countries, accounting for 72.7 percent of the total global nations, but Chinese OFDI stocks in developed countries only occupies 9.4 percent of the total stocks, and Table 4.3 shows the stock of Chinese OFDI in main developed countries. By the year 2010, Chinese OFDI has covered all sectors of national economy, Table 4.4 reports the sectoral distribution of the stock of Chinese OFDI in 15 industries, we can see industry concentration of the stock of Chinese OFDI is very high, 75.4 percent of the stocks are in four major industries (Leasing and Business Services, Finance, Mining, Wholesale and Retail Trades), and Leasing and Business Services is the most favorable one as its largest share. (2010 Statistical Bulletin of China's Outward Foreign Direct Investment).

4.2.2 Data collection

In this thesis, I use a strong balanced panel dataset and I define $_i$ as host country, $_{i=1,2,3\ldots34}$ for 34 OECD countries (the list is shown in Table 4.5); I define $_t$ as the time period, $_{t=1,2,3\ldots8}$ for the time period from 2003 to 2010; $\beta_1, \beta_2, \beta_3 \ldots \beta_{11}$ are the coefficients of the explanatory variables, a is constant, ε_{it} is the error term. The total number of observations should be 272, but reduced to 153 due to logarithmic transformation of independent variables including the transformation of GDP growth

rate, real unit labor cost; and the missing data of tariff rate. The data is collected from several sources, including "Statisticahl bulletin of China's outward foreign direct investment", World Bank Institute (WBI), OECD statistics and CEPII database. The proxies and sources of my variables are presented in Table 4.6; the summary of the data is presented in Table 4.7.

The choice of the time period is 2003-2010. Firstly, "Statistical bulletin of China's outward foreign direct investment" is jointly issued by Ministry of Commerce, National Bureau of Statistics and the Administration of Foreign Exchange of People's Republic of China, they published the data since 2003, and the available data continues until 2010. Secondly, as shown in Figure 4.8, there is sharply increase of Chinese OFDI from 2003 to 2010, it is meaningful to analyze the investments during these years. Moreover, the trend of Chinese OFDI in OECD countries also follows its overall trend.

My focus is on OECD countries, because it is difficult to get the data that meets the requirements for variables. For example, some countries may not publish the annual R&D expenditures and hence I can not get that data for all the recipients of Chinese OFDI. However, the data provided by OECD statistics fulfills the requirements for my model and the theoretical conditions, and analyze Chinese OFDI in OECD countries also contribute to understand Chinese OFDI.

4.2.3 Variable selections and descriptions

The dependent variable $lnOFDI_{it}$ is the logarithm of OFDI in current US dollars from China to host country $_i$ at time $_t$, it is collected from "Statistical bulletin of China's outward foreign direct investment", similar data has been used by previous scholars to analyze OFDI from China (Buckley, et al., 2007; Kolstad and Wiig, 2010; Amighini, Rabellotti and Sanfilippo, 2011).

I first introduce the four independent (main) variables that explain the motivations behind Chinese OFDI:

As I shown in the empirical review of this thesis, there are three proxies (GDP, Per capita GDP and GDP growth rate) for market-seeking motivation. However, Per capita GDP=GDP/population, Root and Ahmed pointed out that Per-capita GDP introduces a bias to a country's income level when a country has huge population. And because GDP has already been introduced as a variable of gravity model, so it is used as a control variable. Thus, I decide to use GDP growth rate as a proxy of market-seeking motivation in this thesis, the rapidly growth market provides more potential opportunities for foreign investors, and hence it is expected to be positively affecting Chinese OFDI (Lim, 1983; Buckley, et al., 2007; Zhang and Kevin, 2011). $lnGDPG_{it}$ is the logarithm of annual GDP growth rate in host country $_i$ at time $_t$, the data is collected from WBI.

Empirical studies suggest that Chinese MNEs invest in foreign countries is trying to satisfy their growing demand for fuels, minerals and other primary resources (Cai, 1999). Followed by previous economists, the resource endowments rate (the ratio of fuels, ores and metals to total merchandise exports) is a proxy of resource-seeking motivation. $lnRER_{it}$ is the logarithm of the resource endowments rate of host country $_i$ at time $_t$, it is expected to be positive, and the data is calculated from WBI.

With regard to the efficiency-seeking motivation, previous economists thought this kind of FDI was trying to find low labor cost, the less the labor cost the more FDI (Cai, 1999; Buckley, et al., 2007). Bellak, Leibrecht and Riedl (2007) provide the measurement for the location decisions of MNEs: the real unit labor cost= $\left[\frac{comp/eps}{gdp/ept}\times\frac{exc}{ppp}\right]\times 100$; comp=annual labor compensation costs (wages); *eps*=employees; *gdp*=gross domestic product; *ept*=employment; *exc*=exchange rate; *ppp*=purchasing power parity. Furthermore, $lnRULC_{it}$ is the logarithm of the real unit

labor cost in country $_i$ at time $_t$, it is expected to be negative, and the data is collected from OECD statistics.

There are three main proxies for strategic asset-seeking motives in previous studies on Chinese OFDI: number of patent registrations in host country (*PATENT*), R&D expenditures rate (the ratio of R&D expenditures to host country's GDP), school enrolment in host country (*SE*). However, the result of patent registrations is found insignificant in the empirical study by Buckley, et al. (2007); De Beule (2010) uses all the 3 indicators in their research and their result of R&D expenditures rate is found significant in the case of China. In this thesis, I also use R&D expenditures rate as a proxy of strategic asset-seeking motivation. In addition, many Chinese MNEs (such as Lenovo, Haier) invest in other countries with advanced abilities in research and development for acquiring leading technology. $lnRDR_{it}$ is the logarithm of R&D expenditures rate in host country $_i$ at time $_t$, it is expected to be positive, and the data is calculated from WBI and OECD statistics.

Now it is the description of the two gravity (control) variables:
As I shown in the part of previous empirical studies on the market-seeking motivation, host market size (measured by GDP) takes positive effect on Chinese OFDI (Buckley, et al., 2007; Kolstad and Wiig, 2010; Amighini, Rabellotti and Sanfilippo, 2011). Since it is a gravity variable, it is used as a control variable. $lnGDP_{it}$ is the logarithm of gross domestic product in current US dollars from the host country $_i$ at time $_t$, it is expected to be positive, and the data is gathered from WBI.

The geographic distance as a factor of transport cost, it is expected to have negative influence on Chinese OFDI (Buckley, et al., 2007; Zhang and Kevin, 2011; Amighini, Rabellotti and Sanfilippo, 2011). $lnDT_{it}$ is the logarithm of the spatial distance between China and the host country $_i$ at time $_t$, and the data is collected from CEPII database.

Now it is the description of three control variables that mainly from previous empirical studies on FDI:

In economics, inflation is a rise in the general level of prices of goods and services in an economy over a period of time, it can be measured by consumer price index. If the price level rises, the future purchasing power of money in host countries may go down (currency devaluation). The currency devaluation reduces the real value of market-seeking MNEs' earnings in host country, and hence discourages market-seeking FDI. And inflation rate is volatile and unpredictable, it creates uncertainty of price-settings and profit-expectation to market-seeking MNEs, and then discourage market-seeking FDI (Buckley et al., 2007). Moreover, Buckley, et al. (2007) find more Chinese OFDI flows to the countries with less inflation rate. As a consequence, I expect Chinese OFDI is negatively associated with host countries' inflation rate. $lnIR_{it}$ is the logarithm of the inflation rate of the host country $_i$ at time $_t$, and the data is collected from WBI.

A more open country offer more convenient conditions for trade and FDI, a country's degree of openness to international investments is a relevant factor in the location of FDI (Chakrabarti, 2001). Followed by Buckley, et al. (2007), I also use host country's openness to OFDI (the ratio of inward FDI to its GDP) as an indicator. $lnOPN_{it}$ is the logarithm of openness to Chinese OFDI in the host country $_i$ at time $_t$, it is expected to be positive. The data is collected from WBI.

'Tariff-jumping' argument posits that exporting and investing abroad are alternative ways to enter foreign markets. As trade costs increase, exports become more costly, and then FDI is more attractive. Tariff is recognized as a trade cost, hence, it is expected to be positively associated with FDI (Barba Navaretti and Venable, 2004; Hijzen, Gorg and Manchin, 2007). $lnTR_{it}$ is the logarithm of tariff rate for all products in the host country $_i$ at time $_t$, and the data is gathered from WBI.

4.2.4 Estimation

After some arguments concerning the specification of the gravity model, the debates also address on the performance of different estimation techniques. The first estimation problem is the presence of heteroscedasticity in the log linearization process of the gravity equation, which will violate the conditions of OLS (Gomez-Herrera, 2010). Santos Silva and Tenreyro (2006) show the biased estimates by OLS estimation under heteroscedasticity, and they propose use Poisson pseudo-maximum-likelihood estimator as a substitution.

The second problem is loss information due to zero trade flows. The gravitational force from Newton's law of universal gravitation can be very small but not zero; however, the bilateral trade or FDI to host economies may not occur and sometimes there are rounding errors. For example, if Chinese OFDI is measured in millions of USD, it is possible that some of the investments do not reach the minimum value, say $5,000, these data will be omitted or equal to zero (see Feenstra, Lipsey and Bowen, 1997), hence $OFDI_{it}$ is equal to zero and there are still observations in the right hand of the gravity equation, the expected error term will depend on other regressors, and then lead to inconsistency.

Some economists try to solve these problems, but each estimation method has its advantages and disadvantages. As shown in Table 4.9, the linear methods (OLS, Fixed and Random effects) are simple, OLS ($1+T_{ij}$) also can deal with zero problem in the dependent variable and Panel fixed-effects controls for unobserved heterogeneity. The critics about using linear methods rely on loss of information and biased coefficients. However, despite the non-linear methods deal with ‘zero problem’ (e.g. Non least squares and Poisson Pseudo Maximum Likelihood) and robust to heteroscedasticity (Feasible Generalised least squares and Gamma Pseudo Maximum Likelihood), these methods still need to improve such as Tobit model lacks theoretical foundation and Non-linear least squares leads to inefficiency. Moreover, Konstantinos, Matthew and Dimitrios (2010) do a ten year (1999-2009) review of empirical studies on the gravity

model specification for modeling international trade flows; they find OLS is the usual technique for estimating the coefficients of the gravity model in its log-linear form, despite there are many critics.

In this thesis, firstly, there are no zero Chinese OFDI flows, my dataset contains many entities but few time periods (short panel data) and my gravity model is a linear model, so the linear estimation methods (Pooled OLS, Fixed-effects and Random-effects) should be used here. In contrast to Pooled OLS model, Fixed-effects model adds individual effect to intercepts and Random-effects model adds individual effect to error terms. Secondly, Breusch-Pagan Lagrange multiplier test (Table 5.3 in appendix) shows Pooled OLS is better than Random-effects because of no individual effect (P value=0.642>0.05). Thirdly, the Hausman test (Table 4.10 in appendix) shows random-effects model is better than fixed-effects model when individual effects are uncorrelated with the other regressors (P value=0.195> 0.05). Thus, I will use OLS regression in this thesis.

To obtain an efficient OLS, some assumptions should be satisfied first (Pickett et al, 2005), several tests will be conducted after regression. (1) No perfect multicollinearity. The correlation matrix reveals the statistical relationship between two variables reflecting the dependence of variables. The coefficient β will be unidentified if there are collinearities among variables. How to test the multicollinearity? The variance inflation factor (VIF) quantifies the severity of multicollinearity, and the multicollinearity is high when VIF>7.5.

(2) To test the autocorrelation, Wooldrige (2002) derive a simple test for autocorrelation in panel-data model, David (2001) makes it possible to do the test in Stata. The wooldrige test in Stata taking the null hypothesis that there is no first order autocorrelation, for a 95 percent confidence level, we will reject the null hypothesis when p-value is smaller than 0.05.

(3) Homoskedasticity, the error term has the same variance given any value of the explanatory variable, $Var(\varepsilon_t | x_{it}) = Var(\varepsilon_t) = \sigma^2.$ The Bruesch-Pagan test whether the residual variance of a variable is constant in a regression model, it has the null hypothesis that H0=the variance of residuals is constant. For a 95 percent confidence level, a p-value is smaller than 0.05 indicates statistically significant heteroscedasticity.

(4) Normality. The residuals should be normally distributed, which is required for valid hypothesis testing. Shapiro-Wilk W test is designed for test normality of residuals, and it takes the null hypothesis that the distribution of residuals is normal. For a 95 percent significance level, a p-value is larger than 0.05 indicates residuals are normal distributed.

(5) T-test shows the statistical significance of every variable. R-square indicates the performance of the model, for example, an R-square value of 0.9 would tell us that my model explains 90 percent of the variation in the dependent variable.

5. Results

Before discussing my empirical results, I would like to interpret the estimation results. As shown in Table 5.1.1. The P value in Bruesch-Pagan test is greater than 0.05, so the variance of residuals is constant, it is homogenous. The P value in Wooldridge test in greater than 0.05, it proves there is no serial autocorrelation in my model. The VIF values of the explanatory variables are smaller than 7.5, so there is no multicollinearity and no redundancy. The P value in Shapiro-Wilk W test is greater than 0.05, so the residuals are normally distributed. Moreover, the correlation matrix (Table 5.1.2 in appendix) shows there are no high correlations between variables. Therefore, the assumptions for an effective OLS are satisfied, my empirical results are valid.

Tabel 5.1.1 The tests after regression (details in Figure 5.3 in appendix)

Test	H0	Result and Explanation
Bruesch-Pagan test	The variance of residuals is constant	P-value=0.6427>0.05, homogenous
Wooldrige test	There is no first order autocorrelation	P-value=0.3468>0.05, no serial correlation
Variance inflation factor	No redundancy	VIF values < 7.5, no multicollinearity
Shapiro-Wilk W test	The residual is normally distributed	P-value=0.83797>0.05, normality

The main results from regression are shown in Table 5.2; my model explains 48 percent of the variation in the variable of Chinese OFDI. I first interpret the results for four main variables, two variables' coefficients are found statistically significant, and two variables of GDP growth rate and resource endowments rate receive the expected sign.

The detail as follows:

Host market growth rate has an expected positive effect on Chinese OFDI, with a 1% rise in the variable increasing Chinese OFDI by 0.07%. This finding indicates that Chinese OFDI seeks to high market growth rate of OECD countries from 2003 to 2010. But its effect is insignificant, so the determinant of market-seeking motivation is not supported. Combine this finding with my later result of GDP, it suggests that Chinese OFDI is attracted by large market size but not high market growth rate. Buckley, et al. (2007) also show insignificant influence from host market growth rate in the case of OECD countries.

Host countries' resource endowments rate is found statistically significant, and it takes an expected positive influence on Chinese OFDI, with a 1% increase in resource endowments rate raising Chinese OFDI by 0.63%. This result supports the idea that the resource-seeking motive determines Chinese OFDI in OECD countries from 2003

to 2010. To secure the supply of natural resources, Chinese firms invest in the mining industry of OECD countries. For example, 82 percent of Chinese OFDI (in Australia) flowed to mining industry in the year 2010. In contrast to previous empirical studies, Buckley, et al. (2007) find negative and insignificant effect from the same variable with regard to OECD countries, Kolstad and wiig (2010) show resource-seeking motivation is a determinant of Chinese OFDI in non-OECD countries.

Table 5.2 Determinants of Chinese OFDI in OECD countries, 2003-2010

		Results (Pooled OLS)
Variables	Descriptions	Coefficient
GDP growth rate	Annual GDP growth rate	0.072
		(0.327)
Resource endowments rate	Annual ratio of fuels, ores and metals to total merchandise exports	0.631*
		(0.262)
Real unit labor cost	Annual real unit labor cost	0.255
		(0.331)
R&D expenditures rate	Annual ratio of R&D expenditures to GDP	-0.134**
		(0.068)
GDP	Annual gross domestic product	2.264*
		(0.219)
Inflation rate	Annual inflation rate	0.053
		(0.403)
Tariff rate	Annual tariff rate	-1.269***
		(0.885)
Openness to OFDI	Annual ratio of inward FDI to GDP	0.465**
		(0.275)
Distance	Distance between China and host countries	-1.398**
		(0.746)
Number of obs=153	R-squared=0.4835	Adj R-squared=0.510

Notes: Standard errors in parentheses. *, ** and *** indicate the coefficient significant at 5%, 10% and 20% levels, respectively.

In the case of efficiency-seeking motivation, the test of host countries' unit labor cost shows an unexpected positive impact on Chinese OFDI, with a 1% rise in the variable increasing Chinese OFDI by 0.26%. Due to cheap labor in China, Chinese MNEs did not find low labor cost locations in OECD countries from 2003 to 2010, this result proves the efficiency-seeking motivation is not a determinant of Chinese OFDI.

With regard to strategic asset-seeking motivation, the unexpected negative coefficient of the variable reflects no strategic asset-seeking motive for Chinese OFDI in the period 2003-2010, with 1% rise in the variable decreasing Chinese OFDI by 0.13%. By using annual total patent registrations in host country as a proxy for strategic asset-seeking motivation, Buckley, et al. (2007) show positive and insignificant influence in OECD countries.

I now discuss the results for control (gravity) variables, I find that two variables inflation rate and tariff rate are not correctly signed; and four variables host countries' GDP, openness to OFDI, tariff rate and distance between China and host countries are statistically significant. The details as follows:

Host market size (GDP) gets a positive sign, as expected; and it is statistically significant, with 1% rise in the variable increasing Chinese OFDI by 2.26%. This result shows Chinese OFDI is driven by large market size in OECD countries, the similar result is also shown in previous studies (Buckley, et al., 2007; Kolstad and Wiig, 2010)

The inflation rate of host countries has an unexpected positive effect on Chinese OFDI but the effect is insignificant, with 1% increase in the variable increasing Chinese OFDI by 0.05%. This association reflects few of Chinese firms are not profit-maximizing, these firms are influenced by China's imperfect capital market and local government. But inflation rate is not a determinant of Chinese OFDI because of its insignificant effect. The similar result also showed in the study by Kolstad and Wiig (2010), Buckley et al. (2007) find positive and significant effect from inflation rate.

The openness to FDI in host countries takes a positive coefficient, as expected; and it is statistically significant (a=10%), with 1% rise in the variable increasing Chinese OFDI by 0.46%. A more openness to inward FDI creates a favorable environment for

investment, and hence Chinese firms are easily to gain technologies and management skills from merging or acquiring OECD countries' firms. Furthermore, Buckley, et al. (2007) show positive but insignificant effect of this variable in their study.

Tariff rate for all products in host countries receives an unexpected negative sign; and its influence is statistically significant (a=20%), with 1% rise in the variable reducing Chinese OFDI by 1.27%. This finding shows Chinese OFDI is not an alternative way of China' exports to enter OECD countries' market, a high tariff rises the price of foreign products, subsequently, foreign products are less competitive than local products in host markets, and hence reduces market-seeking Chinese OFDI.

Geographic distance between China and host countries receives an expected negative sign and it is statistically significant (a=10%), with 1% rise in the variable decreasing Chinese OFDI by 1.40%. Distance is a factor of transport cost, the distance is too far between China and most of the OECD countries as we can see in the map of the world, and there are oceans between them. So it is costly (money, time) to transport the goods from China to these countries, and hence reduces Chinese OFDI.

To sum up, resource-seeking motivation is a determinant of Chinese OFDI in OECD countries, and Chinese OFDI is driven by host market size, openness to FDI, tariff rate and distance between China and host countries.

6. Conclusion

China's outward foreign direct investment (OFDI) is an important category of China's activities in global economies. Dunning (1993) provide four main motivations for FDI based on location advantages: market-seeking, resource-seeking, efficiency-seeking and strategic asset-seeking motivation. The gravity model is considered as an empirical framework for analyzing FDI, and OLS estimator is used for the estimation. All of these backgrounds motivate this thesis.

This thesis has shown an empirical country level analysis on the determinants of Chinese OFDI in 34 OECD countries from 2003 to 2010. I find that only resource-seeking motive determines Chinese OFDI; the market-seeking, efficiency-seeking motivations are shown insignificant influences; the strategic-asset seeking motivation is not supported in this thesis. In the meanwhile, I find host market size (GDP), openness to FDI, tariff rate and distance between China and host countries are also the drivers of Chinese OFDI.

This thesis contributes to the investigation of the determinants of Chinese OFDI, but there are some limitations in this thesis. Firstly, there are still some influences from other aspects such as exchange rate in host countries, policy issues and so on, which are not include in my independent variables. Secondly, the OLS estimator is still a controversial estimator, it will cause bias and inconsistent as Santos Silva and Tenreyro (2006) propose in their article. For further study, it could extend the model that adds more variables; it could include more countries and longer time period to the dataset.

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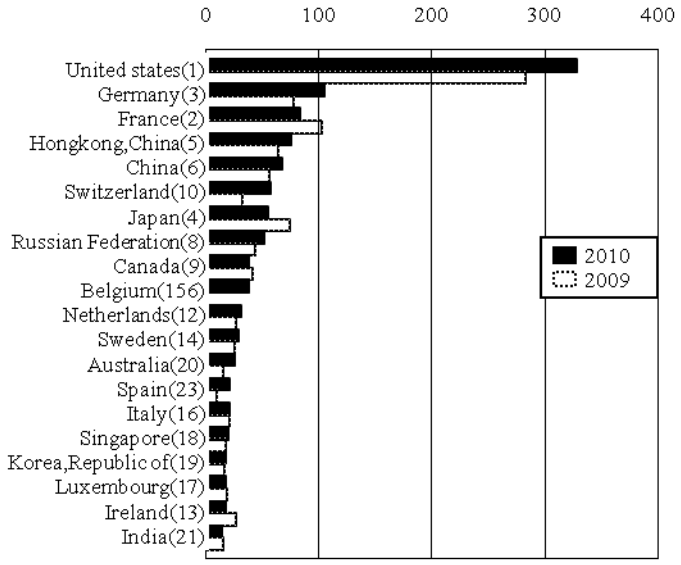
Appendix

Figure 4.1: The top 20 home economies of Global OFDI flows in 2009 and 2010 (Unit: billions of USD)



Source：UNCTAD《World Investment Report 2011》
Note: The number in bracket after the name of the country refers to the ranking in 2009. British Virgin Islands, which ranked 16th in 2010, is excluded from the list.

Figure 4.2 The distribution of Chinese OFDI stock in different areas by the year 2010

Area	Stock (Billions of USD)	Proportion (%)
Asia	228.14	71.9
Latin America	43.88	13.8
Europe	15.71	5
Africa	13.04	4.1
Oceania	8.61	2.7
North America	7,83	2.5

Source: 2010 Statistical Bulletin of China's Outward Foreign Direct Investment.

Table 4.3 Chinese OFDI stock in developed countries by the year 2010

Countries or Economies	Stock (Billions of USD)	Proportion (%)
European Union	12.5	42.1
Australia	7.87	26.5
USA	4.87	16.4
Canada	2.6	8.8
Japan	1.11	3.7
other	0.74	2.5

Source: 2010 Statistical Bulletin of China's Outward Foreign Direct Investment

Table 4.4 Sectoral distribution of the stock of Chinese OFDI by the year 2010

Industries	Stock (Billions of USD)	Proportion (%)
Leasing and Business Services	97.25	30.7
Finance	55.25	17.4
Mining	44.66	14.1
Wholesale and Retail Trades	42.01	13.2
Transport, Storage and Post	23.19	7.3
Manufacturing	17.8	5.6
Information Transmission, Computer Services and Software	8.41	2.7
Real Estate	7.27	2.3
Construction	6.17	1.9
Scientific Research, Technical Service and Geologic Prospecting	3.97	1.3
Production and Supply of Electricity, Gas and Water	3.41	1.1
Services to Households and Other Services	3.23	1
Agriculture, Forestry, Animal Husbandry and Fishery	2.61	0.8
Management of Water Conservancy, Environment and Public Facilities	1.13	0.4
Hotels and Catering Services	0.45	0.1
Other sector	0.4	0.1

Source: 2010 Statistical Bulletin of China's Outward Foreign Direct Investment

Table 4.5 The list of OECD countries

1	Australia	18	Japan
2	Austria	19	Korea
3	Belgium	20	Luxemburg
4	Canada	21	Mexico
5	Chile	22	Netherlands
6	Czeche republic	23	New Zealand
7	Denmark	24	Norway

8	Estonia	25	Poland
9	Finland	26	Portugal
10	France	27	Slovak Republic
11	Germany	28	Slovenia
12	Greece	29	Spain
13	Hungary	30	Sweden
14	Iceland	31	Swizerland
15	Ireland	32	Turkey
16	Israel	33	Uk
17	Italy	34	Us

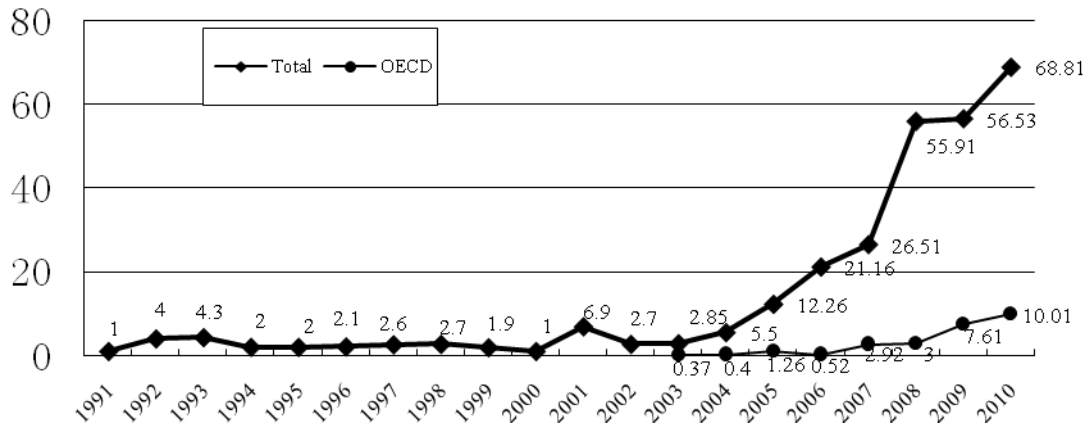
Table 4.6 Variable list and descriptions

Variable	Explanation	Expected sign	Main or control	Theoretical justification	Source
OFDI	Chinese OFDI to OECD countries				Statistical bulletin of China's outward foreign direct investment
GDPG	GDP growth rate	+	Main	Market seeking	World Bank Institute(WBI)
RER	Ratio of fuels, ores and metals to merchandise exports	+	Main	Resource seeking	World Bank Institute(WBI)
RULC	Real unit labor cost	-	Main	Efficiency seeking	OECD statistics
RDR	Ratio of R&D expenditures to GDP	+	Main	Strategic asset seeking	calculated from OECD statistics and WBI
GDP	Gross domestic product	+	Control	Gravity relationship	World Bank Institute(WBI)
IR	Inflation rate (consumer price)	-	Control	Gravity relationship	World Bank Institute(WBI)
TR	tariff rate for all products	+	Control	Gravity relationship	World Bank Institute(WBI)
OPN	Ratio of inward FDI to GDP	+	Control	Gravity relationship	computed from SBOCFDI and WBI
DT	The geographic distance between China and host country	-	Control	Gravity relationship	CEPII, http: www.cepii.fr/

Table 4.7 Summary of data

Variable	Obs	Mean	Std.Dev.	Min	Max
OFDI	272	13.401	4.696	6.908	21.889
GDP growth rate	222	1.014	0.844	-3.859	2.351
Resource endowments rate	272	2.161	1.061	-7.419	4.319
Real unit labor cost	218	0.834	0.944	-3.530	3.056
R&D expenditure rate	272	-7.217	5.172	-21.275	-4.145
GDP	272	26.637	1.522	23.010	30.310
Inflation rate	249	0.826	0.794	-2.848	3.231
Tariff rate	259	1.218	0.331	-0.248	2.737
Openness to OFDI	254	1.094	1.267	-3.926	5.152
Distance	272	15.823	0.477	13.770	16.764

Figure 4.8 Chinese OFDI 1991-2010 (Unit: billions of USD)



Source：2010 Statistical Bulletin of China's Outward Foreign Direct Investment

Table 4.9 Summary of estimation methods

Estimation method	Advantages	Disadvantages
Truncated OLS	Simple	Loss of information; Biased coefficients
OLS (1+Tij)	Simple; Deals with the zero trade flows problem	Biased coefficients
Tobit(censored regression)	Simple; Deals with the zero trade flows problem	Same set of variables to determine the probability that an observation will be censored and the value of the dependent variable; Lack of theoretical foundation
Panel fixed effects	Simple;	Loss of information;

	Controls for unobserved heterogeneity	Elimination of zero flows; Sample selectionbias
Heckman two-step	No multicollinearity problems;	Difficult to find an identification restriction; Exclusion variables are required
PPML(Poisson Pseudo Maximum Likelihood)	All observations are weighted equally; The mean is always positive; Deals with the zero trade flows problem; Unbiased estimates in the presence of heteroskedasticity	It may present limited-dependent variable bias when a significant part of the observations are censored
NLS(Nonlinear Least Squares)	Deals with the zero trade flows problem	Inefficiency; Not robust to heteroskedasticity; Sample selection bias
FGLS(Feasible Generalised Least Squares)	Deals with the zero trade flows problem; Robust to heteroscedasticity	Estimate variance covariance matrix first
GPML(Gamma Pseudo Maximum Likelihood)	Deals with the zero trade flows problem; Robust to heteroscedasticity	Less weight to observations with a large conditional mean
Helpman sample selection model	Provides a rationale for zero trade flows; Unbiased estimates	Difficult to estimate; Exclusion variables are required

Note: the contents are from Estrella Gomez Herrera's article

Table 4.10. Hausmantest: FE vs RE

	- coefficients -			
	(b)	(B)	(b-B)	sqrt (diag(v_b-B))
	fe	re	Difference	S.E.
lnGDPG	-0.264	-0.042	-0.222	0.143
lnRER	0.790	0.664	0.126	0.315
lnRULC	-0.364	-0.039	-0.325	0.172
lnRDR	-0.029	-0.107	0.078	0.055
lnGDP	2.828	2.212	0.616	1.461
lnIR	0.225	0.239	-0.013	0.363
lnTR	-3.773	-2.036	-1.737	1.301
lnOPN	0.211	0.362	-0.152	0.236

b=consistent under H0 and Ha;obtained from xtreg

B=inconsistent under Ha,efficient under H0;obtained from xtreg

Test: H0: difference in coefficients not systematic

chi2(8) = (b-B)'[(v_b-v_B)^(-1)](b-B)

= 11.12

prob>chi2 = 0.195

Note: lnDT is omitted from Fixed effect regression

Table 5.1.2 correlation matrix

	lnOFDI	lnGDPG	lnRER	lnRULC	lnRDR	lnGDP	lnIR	lnTR	lnOPN	lnDT
lnOFDI	1.0000									
lnGDPG	-0.1507	1.0000								
lnRER	0.2041	-0.1192	1.0000							
lnRULC	-0.0175	-0.2942	0.0283	1.0000						
lnRDR	-0.0878	-0.0666	-0.0177	-0.0065	1.0000					
lnGDP	0.6578	-0.1966	0.1138	-0.1065	0.0079	1.0000				
lnIR	-0.0608	0.0499	0.0206	0.1478	-0.2396	-0.1395	1.0000			
lnTR	-0.0315	0.0298	0.0619	-0.0444	-0.1053	0.0483	0.1590	1.0000		
lnOPN	-0.1595	0.0470	-0.0292	0.0637	0.1566	-0.3496	0.1183	-0.2293	1.0000	
lnDT	-0.0402	-0.0706	0.0865	0.0440	-0.1111	-0.0072	0.1049	-0.2689	0.3034	1.0000

Table 5.3 Details of estimations

VIF test

Variables	VIF	1/VIF
GDP growth rate	1.19	0.838288
Resource endowments rate	1.04	0.960564
Real unit labor cost	1.16	0.858884
R&D expenditures rate	1.15	0.870225
Market size (GDP)	1.25	0.802156
Tariff rate	1.18	0.850451
Openness to OFDI	1.37	0.727445
Distance	1.24	0.806349
Mean VIF	1.20	

Breusch-Pagan / Cook-weisberg test for heteroskedasticity

H0: Constant variance

Variables: fitted values of lnOFDI

Chi2(1) =0.22

Prob > chi2 = 0.6427

Shapioro-Wilk W test for normal data

Variable	Obs	W	V	Z	Prob>Z
R	153	0.99453	0.648	-0.986	0.83797

Wooldridge test for autocorrelation in panel data

H0: no first-order autocorrelation
F(1,24) = 0.921
Prob > F = 0.3468