ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SOCIAL SCIENCES

FOREIGN DIRECT INVESTMENT AND PLANT LOCATION CHOICE

M.A. Thesis by
Suna GÖNÜLTAŞ

Department : Economics

Programme : Economics

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Suna GÖNÜLTAŞ
(412051017)

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Supervisor (Chairman) : **Prof. Dr. Benan ZEKİ ORBAY (ITU)**
Members of the Examining Committee : **Assoc. Prof. Dr. Özgür KAYALICA (ITU)**
Assoc. Prof. Dr. Y. İlker TOPÇU (ITU)

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Suna GÖNÜLTAŞ
(412051017)

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Tez Danışmanları : Prof. Dr. Benan Zeki ORBAY (İTÜ)
Diğer Jüri Üyeleri : Doç. Dr. Özgür KAYALICA (İTÜ)
Doç. Dr. Y. İlker TOPÇU (İTÜ)

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TABLE OF CONTENTS

ABBREVIATIONS

FDI	: Foreign Direct Investment
MNC	: Multinational Corporations
R&D	: Research and Development
TNC	: Transnational Corporations

LIST OF FIGURES

LIST OF SYMBOLS

c_i	: Marginal cost of firm i
f_i	: Fixed cost in country i
λ	: Exchange rate between country A and B
ϕ	: Technological spillover rate
Q_i	: Quantity demanded in country i
P_i	: Market price in country's own currency unit
α	: Market size
π_{XA}	: Profit of MNC if it invests in country A
π_{XB}	: Profit of MNC if it invests in country B
π_A	: Profit of firm A
π_B	: Profit of firm B
q_{ij}	: Equilibrium output of firm i in country j
λ^*	: Threshold value of exchange rate of investing in developed country for Case 1
π_{XA-XB}	: Difference of profits of MNC resulted from investing two different locations
$\partial\pi_{XA-XB}/\partial\phi$	: Derivative of $\partial\pi_{XA-XB}$ with respect to technological spillover rate
$\partial\pi_{XA-XB}/\partial\alpha$	: Derivative of $\partial\pi_{XA-XB}$ with respect to market size
$\partial\pi_{XA-XB}/\partial c_B$	: Derivative of $\partial\pi_{XA-XB}$ with respect to marginal cost of firm B
π^*_{XA}	: Profit of MNC if it invests in country A and when there is no spillover
π^{**}_{XA}	: Profit of MNC if it invests in country A and when there is perfect spillover
λ^{**}	: Threshold value of exchange rate of investing in developed country for Case 2

FOREIGN DIRECT INVESTMENT AND PLANT LOCATION CHOICE

SUMMARY

Advantages of foreign direct investment inflows for the host countries increase the importance of the question of the plant location choice of MNC. Not only developing countries but also developed countries are trying to attract FDI into their countries in order to take advantages. The most important advantages can be considered as the transfer of technology through knowledge spillover.

The aim of the study is to analyze the effects of exchange rate, technological spillover, technological capabilities and size of market on the plant location choice of a MNC in a simple game theoretic model. In the model, there are two host countries which are assumed to be developed and developing according to their technological capabilities and a MNC from third country is planning to invest one of them. In the first stage, MNC decides the location of investment and in the second stage firms compete for both countries market *a la Cournot*. The investment decision of MNC investigated in two parts depending on the competition in developing country. In the first case, developing country is technologically inefficient that does not have a local firm to compete, while in the second case it has a local firm which can serve only to domestic market.

This study shows that the attractiveness of the developing country increases with the relative market size of the developed country and depreciation of the local currency of developing country. Moreover, it is found that technological spillover rate raises the incentive to invest in developing country without depending on the competition in developing country. Comparison of two cases shows that, increase in competition reduces the threshold value of exchange rates to invest in developed country.

DOĞRUDAN YABANCI YATIRIM VE KURULUŞ YERİ SEÇİMİ

ÖZET

Doğrudan yabancı yatırımların ev sahibi ülkelere sağladığı avantajlar, çokuluslu şirketlerin kuruluş yeri seçimi sorununun öneminin artmasına yol açmıştır. Sadece gelişmekte olan ülkeler değil, gelişmiş ülkeler de bu avantajlardan faydalanmak amacıyla kendi ülkelerine doğrudan yabancı yatırımı çekmek için çaba harcamaktadırlar. Bu avantajlardan en önemlisi de doğrudan yabancı yatırımın bilgi yayılımı yoluyla teknolojinin transfer edilmesini sağlaması olarak görülebilir.

Bu çalışmanın amacı ülkelerin döviz kurları, bilgi yayılım oranları, teknolojik yeterlilikleri ve piyasa büyüklüklerinin çokuluslu bir firmanın kuruluş yeri seçimi üzerindeki etkilerini oyun teorik basit bir model çerçevesinde analiz etmektir. Modelde, teknolojik yeterliliklerine dayanılarak gelişmiş ve gelişmekte olduğu kabul edilen iki ev sahibi ülke vardır ve üçüncü bir ülkeden gelen çokuluslu bir firma bu ülkelerden birine yatırım yapmayı planlamaktadır. İlk aşamada, çokuluslu firma yatırımın yerine karar vermekte, ikinci aşamada da firmalar her iki ülke piyasası için Cournot tipi rekabet etmektedirler. Çokuluslu firmanın yatırım kararı, gelişmekte olan ülkedeki rekabet durumuna bağlı olarak iki kısımda incelenmektedir. İlk kısımda, gelişmekte olan ülkenin teknolojik olarak geri kalmış olmasından ötürü rekabet edecek yerel bir firmaya sahip olmadığı bir durum ele alınırken, ikinci kısımda ise sadece kendi yurtiçi piyasasına hizmet verebilen bir yerel firmaya sahip olduğu durum incelenmiştir.

Bu çalışma, gelişmekte olan ülkelerin yerel ulusal parası değer kaybettikçe ve gelişmiş ülkenin göreceli piyasa büyüklüğü arttıkça, gelişmekte olan ülkenin daha cazip hale geldiğini ortaya koymaktadır. Ayrıca, gelişmekte olan ülkedeki rekabete bağlı olmaksızın, bilginin yayılım oranı arttıkça gelişmekte olan ülkeye yatırım yapma eğiliminin artmakta olduğu sonucuna ulaşılmıştır. Her iki durumun karşılaştırılması, rekabetin artmasının gelişmiş ülkeye yatırım yapılması için gerekli olan döviz kurunun eşik değerini düşürdüğünü göstermiştir.

1. INTRODUCTION

Rapid globalization and competitive pressures have increased the importance of foreign direct investment (FDI) over the last two decades. FDI inflows reached $1.306 billion in 2006 with a growth of 38 %. The goods and services produced by transnational corporations (TNCs) outside their home countries have been estimated as 10 % of world GDP and one third of world exports. Increasing corporate profits worldwide caused a more recent growth in FDI inflows. According to World Investment Report (2007), not only mergers and acquisitions but also greenfield investment increased. The largest inflows among developing countries are China and Singapore with the help of their policies attracting to FDI.

The reason of enormous increase in FDI is that it creates many advantages for the host countries. First of all FDI is a very efficient way to generate employment opportunities for the host countries. In addition to that, foreign presence has ability to produce spillover of new advanced technology and human skills, since important part of the R&D investments in world are done by MNCs. As Sachs (2005) stated that, many East Asian countries became successful to improve their technological capability by not through domestic investments on R&D projects but through successfully attracting foreign direct investment which brought improved technologies with them. Multinational firms have not only advanced technology but also other non tangible productive assets such as managerial and marketing ability, export contracts and reputation (Markusen, 2002). Furthermore, as stated by Christiansen et al. (2003), FDI can also be considered as the most promising source of stable and long-term finance, especially for the low saving areas where major investment projects are difficult to finance. According to Kose et al. (2006), FDI accounts for almost half of total inflows into developing economies. It is undeniable fact that FDI inflows help countries' economic growth process. Morgan Stanly estimates that if India were to receive FDI inflows of 3 percent of GDP, its economic growth would be 0,4 percentage points higher[1]. Because of its contribution to long

[1] Financial Times, 31 May 2007.

term economic development when MNC decides to establish new plants in a foreign country, competition to attract investment often arises. However, since foreign entry and competition may cause profits shift from local firms to foreign ones, governments may choose to protect some sectors especially considered as having "strategic" importance.

Traditionally studies on foreign direct investment mainly have focused on how the returns on investment should be taxed. However, with the increasing wave of liberalization in world economy, governments are eliminating many barriers in order to attract FDI and multinational companies (MNCs) are often offered substantial investment incentives by host countries. Some countries have imposed lower corporate taxes or more specifically offer free land, employment and infrastructure subsidy. According to OECD Report on Incentives (2003), these strategies have been followed by not only developing but also developed countries.

The production pattern of the world economy has been changed and now more countries involve in international production. Since multinational firms have many affiliates in different countries with different currency units, exchange rate movements can affect the firm's decision of location of production through affecting profit level.

Most of the studies on FDI are about horizontal and vertical foreign direct investment. Horizontal FDI is defined as foreign production of products and services roughly similar to those the firm produces for its home market. Vertical investment is considered as geographically fragmented production process (Markusen, 2002). Another type of FDI which gains importance is export platform FDI defined by Eckholm et al. (2003) as the type of FDI where foreign affiliates of MNCs sale most of their production to third countries rather than in the parent or host countries.

In this study, we investigate plant location decision of a multinational corporation. In the model, there are two countries differentiated by their market size, technological capability of their local firms and the value of their currency. We assume that MNC can invest only one of these two countries and export to the other. We focus on how market size, technological spillovers and exchange rates affect the MNC's location choice. To understand the effects of competition in developing country, we analyze the model in two different cases. In the first case, firm B is assumed to be technologically so lagged that cannot compete with multinational firm and do not produce at all. In the second case firm B is assumed to produce but cannot export and only serve for its local market. In both cases, firm A is allowed to export to country B.

This study is organized as follows: Section 2 summarizes previous studies on FDI and plant location choice. Review on the literature is divided into three subsections, according to their scope of the analysis. Studies which analyzing the government policies to attract FDI, effects of exchange rate on FDI and the relation between FDI and technological spillover are discussed separately. Section 3 introduces the model. General assumptions of the model are discussed and examined for two different cases which differentiated by competition level in developing country. Moreover, these two cases are briefly compared. Finally, Section 4 gives a brief summary and conclusion of the study.

2. LITERATURE REVIEW

Growth in the importance of FDI has generated an extending theoretical and empirical literature on this subject. This paper analyzes plant location choice of a MNC which decides to invest in one of two countries in a region. Before the firm determines which country to invests, it also takes into account exchange rate of the country since firm's profit levels are affected by exchange rate level.

Most of the previous studies analyze policy competition and welfare implications. Guariglia et al. (2006) analyze the location decision of a MNC when it has an option to invest in one of two countries which are different in terms of technological capabilities of local firms. In their study, various scenarios are investigated, such as the case whether exporting is possible or not and whether or not technologically lagging country can compete in the product market. They have shown that, investment decision of the MNC depends on the technological difference between the MNC and the local firms and the exporting ability of the latter. They have found that when host countries cannot export and local companies can all produce, the MNC will invest in the more technologically lagging country. On the other hand, if there are huge differences between technologies that lagged country firm cannot compete, and then the MNC invests in less technologically lagging country. Our study follows a similar method to analyze plant location decision of the MNC. But we extend the analysis taking into account differences in market size between host countries, allowing technological spillover and considering the effects of exchange rates.

Related theoretical literature is reviewed under three sub-categories. In the first group of studies, plant location decision is analyzed in terms government subsidies and welfare implications. The second related theoretical studies are on the importance of exchange rate. These studies vary from firms' investment decision to market entry choice. The third group of studies reviews both theoretical and empirical works that focus on the relationship between FDI and technological spillover.

2.1 Effects of Government Policies on FDI Decision

Because of the many governments try to attract FDI in order to get advantages associated with it, literature on policy competition on location decision grew in number. Studies of Bjorvatn and Eckel (2006), Barros and Cabral (2000), Fumagalli (2003), Haufler and Wooton (1999) and Haaparanta (1996) are the most important papers in this area.

Haaparanta (1996) analyses the subsidy game of FDI between governments or regional authorities. According to the model, the MNC decides how to allocate its investment between two countries in the region. The quantity of investment is assumed to be perfectly divisible. The timing of the game is as follows: Firstly, countries of the region decide whether to subsidize investments and announce their subsidy levels as a function of the investment amount. Then in the second stage, the MNC chooses the allocation of investment.

Haaparanta (1996) assumes there is a certain amount of unemployment in the economy and FDI would increase welfare of country by creating jobs. Moreover, it is assumed that the only gain is the wage income from FDI. Differences in market sizes are also included into analysis. It has shown that, with the absence of subsidies, the lower the wages and the larger markets are, the more attractive the country is. In case of subsidies, elasticity of demand affects investment allocation. All in all, subsidies can affect allocation of investment depending on production technology, elasticity of demand, market size and wage differentials.

Haufler and Wooton (1999) investigate tax competition of two asymmetric countries, which have different market size, to attract FDI from a third country. The MNC is assumed to be monopolist and charge same price for its goods in two countries. However, since there is a trade cost in the model, price of goods depends on production location. If the good is imported, its price increased by unit trade cost. Labor is the only factor of production and marginal costs are set to be equal to the wage rate, which is assumed to be same in both countries. A lump sum tax is imposed by the host country’s government if the MNC establishes a plant in there. According to Haufler and Wooton (1999), under the same trade costs, larger market becomes more attractive for the MNC, assuming that both countries have same wage and tax rates. Under symmetric trade costs, although large country can impose higher tax rate than small one, it is still able to attract FDI.

In the second part of the study of Haufler and Wooton (1999), they investigate the effect of trade tax on plant location decision of the MNC. The plan of the game is as follows: First of all, all countries set their profit tax rates, then the MNC decides where to locate and finally in the third stage of the game, optimal tariff rate is determined by the importing country. They have found that, large country can offer lower incentives to attract MNC then previous case relative to small country.

In Bjorvatn and Eckel (2006) article, policy competition for FDI between two asymmetric countries is analyzed in terms of welfare implications, too. The large country has a local firm, while small country does not have any firm to compete in product market. The MNC is going to invest one of these two countries. Marginal costs, c, are same for local firm and the MNC. Model also takes into account a unit export cost, t. Firms play Cournot game to determine equilibrium quantities. They found that, with symmetric policies, there is a trade of between market size effect and competition effect. If the difference between the market sizes is large, profitability of the MNC would be much higher in large country and production takes place in there. Since a country in order to attract investment must consider the earnings of investor if it would invest in the other country; a lump sum minimum subsidy is calculated in the model. They have found that, policy competition increases the attractiveness of small country, since small country is eager to attract investment and hence gives larger amount of subsidy. They also found that the more similar the location advantages of countries are, the deeper the policy competition is. However, if countries are asymmetric enough, countries can actually tax FDI. They strongly focus on the importance of market structure on the location choice of the investment. Our study is similar in terms of country demands, i.e. we also consider differences in market size, while we also differentiate marginal costs of firms and add exchange rate into analysis. Another difference is that, exporting of host country is possible which is excluded in Bjorvatn and Eckel (2006) article.

Barros and Cabral (2000) also consider a subsidy game between two asymmetric countries which small one has unemployment problem. The model aims to show the role of interaction between the relative size of each country and relative importance of employment gains in the policy competition to attract FDI. The option of the

MNC to export from home country is excluded from analysis. Both countries do not have local production; therefore the MNC would act like monopolist. Demand functions are given by;

$$Q_i = (a - P_i)\, S_i, \quad i=1, 2 \qquad \textbf{(2.1)}$$

where Q_i shows quantity of country i, P_i shows the price and S_i implies the relative market size. The model adds transportation cost, t, into analysis. The production technology has chosen so that one unit of labor produces one unit of output. Therefore the firm's cost function is:

$$C = (w - z)\, Q + F \qquad \textbf{(2.2)}$$

where Q is the quantity produced, F is the fixed cost; w is the wage rate and z a subsidy to marginal cost.

Two stage game is played. First subsidy levels to the MNC's marginal cost is determined by countries, then in the second stage, the MNC decides which country to invest and determines quantities to produce. They have found that, if both countries do not offer any subsidies, then the MNC will invest in large country and export to the small one. Higher transportation cost also makes large country more attractive. Since small country has employment gains, it would pay more subsidies to attract the MNC and hence with policy competition the MNC will invest in small country and export to the other. As far as countries' welfare is concerned, small country's welfare is greater under subsidy while large country's situation is always worse. Barros and Cabral (2000) also reached the conclusion that, cooperation of countries reduces the amount of subsidy without changing optimal location of FDI which is small country.

Another theoretic article about FDI and plant location choice is written by Fumagalli (2003). She analyses welfare effect of plant location choice of the MNC on two asymmetric countries in terms of their marginal costs. Differences in size are not considered, therefore countries are assumed to have same market demand.

$$Q_i = (a - P_i)\, S/2, \quad i=1, 2 \qquad \textbf{(2.3)}$$

where Q_i shows quantity of country i, P_i shows the price and S implies the market size. In her study she investigates the MNC's decision to invest one of those two countries or export back from its home country. Each country has one local firm to compete with the MNC. She also allows technological spillover in her model.

The timing of the game is as follows: In the first stage, subsidy levels are determined simultaneously by the host countries. In the second stage, the MNC decides whether to export back from its home country or to undertake a greenfield investment between those two countries and where to invest in the second case. At final stage, spillover rate is realized and the equilibrium payoffs for MNC and two host countries are determined. She has found out that depressed region benefits more from FDI and hence pay more subsidy. Moreover, welfare gain of the lagging country is positively related with the technological gap and the intensity of the spillover. As far as aggregate welfare is concerned, subsidies play the positive role to allocate investment to highest benefit area which is the technologically lagging country. Hence, welfare of depressed area is improving, while situation of advanced area is deteriorating. On the other hand, if technological differences are so extreme, subsidies increases aggregate welfare.

2.2 Effects of Exchange Rates on FDI

Multinational firms have various branches in different currency units and hence exchange rate movements have an impact on the profit level of the firm. The theoretical and empirical studies on the effect of exchange rates on FDI have reached different conclusions depending on the views the issue is taken into account.

Froot and Stein (1991) examine the connection between exchange rates and FDI in globally integrated capital markets. In their model, agents are risk-neutral and expected gross profits are the same for both domestic and foreign entrepreneurs. They assume the existence of informational imperfections that makes external borrowing more costly than using their own resources. By this, they established a connection between wealth of entrepreneurs and investment abilities. The depreciation of the domestic currency has increased the relative wealth of the foreigners, since their wealth consists of mostly their own currency units. As a result, in case of depreciation of the domestic currency, the relative cost of capital decreases for foreigners and (all else equal) their ability to win auctions increases. They empirically prove this by showing that FDI into US is negatively correlated with the value of the dollar. However, it is accepted also by writers that there are also many other factors that affect FDI inflows.

Cushman (1985) also modeled the effect of exchange rates on FDI by including uncertainty and expectations about future exchange rate movements. He analyzes four possible situations as follows:

In the first case, firm produces and sells in the foreign country by using domestic or foreign sources. In the second case, foreign production and sale financed domestically with the possibility of exporting domestically produced intermediate good. In the third case, local production and sale is considered while domestically financed intermediate good is imported during the production process. In the last case, the firm chooses between the alternatives of domestic investments for export production and domestically financed foreign production and sales.

The effects of the risk adjusted expected real foreign currency appreciation varies for the cases above. It reduces foreign capital cost and hence increase foreign direct investment for case one and two, while by increasing price of other inputs (for case three) or through price changes (for case four) may decrease foreign direct investment. Cushman (1985) also tests his model using bilateral FDI flows from US to several countries for the years 1963 to 1978. From this analysis, he found a strong relation between a decrease in US direct investment and expected appreciation of real foreign currency. He also shows that increases in risk also increases direct investment. His findings are consistent with his theoretical model for case three and four.

The relation between exchange rate and FDI flows are also discussed in the context of Chinese ability to attract FDI. Xing (2006) discussed the importance of China's exchange rate policy in order to explain the recent success of the country. The paper focuses on the investment by Japanese MNCs for the following reasons: Japanese MNCs have a significant role in the inward FDI. In addition to that Japanese production is export oriented and hence very sensitive to the exchange rate movements. Lastly, Yuan has pegged to the US dollar and this makes the Yuan fluctuates against the Yen as the Yen moves against the Dollar.

The devaluation of the Yuan decreases production costs relative to foreign production by decreasing the cost of Chinese labor and other inputs. In addition to that, since Japan uses China as an export platform its sales revenues are not affected from devaluations.

The bilateral exchange rate between the Yen and the Yuan and Japanese FDI in China correlates strongly. A real appreciation in the Yen was associated with an increase in FDI inflows. In order to prove his argument, an econometric model is specified and analysis conducted for the panel data set that covers 1981 to 2002 including nine manufacturing sector. From the analysis, he concludes that the real exchange rate is one of the most important factors in the Japanese FDI in China. The other factors, such as market size and the growth rate have a positive impact on the inward FDI.

Another paper that analyzes Japanese direct investment in Asia is written by Baek and Okawa (2001). They conduct an econometric study to show the relation between exchange rate and FDI and reached the conclusion that appreciation of the foreign currency (the Yen), increases inward FDI. This appreciation of yen makes Japanese firms to invest abroad, as theoretical models also suggests. Their analysis also takes into account wage rates that higher wages in Japan also has a positive correlation with FDI into Asian countries as in the theory of FDI suggest that labor cost differentials is a main determinant of FDI.

Sung and Lapan (2000) investigates the role of exchange rate uncertainty on the FDI decision of a risk-neutral MNC with the possibility of opening multiple plants in two countries. They allow shifting production from one plant to another in response to exchange rate movements. By including sunk costs into their model, they allow permanent effects of exchange rate movements on the profit levels. Their study consists of two parts: First they assume that the MNC can only sell in domestic market, but has an option to locate at home or abroad. The model assumes constant marginal costs in each plant with the same expected marginal costs. However, opening a plant in abroad yield higher sunk costs. The timing of the model is as follows: Firstly, investments decisions are made by the firm. The exchange rate that will prevail when the production takes place is determined. Finally, the MNC decides the location and amount of production. They have found that increase in the exchange rate variability raises the expected profits if foreign plants opened, therefore for larger values in variability yields opening of two plants whereas for small values the MNC operates by only investing in home country.

In the second part of their analysis, they allow for selling both in domestic and foreign markets and include a competition in foreign market. They reached the following conclusion that exchange rate volatility provides a strategic advantage to the MNC over local firm by allowing to invest in several locations.

2.3 Technological Spillover and FDI

One of the most important advantages of FDI is that FDI generates externalities in the form of technology transfer. There is a huge difference between developed and developing markets in their tendency to innovate. Developed countries have an access to larger markets and this increases innovation motive, technologies are improved and this raises productivity and expands the market and increases the incentive to innovate. Developed countries invest at least 2% of their gross domestic product to R&D process (Sachs, 2005).

Although poor countries are not inventors of new technology, they can still take the advantages by importing technology through foreign direct investment. As Sachs (2005) stated that, many East Asian countries became successful to improve their technological capability by not through domestic investments on R&D projects but through successfully attracting foreign direct investment which brought improved technologies with them. Multinational firms have not only advanced technology but also other non tangible productive assets such as managerial and marketing ability, export contracts and reputation (Markusen, 2002). Growing number of MNCs' investments in East Asia introduced sophisticated technology and advanced management process. Hosting of high-technology enterprises can lead to diffusion of knowledge, so that benefits of technology can be transferred to domestic firms. When workers employed by foreign firms take a job in local firms, their experience and knowledge can transfer to the latter In addition to that, domestic firms can increase their productivity by engaging business relations or simply observing foreign firms.

The successful international transfer of technology is undeniably linked with the economic growth. However, the cost of transfer can be considerably high when the technology is complex and the recipient firm does not have enough capability to utilize the technology. Teece (1977) defines transfer costs as the costs of transmitting and absorbing the relevant knowledge. He conducts an empirical research to analyze the transfer costs. He categorizes factors that affect cost of transfer under two groups. First group is about the factors that are related with the technology and transferor. He states that, there is a negative correlation between the understanding of the technology by the transferor, and the age of the technology and cost of transfer. Moreover, an increase in the number of similar and competitive technologies reduces cost of acquisition through increasing the availability of technology. The other group of factors that affect the cost of technology is related with the host country characteristics. First of all, the technical and managerial ability of the transferee facilitates the transfer. Skilled personnel can better understand and apply new process. Secondly, the size of the transferee reduces the cost of transfer through wide range of technical and managerial abilities. Another factor that decreases the cost of transfer is the R&D capability of the transferee and the infrastructure of the host country.

His empirical findings strongly support that transfer cost declines with the experience of transferee and number of firms using similar or competitive industry. The other factors are also found as significant but there are differences between the industry groups.

Aitken and Harrison (1999) investigate technological spillover to domestically owned firms from foreign entrants as well as changes in plant's productivity with the foreign ownership by using Venezuelan data. They used an unbalanced panel data set that covers 1976 to 1989 and includes up to 6.044 plants. According to their econometric analysis, there are large productivity gains related with foreign ownership within the plant. However, the productivity of domestic firms decreases as the foreign presence increase in the sector. Since multinational companies choose more productive sectors to invest, it may create a bias towards positive spillovers. Nevertheless, the study eliminates this bias by considering industry specific variables and reaches negative spillovers for domestic firms. The reason of the decline in productivity of domestic firms is that, foreign firms forces domestic ones to contract and hence increases their average costs. They also empirically investigate whether technology is transferred locally to domestic firms from the MNCs. The results are parallel to the previous case that technology is not transferred locally from foreign firms to domestic ones. According to their findings, benefits of FDI are not for the economy as a whole but only to joint ventures.

Blomström and Sjöholm (1999) analyze the effects of foreign ownership type on the technological spillover to host country using Indonesian manufacturing sector data of the year 1991. The majority of ownership brings about greater control over the profit, MNCs are assumed to transfer sophisticated technology to the host country, and hence spillover is expected to be high. To examine this assumption, they first look at labor productivity differences between domestic and foreign firms and then variation the degree of spillover with foreign participation. From the econometric analysis, they have reached the conclusion that foreign firms are more productive than the domestic ones and the degree of foreign ownership does not generate any difference in productivity levels. From examining degree of spillover, they found that domestic firms benefit from presence of foreign firms and the degree of spillover does not significantly change with the structure of foreign ownership. They reached the conclusion that technological spillover is not a result of local participation of MNCs but a result of competitive pressure of the foreign existence. They empirically support their arguments by showing positive spillovers in non-exporting local firms that did not face international competition before.

Kokko (1996) also finds evidence of productivity spillovers from foreign firms to local firms using Mexican data. According to his study, labor productivities of foreign and local firms are simultaneously determined because of the competition. As far as productivity spillovers are concerned, competition has an independent effect and does not depend on the foreign presence. He reached the conclusion that, spillovers are not important in the industries where competition is limited.

In a recent study Bwarya (2006) examine the technological spillovers both in intra-industry and inter-industry by using manufacturing sector data from Zambia. Data set consists of different industries and covers 1993-1995. The ratio of labor employed by foreign firms to total labor employed used as a proxy for computing intra-industry spillover rates, and the proportion of output produced by downstream sectors and supplied to upstream sectors weighted by the share of foreign employment to total employment in the industry used as a proxy for calculating inter-industry spillover rates. According to the econometric analysis, they have reached the conclusion that there is no spillover exists between intra-industry firms, but there exists technological spillover from foreign firms to domestic firms as far as inter-industry trade is concerned. Empirical results are consistent with Aitken and Harrison (1999) that an increase in foreign presence reduces productivity of domestic firms because of the limited competitive ability of the later.

Liu (2008) also examines whether presence of FDI increases the productivity level of domestic firms through technological spillover. The model assumes that technology cannot be transferred automatically and it requires a cost. His data set includes 20,000 Chinese firms from manufacturing sector over a 5 year period. His findings show that, FDI generates technology spillovers from foreign firms to domestic ones. However, like Aitken and Harrison (1999) stated, this spillover reduces productivity. Liu (2008) shows that productivity decline is only for short term, while in the long run there is a productivity growth of domestic firms. The logic behind is that, in short run domestic firms devote some of their resources to adopt new technologies from foreign firms. However, such learning and adaptation process help firms to increase their productive capacity in the future.

3. THE MODEL

The aim of the study is to analyze the effects of exchange rate level, technological spillover rate, technological advancement and market size differences on the plant location choice of a MNC in a game theoretic model.

For this purpose we construct a model with a region consisting of two asymmetric countries, namely A and B. The former is assumed to be large and technologically advanced while the latter one is relatively small and technologically lagged behind. There is a MNC from a third country, firm X, which is going to invest one of these two countries. The possibility of exporting from its country of origin is excluded since trade costs between the home country of X and the region under the question is assumed to be too high to be profitable. By assuming high trade costs, we also exclude the option of exporting back to home country. Therefore firm X can only serve the regional demand. With this structure, the model turns to be an export platform FDI.

In addition to that, the model also rules out the possibility that firm X invests in both countries because of high fixed cost. Hence, firm X invests only one of the countries and export to the other one.

In each country there is only one local firm and all firms, including MNC, produce identical products. Since country A is considered as a developed country, technology is assumed to be more advanced than those of B. Furthermore, because of the fact that multinational companies are the main source of research and development (R&D) activities and innovations, firm X uses the most efficient technology. Hence, cost structure of firms can be considered as $c_X = 0 < c_A < c_B$, where c_i, $i = X, A, B$ represents constant marginal costs of firms. Also investment in country A and country B incurs a fixed cost, f_A and f_B respectively. Since tariff barriers have been reduced in recent years and countries are assumed to be geographically close to each other, transportation costs are assumed to be negligible and are not included in the model.

Although these two countries are in the same region, they are assumed to have different currency units. In order to understand the effects of exchange rate on location decision of the MNC in a simple model, we assume that λ is the exchange rate between country A and B, and measured as developed country's (country A's) currency units per unit of developing country's (country B's) currency. The exchange rate between country A and firm X's home country is assumed to be 1.

Generally it is accepted that multinational companies bring superior technology, managerial know-how and other non-tangible productive assets and they can generate externalities in the form of technology transfer. As stated by Liu (2008) local firms can take benefit by observation and conducting business relations or through labor turnover as domestic employees move from foreign to domestic firms. Hence, our model also considers technological spillover; however this spillover occurs only between the MNC and technologically advanced firm A on the condition that the MNC invests in country A. If the MNC invests in country B and exports to country A, then spillover does not occur. We ignore the possibility of technological spillover between the MNC and firm B, since firm B is technologically so inefficient that cannot utilize advanced technology. Therefore our model adds technological spillover in terms of reducing firm A's marginal cost by the amount of $\phi\, c_A$ with $\phi \in (0\,,1]$. The spillover rate cannot be negative because we assume that the MNC uses the most efficient technology and it cannot have any negative effect on the other firm's original technology. ϕ can be at most a unity, in that case the firm becomes as efficient as the MNC.

In order to analyze market size on the plant location decision, country A and country B are also differentiated by their size. Linear demand function of country A is:

$$Q_A = \alpha\,(1- P_A) \qquad \textbf{(3.1)}$$

and of country B is:

$$Q_B = 1- P_B \qquad \textbf{(3.2)}$$

where Q_i is the quantity demanded in country i, P_i is the associated market price in country's own currency unit and α is a measure for market size. Since we assume that county A is larger than country B, we set the condition of $\alpha>1$.

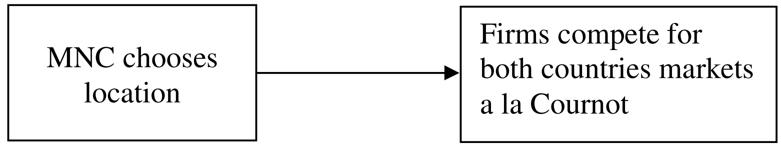

Figure 3.1: Timing of the Game

The timing of the game is as follows: At the first stage the MNC decides which country to locate its investment. In the second stage, firm X and local firms decide how much to produce and how much to export to the country not chosen as investment location. Firms compete under Cournot type competition and choose the quantity levels that maximize their profits. Figure 3.1 represents this game.

In this study, two cases are investigated separately in order to understand that how competition can affect the location choice in an environment where countries have different currencies. In the first case, firm B is assumed to be technologically so lagged that cannot compete with multinational firm and does not produce at all. In the second case firm B is assumed to produce but cannot export and only serve for its local market. In both cases, firm A is allowed to export to country B.

3.1. Case 1: No Competition in the Developing Country

In this case, we start by assuming that firm B has an inferior technology that makes marginal cost too high to produce positive quantities. As a result, it is assumed to be no local firm in developing country, and local demand is served by the MNC and exports of firm A.

Firm X looks profit levels in both countries than decides where to produce. Therefore, profit of firm X in both countries should be calculated.

To start with, we first consider the situation that firm X invests in country A. Profits of firm X and local firm A are simply summation of profits that earned in country A and country B after converted to country A's currency unit.

The profit functions of the firms are as follows:

$$\pi_{XA} = \left(1 - \frac{1}{\alpha}(q_A + q_{XA})\right) q_{XA} - f_A + (1 - q_{XB} - q_{Ab}) q_{XB} \lambda \quad \textbf{(3.3)}$$

$$\pi_A = \left(1 - \frac{1}{\alpha}(q_A + q_{XA}) - (1-\phi)c_A\right) q_A + (1 - q_{Xb} - q_{Ab} - (1-\phi)c_A) q_{Ab} \lambda \quad \textbf{(3.4)}$$

where q_{XA} and q_A are quantities produced by firm X and A respectively to serve country A, while q_{Xb} and q_{Ab} are quantities produced again by firm X and firm A respectively to be exported to the country B[2].

Then, firms maximize their profits with respect to their outputs as follows:

$$\max_{q_{XA}\ q_{Xb}} \pi_{XA} \quad \text{and} \quad \max_{q_A\ q_{Ab}} \pi_A \tag{3.5}$$

From the maximization above, equilibrium quantities of outputs can be obtained as follows[3]:

$$q_{XA} = \frac{1}{3}\alpha\left(1+(1-\phi)\,c_A\right) \tag{3.6}$$

$$q_A = \frac{1}{3}\alpha\left(1-2(1-\phi)\,c_A\right) \tag{3.7}$$

$$q_{Xb} = \frac{1}{3}\left(1+(1-\phi)c_A\right) \tag{3.8}$$

$$q_{Ab} = \frac{1}{3}\left(1-2(1-\phi)c_A\right) \tag{3.9}$$

In order to have positive quantities at the equilibrium level, our parameters must satisfy the condition of $1-2(1-\phi)c_A > 0$.

Equilibrium profits of firm X and firm A can be found by inserting (3.6), (3.7), (3.8) and (3.9) into profit functions (3.3) and (3.4):

$$\pi_{XA} = \frac{1}{9}(\alpha+\lambda)\left(1+(1-\phi)c_A\right)^2 - f_A \tag{3.10}$$

$$\pi_A = \frac{1}{9}(\alpha+\lambda)\left(1-2(1-\phi)c_A\right)^2 \tag{3.11}$$

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[2] The first letter in the subscript shows who produces, while the second letter shows whether the goods are produced in the country or exported. If the second letter is small, it means that the goods are exported.

[3] Second order conditions for profit maximization are satisfied.

In the second part of the analysis, we consider the case where the MNC invests in country B and serves country A by means of export. In this case, there will be no technological spillover from the MNC to firm A as it mentioned before. Profit functions are as follows:

$$\pi_{XB} = \left(1 - \frac{1}{\alpha}(q_A + q_{Xa})\right) q_{Xa} - f_B \lambda + (1 - q_{Ab} - q_{XB}) q_{XB} \lambda \quad \textbf{(3.12)}$$

$$\pi_A = \left(1 - \frac{1}{\alpha}(q_A + q_{Xa}) - c_A\right) q_A + (1 - q_{Ab} - q_{XB} - c_A) q_{Ab} \lambda \quad \textbf{(3.13)}$$

where q_A and q_{Ab} are the quantities produced by firm A to serve local demand of country A and for exporting to country B respectively; q_{Xa} and q_{XB} are the quantities produced by firm X, to be exported to country A and to be sold in country B respectively.

Both firms choose their output levels maximizing profits simultaneously:

$$\max_{q_{XB}\, q_{Xa}} \pi_{XB} \text{ and } \max_{q_A\, q_{Ab}} \pi_A \quad \textbf{(3.14)}$$

Solving the first order conditions of the maximization problem of (3.14) we can get the equilibrium output levels such as[4]:

$$q_{XB} = \frac{1}{3}(1 + c_A) \quad \textbf{(3.15)}$$

$$q_{Ab} = \frac{1}{3}(1 - 2c_A) \quad \textbf{(3.16)}$$

$$q_{Xa} = \frac{1}{3}\alpha(1 + c_A) \quad \textbf{(3.17)}$$

$$q_A = \frac{1}{3}\alpha(1 - 2\, c_A) \quad \textbf{(3.18)}$$

with the condition of $c_A < \frac{1}{2}$ which ensures positive output levels for firm A.

[4] Second order conditions for profit maximization are satisfied.

By inserting optimal quantities which are found as (3.15), (3.16), (3.17) and (3.18) into the profit functions (3.12) and (3.13), we obtain equilibrium profit levels of firm X and firm A respectively:

$$\pi_{XB} = \frac{1}{9}(\alpha + \lambda)(1 + c_A)^2 - \lambda f_B \quad \textbf{(3.19)}$$

$$\pi_A = \frac{1}{9}(\alpha + \lambda)(1 - 2c_A)^2 \quad \textbf{(3.20)}$$

In order to find out where the MNC is going to invest, we have to compare profits it would earn by establishing a greenfield investment at each country. If $\pi_{XA} > \pi_{XB}$, then firm X will invest in country A, otherwise it will invests in country B. From comparing equation (3.10) to (3.19), we reach the condition to invest in country A as follows:

$$(\alpha + \lambda)\phi\, c_A\,(-2 + (-2 + \phi)\, c_A) > 9 f_A - 9\lambda f_B \quad \textbf{(3.21)}$$

The condition to invest in country A can be rewritten as below:

$$\lambda > \frac{\alpha\phi\, c_A(2 - (-2 + \phi)c_A) + 9 f_A}{\phi c_A(-2 + (-2 + \phi)c_A) + 9 f_B} = \lambda^* \quad \textbf{(3.22)}$$

Proposition 1: If there is no firm in the developing country which can compete with MNC, MNC finds profitable to invest in larger developed country if exchange rate between two currencies is sufficiently large.

This implies the importance of the exchange rate level on the decision of plant location choice. If developing country devaluates its currency, exchange rate may decline below the threshold level and decrease the incentive to invest in larger developed country or vise versa. This result is in line with the former studies such as Cushman (1985), Froot and Stein (1991) and Xing (2006) and who state that domestic currency depreciation lead to inward FDI. The devaluation of country B's currency increases profit of the MNC by reducing the set-up cost in our model. Although it also reduces the sales revenue in country B, it would happen again in the case of producing in country A and exporting to country B.

Proposition 2: When the technologically lagged developing country firm cannot compete with MNC and local firm in large country, other things equal, if technological spillover rate increases, the attractiveness of developing country increases with higher spillover rates.

Proof of Proposition 2: Let us call the difference between profits that the MNC earns by investing country A and B as π_{XA-XB} and rewrite from the inequality (3.21):

$$\pi_{XA-XB} = (\alpha+\lambda)\phi\, c_A\,\left(-2+(-2+\phi)\,c_A\right)-9f_A+9\lambda f_B>0 \qquad \textbf{(3.23)}$$

After taking the derivative with respect to ϕ, it is found that

$$\frac{\partial \pi_{XA-XB}}{\partial \phi} = -2(\alpha+\lambda)\,c_A\left(1+(1-\phi)c_A\right)<0. \qquad \textbf{(3.24)}$$

The term in second parenthesis is positive with $0<\phi<1$ and $0<c_A<$ ½. This term is also equilibrium quantity of firm X in the case where it invests in country A. Since the values of α and λ are both positive, this whole term becomes negative.

As stated before, technological spillover is a factor that decreases marginal cost of the local firm of the developed country. Since we assume that it is allowed only between developed country firm and the MNC in the case of investing in there, if the MNC invests in developing country there will be no cost reduction for firm A. Higher costs of firm A will increase the profit level of the MNC under the Cournot competition.

If technological spillover is assumed to be protected by patent laws, then two alternative locations of investment are only differentiated by set up costs and exchange rates. In this case profit of the MNC earned by investing in country A will change while profit obtained by investing in country in B remains the same.

We can obtain profit function of the MNC simply by substituting ϕ with 0 in the equation (3.10), and then we get:

$$\pi^*_{XA} = \frac{1}{9}(\alpha+\lambda)(1+c_A)^2 - f_A \qquad \textbf{(3.25)}$$

Then the comparison of new profits yields the result that in order to invest the developed country the following condition should be satisfied:

$$\lambda f_B > f_A \quad \textbf{(3.26)}$$

From this we can clearly see the determinants of investment in one of these two countries. In other words, set up costs and exchange rate levels determine the plant location of MNC in the absence of technological spillover. Since λf_B is the set up denominated in country A's currency, we can write the following proposition:

Proposition 3: In the absence of technological spillover, the plant location decision of the MNC depends on the difference between the set-up costs in two countries.

Now we investigate the other extreme case that there is a perfect technological spillover between the developed country firm and the MNC. In this case, local firm becomes as efficient as the MNC. The profit of firm A can be calculated by substituting ϕ with 1:

$$\pi_{XA}^{**} = \frac{\alpha + \lambda}{9} - f_A \quad \textbf{(3.27)}$$

Therefore the difference between profits to invest in developed country becomes as follows:

$$9\lambda f_B > (\alpha + \lambda)c_A(2 + c_A) + 9f_A \quad \textbf{(3.28)}$$

From this we can say that either exchange rate or set up costs of investing in country B should be sufficiently high to satisfy this condition. It should be noted that, the setup costs in the developing country should be higher in order to invest in the developed country than the previous case where there is no technological spillover. Since the marginal cost of firm A turned out to be zero, it becomes as competitive as the MNC. In this case, in order to eliminate a powerful competitor and stay as the most efficient firm in the region the MNC prefers to locate in developing country where there is no room for technological spillover there. This finding can be summarized in the following proposition:

Proposition 4: If technological spillover is perfect that the local firm of developed country is as efficient as the MNC, setup cost of country B must be sufficiently high to ensure MNC's investment in developed country.

Proposition 5: Assuming that technologically lagged firm cannot compete with the MNC and local firm in large country, an increase in relative market size increases the attractiveness of developing country.

Proof of Proposition 5: If we take the derivative of (3.23) with respect to market size, we get:

$$\frac{d\pi_{XA-XB}}{d\alpha} = \phi c_A\left(-2+\left(-2+\phi\right)c_A\right) < 0 \qquad \textbf{(3.29)}$$

for $0<\phi<1$ and $c_A>0$, (3.29) is obviously negative.

With the absence of transportation costs and tariffs, when two markets are differentiated by technological spillover rate, set up costs and exchange rates, an increase in the size of the market increases the profit that the MNC would earn without depending on the location choice. However, since investing in country A yields lower profits because of the technological spillover has a cost reducing effect on local firm, increase in market size makes country B more attractive location.

This result is contradictory with former studies such as Haufler and Wooton (1998), Barros and Cabral (2000) and Bjorvatn and Eckel (2006) that have found that increase in market size increases the incentive to invest in larger country. However, since our model considers zero trade costs, everything else equal, increase in the size of the market causes a rise in domestic or foreign demand, depending on the location of production in the same way. Hence the effects of market size on local sales and exports are the same. If MNC produces in small developing country, relative increase in the size of the developed country means larger quantities of export without having extra transportation cost. The MNC hence chooses to produce in small country where there is no spillover to reduce marginal cost of the other exporting firm and no local competition.

3.2. Case 2: Competition in the Developing Country

Under this scenario, we assume that technological difference between the firm in the developing country and the MNC is not so high that all firms can produce positive amount. On the other hand, firm B still has inefficient technology that cannot export to the developed country, it can only serve the domestic demand.

As usual fashion, profit levels in both countries are calculated and then firm X decides where to produce and export to the other country.

To start with, we consider the situation that the MNC invests in country A. Profit of firm X and firm A are the summation of profits earned in both countries after converting to the same currency unit. Throughout the analysis, we converted developing country's currency to country A's currency unit in order to make them comparable.

The profit maximization problems of the firms are as follows:

$$\max_{q_{XA}\ q_{Xb}} \pi_{XA} = \left(1 - \frac{1}{\alpha}(q_A + q_{XA})\right) q_{XA} - f_A + (1 - q_{Xb} - q_{Ab} - q_B) q_{Xb} \lambda \quad \textbf{(3.30)}$$

$$\begin{aligned} \max_{q_A\ q_{Ab}} \pi_A = &\left(1 - \frac{1}{\alpha}(q_A + q_{XA}) - (1-\phi)c_A\right) q_A \\ &+ (1 - q_{Xb} - q_{Ab} - q_B - (1-\phi)c_A) q_{Ab} \lambda \end{aligned} \quad \textbf{(3.31)}$$

$$\max_{q_B} \pi_B = (1 - q_{Xb} - q_{Ab} - q_B - c_B) q_B \quad \textbf{(3.32)}$$

Since firm B cannot export, its profit function consists of only production in its own country. Firm A and X are producing and selling in country A and exporting to country B, hence their profits are simply the sum of the profits earned in both countries.

By solving the maximization problems formulated in (3.30), (3.30) and (3.32), equilibrium quantities of outputs can be found as follows:[5]

$$q_{XA} = \frac{1}{3}\alpha(1 + (1-\phi)c_A) \quad \textbf{(3.33)}$$

[5] Second order conditions for profit maximization are satisfied.

$$q_A = \frac{1}{3}\alpha\left(1 - 2\left(1 - \phi\right)c_A\right) \tag{3.34}$$

$$q_{Ab} = \frac{1}{4}\left(1 - 3\left(1 - \phi\right)c_A + c_B\right) \tag{3.35}$$

$$q_B = \frac{1}{4}\left(1 + \left(1 - \phi\right)c_A - 3c_B\right) \tag{3.36}$$

$$q_{Xb} = \frac{1}{4}\left(1 + \left(1 - \phi\right)c_A + c_B\right) \tag{3.37}$$

The equilibrium profit levels are obtained by inserting quantities from (3.33) to (3.37) into equations from (3.30) to (3.32):

$$\pi_{XA} = \frac{1}{9}\alpha\left(1 + \left(1 - \phi\right)c_A\right)^2 + \frac{1}{16}\lambda\left(1 + \left(1 - \phi\right)c_A + c_B\right)^2 - f_A \tag{3.38}$$

$$\pi_A = \frac{1}{9}\alpha\left(1 - 2\left(1 - \phi\right)c_A\right)^2 + \frac{1}{16}\lambda\left(1 - 3\left(1 - \phi\right)c_A + c_B\right)^2 \tag{3.39}$$

$$\pi_B = \frac{1}{16}\lambda\left(1 + \left(1 - \phi\right)c_A - 3c_B\right)^2 \tag{3.40}$$

Next, we assume that the MNC invests in small developing country and exports to large developed one. Like the first case that investigated in Section 3.1, technological spillover does not allowed in this case. The profit maximization problems of the firms can be formulated as follows:

$$\max_{q_{Xa}\, q_{XB}} = \left(1 - \frac{1}{\alpha}\left(q_A + q_{Xa}\right)\right)q_{Xa} - f_B\lambda + \left(1 - q_{XB} - q_{Ab} - q_B\right)q_{XB}\lambda \tag{3.41}$$

$$\max_{q_{Ab}\, q_A} = \left(1 - \frac{1}{\alpha}\left(q_A + q_{Xa}\right) - c_A\right)q_A + \left(1 - q_{XB} - q_{Ab} - q_B - c_A\right)q_{AB}\lambda \tag{3.42}$$

$$\max_{q_B} = \left(1 - q_{XB} - q_{Ab} - q_B - c_B\right)q_B\lambda \tag{3.43}$$

By solving the problem above, following equilibrium quantities can be derived:[6]

$$q_{Xa} = \frac{1}{3}\alpha(1 + c_A) \tag{3.44}$$

$$q_A = \frac{1}{3}\alpha(1 - 2c_A) \tag{3.45}$$

$$q_{Ab} = \frac{1}{4}(1 - 3c_A + c_B) \tag{3.46}$$

$$q_B = \frac{1}{4}(1 + c_A - 3c_B) \tag{3.47}$$

$$q_{XB} = \frac{1}{4}(1 + c_A + c_B) \tag{3.48}$$

After replacing the equilibrium quantities which are shown equations from (3.44) to (3.48) into (3.30) to (3.32), we can derive the equilibrium profit levels that would occur if the MNC invests in technologically lagged small developing country, and export to the other:

$$\pi_{XB} = \frac{1}{9}\alpha(1 + c_A)^2 + \frac{1}{16}\lambda(1 + c_A + c_B)^2 - \lambda f_B \tag{3.49}$$

$$\pi_A = \frac{1}{9}\alpha(1 - 2c_A)^2 + \frac{1}{16}\lambda(1 - 3c_A + c_B)^2 \tag{3.50}$$

$$\pi_B = \frac{1}{16}\lambda(1 + c_A - 3c_B)^2 \tag{3.51}$$

In order to understand the investment decision of the MNC we should compare the profit levels that firm X earns under these two scenarios that are discussed above. If $\pi_{XA} > \pi_{XB}$, then the MNC invests in country A, and otherwise it invests in country B.

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[6] Second order conditions for profit maximization are satisfied.

Let us call the difference between profit levels π_{XA-XB}. The comparison of profits from equations (3.38) and (3.49) requires the following condition to invest in developed country:

$$\phi c_A\left(\left(16\alpha+9\lambda\right)\left(-2+\left(-2+\phi\right)c_A\right)-18\lambda c_B\right)+144\lambda f_B>144 f_A \qquad \textbf{(3.52)}$$

From this comparison threshold exchange rate level can be calculated as:

$$\lambda>-\frac{16\alpha\phi c_A\left(-2+\left(-2+\phi\right)c_A\right)+144 f_A}{9\phi c_A\left(\left(-2+\phi\right)c_A-2\left(1+c_B\right)\right)+144 f_B}=\lambda^{**} \qquad \textbf{(3.53)}$$

From this analysis above, it can be written a similar proposition as in for the first case.

Proposition 6: If both developing and developed countries have local firms, there is a threshold exchange rate level that MNC finds profitable to invest in larger developed country if exchange rate between two currencies is sufficiently large.

As in the previous case, depreciation of the developing country currency increases the attractiveness of the developed country. Since the mechanism is same as the first case, there is no need for further explanations.

The market size effect also works in the same direction as in the first case. It can be stated in the following proposition.

Proposition 7: If both developing and developed countries have local firms, an increase in relative market size increases the attractiveness of developing country.

Proof of Proposition 7: In order to show that, let us define the difference between profits that the MNC earns from investments in two different countries as π_{XA-XB} and rewrite inequality as follows:

$$\pi_{XA-XB}=\phi c_A\left(\left(16\alpha+9\lambda\right)\left(-2+\left(-2+\phi\right)c_A\right)-18\lambda c_B\right)+144\lambda f_B-144 f_A>0 \qquad \textbf{(3.54)}$$

Then we take the derivative with respect to market size, we get the following result:

$$\frac{\partial\pi_{XA-XB}}{\partial\alpha}=16\phi c_A\left(-2+\left(-2+\phi\right)c_A\right)<0 \qquad \textbf{(3.55)}$$

for $0<\phi<1$ and $c_A>0$, (3.55) is obviously negative.

Proposition 8: If both countries have a local firm, the attractiveness of developed country increases with the technological efficiency of the developing country firm.

Proof of Proposition 8: The derivative of the difference of profits with respect to marginal cost of the local firm in the developing country is as follows:

$$\frac{\partial \pi_{XA-XB}}{\partial c_B} = -18\lambda\phi c_A < 0 \qquad \textbf{(3.56)}$$

Since it is assumed that marginal costs of firms are the reflection of technological ability, it is obvious that a decrease in the marginal cost of the developing country firm increases the difference between profit levels. An increase in the marginal cost of the firm reduces its equilibrium output while increasing its competitors' output and profit level. In this case, attractiveness of the developing country increases.

As far as technological spillover rate is concerned, we reach similar results as we have found as market size. The effect of an increase in technological spillover leads to an increase in the attractiveness of developing country. It can be written as the following proposition:

Proposition 9: If both countries have a local firm, the attractiveness of developing country increases with higher spillover rates.

Proof: The derivative of the difference of profits with respect to technological spillover rate is as follows:

$$\frac{\partial \pi_{XA-XB}}{\partial \phi} = c_A\left(2(16\alpha+9\lambda)((\phi-1)c_A-1)-18\lambda c_B\right) < 0 \qquad \textbf{(3.57)}$$

for $0<\phi<1$, $c_B>c_A>0$, $\alpha>0$, $\lambda>0$; (3.57) becomes negative.

In order to see the differences in profit levels graphically, we can give certain values to parameters and find out the effect of changes in these variables. Appendix-C provides a brief numerical analysis.

3.3 Comparison of Two Cases

In order to see the effects of considering firm B as a competitive firm in developing country, we can compare two threshold levels that we found under two different scenarios. However, the net effect is inconclusive since the result depends on the value of variables especially the value of fixed cost in the developing country. But, if we have assumed that fixed costs in county B is greater than 0.09 we get the following proposition[7]:

Proposition 10: Assuming that there is a local firm in the developed country which can export, adding competition into developing country increases the incentive of MNC to invest in the developed country for sufficiently large fixed costs in developing country, compared to situation where there is no local firm in the developing country.

Threshold exchange rate level is smaller in the case where we include firm B as a competitor in the developing country. The competition in the developing country reduces the attractiveness of county B, and the MNC prefers to invest in the developed country.

Since the aim of the study is to analyze the effects of exchange rate and technological spillover on plant location decision of MNC, the comparison of two cases is not stressed. In this study since each case is analyzed in detail, we did not focus on the comparison. However, the comparison of two cases can be extended in further studies.

[7] Mathematica outputs are in the Appendix A

4. SUMMARY AND CONCLUSIONS

The aim of the study is to analyze the effects of exchange rates, technological spillover, technological capabilities of local firms and market size differences on a MNC's location choice in a game theoretical model.

Even though there is a wide literature on FDI and plant location choice of MNC, our study differentiates from previous studies in several ways. First of all, studies that summarized in the first part of the literature survey such as Fumagalli (2003), Barros and Cabral (2000), Haaparanta (1996) and others analyze the effects of government policies on plant location decision of a MNC. Except Fumagalli (2003), they did not consider technological spillover rate. We extend the analysis by considering effects of exchange rates and technological spillover. The related literature on exchange rates and technological spillover are mostly deal with the problem of location choice by using econometric models. We benefit from these results in constructing and analyzing our game theoretic model.

In the third part, we constructed a simple model to analyze MNC's location choice. Two different scenarios are examined to understand the effects of competition in the developing country. From the analysis of the model, several propositions were derived. Moreover, a comparison of two cases is presented.

The analysis of the model shows that the location decision of the MNC depends on the level of exchange rate, technological spillover rate, market size and technological ability of local firms. It is found that the attractiveness of the developing country increases with the market size of the developed country and depreciation of the local currency without depending on the competition in the developing country. As far as technological spillover is concerned, we reached a similar result that the attractiveness of developing country increases with higher spillover rates.

The comparison of two cases indicates that, an increase in competition in the developing country reduces the threshold level of exchange rate. In other words, the attractiveness of developed country increases.

The model is analyzed in an environment where there are no trade costs. The countries are assumed to be located geographically close to each other. The recent developments in transportation technology reduce cost of transport. In addition to that trade barriers are reduced by governments. However, the analysis can be extended by considering trade costs.

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APPENDIX-A

MATHEMATICA OUTPUTS

Profit of MNC if it invests in country A;

$$\pi_{XA} = \left(1 - \frac{1}{\alpha}\left(q_A + q_{XA}\right)\right) q_{XA} - f_A + \left(1 - q_{Xb} - q_{Ab}\right) q_{Xb} * \lambda;$$

$$D[\pi_{XA},\ q_{XA}]$$

$$D[\pi_{XA},\ q_{Xb}]$$

$$1 - \frac{q_{XA}}{\alpha} - \frac{q_A + q_{XA}}{\alpha}$$

$$\lambda\ (1 - q_{Ab} - q_{Xb}) - \lambda\ q_{Xb}$$

profits of firm A, if MNC invests in country A

$$\pi_A = \left(1 - \frac{1}{\alpha}\left(q_A + q_{XA}\right) - (1-\phi)\ c_A\right) q_A + \left(1 - q_{Xb} - q_{Ab} - (1-\phi)\ c_A\right) q_{Ab} * \lambda;$$

$$D[\pi_A,\ q_A]$$

$$D[\pi_A,\ q_{Ab}]$$

$$1 - (1-\phi)\ c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{XA}}{\alpha}$$

$$-\lambda\ q_{Ab} + \lambda\ (1 - (1-\phi)\ c_A - q_{Ab} - q_{Xb})$$

$$\text{Solve}\left[\left\{1 - \frac{q_{XA}}{\alpha} - \frac{q_A + q_{XA}}{\alpha} == 0,\ 1 - (1-\phi)\ c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{XA}}{\alpha} == 0\right\},\ \{q_{XA},\ q_A\}\right]$$

$$\left\{\left\{q_{XA} \to \frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A),\ q_A \to \frac{1}{3}\ (\alpha - 2\ \alpha\ c_A + 2\ \alpha\ \phi\ c_A)\right\}\right\}$$

$$\text{Solve}[\{\lambda\ (1 - q_{Ab} - q_{Xb}) - \lambda\ q_{Xb} == 0,\ -\lambda\ q_{Ab} + \lambda\ (1 - (1-\phi)\ c_A - q_{Ab} - q_{Xb}) == 0\},\ \{q_{Xb},\ q_{Ab}\}]$$

$$\left\{\left\{q_{Xb} \to \frac{1}{3}\ (1 + c_A - \phi\ c_A),\ q_{Ab} \to \frac{1}{3}\ (1 - 2\ c_A + 2\ \phi\ c_A)\right\}\right\}$$

$$\text{ReplaceAll}\left[\left(1 - \frac{1}{\alpha}\left(q_A + q_{XA}\right)\right) q_{XA} - f_A + (1 - q_{Xb} - q_{Ab})\ q_{Xb} * \lambda,\right.$$
$$\left.\left\{q_{XA} \to \frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A),\ q_A \to \frac{1}{3}\ (\alpha - 2\ \alpha\ c_A + 2\ \alpha\ \phi\ c_A),\ q_{Xb} \to \frac{1}{3}\ (1 + c_A - \phi\ c_A),\ q_{Ab} \to \frac{1}{3}\ (1 - 2\ c_A + 2\ \phi\ c_A)\right\}\right]$$

$$\frac{1}{3}\ \lambda\ (1 + c_A - \phi\ c_A)\ \left(1 + \frac{1}{3}\ (-1 + 2\ c_A - 2\ \phi\ c_A) + \frac{1}{3}\ (-1 - c_A + \phi\ c_A)\right) +$$
$$\frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A)\ \left(1 - \frac{\frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A) + \frac{1}{3}\ (\alpha - 2\ \alpha\ c_A + 2\ \alpha\ \phi\ c_A)}{\alpha}\right) - f_A$$

$$\text{FullSimplify}\left[\frac{1}{3}\ \lambda\ (1 + c_A - \phi\ c_A)\ \left(1 + \frac{1}{3}\ (-1 + 2\ c_A - 2\ \phi\ c_A) + \frac{1}{3}\ (-1 - c_A + \phi\ c_A)\right) +\right.$$
$$\left.\frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A)\ \left(1 - \frac{\frac{1}{3}\ (\alpha + \alpha\ c_A - \alpha\ \phi\ c_A) + \frac{1}{3}\ (\alpha - 2\ \alpha\ c_A + 2\ \alpha\ \phi\ c_A)}{\alpha}\right) - f_A\right]$$

$$\pi_{XA} = \frac{1}{9}\ (\alpha + \lambda)\ (-1 + (-1 + \phi)\ c_A)^2 - f_A$$

$$\text{ReplaceAll}\left[\left(1-\frac{1}{\alpha}(q_A+q_{XA})-(1-\phi)\,c_A\right)q_A+(1-q_{Xb}-q_{Ab}-(1-\phi)\,c_A)\,q_{Ab}*\lambda,\right.$$
$$\left.\left\{q_{XA}\to\frac{1}{3}(\alpha+\alpha\,c_A-\alpha\,\phi\,c_A),\ q_A\to\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A),\ q_{Xb}\to\frac{1}{3}(1+c_A-\phi\,c_A),\ q_{Ab}\to\frac{1}{3}(1-2\,c_A+2\,\phi\,c_A)\right\}\right]$$

$$\frac{1}{3}\lambda\,(1-2\,c_A+2\,\phi\,c_A)\left(1-(1-\phi)\,c_A+\frac{1}{3}(-1+2\,c_A-2\,\phi\,c_A)+\frac{1}{3}(-1-c_A+\phi\,c_A)\right)+$$
$$\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A)\left(1-(1-\phi)\,c_A-\frac{\frac{1}{3}(\alpha+\alpha\,c_A-\alpha\,\phi\,c_A)+\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A)}{\alpha}\right)$$

$$\text{FullSimplify}\left[\frac{1}{3}\lambda\,(1-2\,c_A+2\,\phi\,c_A)\left(1-(1-\phi)\,c_A+\frac{1}{3}(-1+2\,c_A-2\,\phi\,c_A)+\frac{1}{3}(-1-c_A+\phi\,c_A)\right)+\right.$$
$$\left.\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A)\left(1-(1-\phi)\,c_A-\frac{\frac{1}{3}(\alpha+\alpha\,c_A-\alpha\,\phi\,c_A)+\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A)}{\alpha}\right)\right]$$

$$\frac{1}{9}(\alpha+\lambda)\,(1+2\,(-1+\phi)\,c_A)^2$$

$$\pi_A=\frac{1}{9}(\alpha+\lambda)\,(1+2\,(-1+\phi)\,c_A)^2$$

in order to have positive profits ,

$$\text{FullSimplify}\left[\frac{1}{3}(\alpha+\alpha\,c_A-\alpha\,\phi\,c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_A>0\}\right]$$

True

$$\text{FullSimplify}\left[\frac{1}{3}(\alpha-2\,\alpha\,c_A+2\,\alpha\,\phi\,c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_A>0\}\right]$$

$$1+2\,(-1+\phi)\,c_A>0$$

$$\text{FullSimplify}\left[\frac{1}{3}(1+c_A-\phi\,c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_A>0\}\right]$$

True

$$\text{FullSimplify}\left[\frac{1}{3}(1-2\,c_A+2\,\phi\,c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_A>0\}\right]$$

$$1+2\,(-1+\phi)\,c_A>0$$

profits of MNC if it invests in county B

$$\pi_{XB} = \left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa})\right) q_{Xa} - f_B * \lambda + (1 - q_{Ab} - q_{Xb})\, q_{Xb} * \lambda;$$

$$D[\pi_{XB},\, q_{Xa}]$$

$$D[\pi_{XB},\, q_{Xb}]$$

$$1 - \frac{q_{Xa}}{\alpha} - \frac{q_A + q_{Xa}}{\alpha}$$

$$\lambda\,(1 - q_{Ab} - q_{Xb}) - \lambda\, q_{Xb}$$

profits of firm A if MNC invests in country B

$$\pi_A = \left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa}) - c_A\right) q_A + (1 - q_{Ab} - q_{Xb} - c_A)\, q_{Ab} * \lambda;$$

$$D[\pi_A,\, q_A]$$

$$D[\pi_A,\, q_{Ab}]$$

$$1 - c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{Xa}}{\alpha}$$

$$-\lambda\, q_{Ab} + \lambda\,(1 - c_A - q_{Ab} - q_{Xb})$$

$$\text{Solve}\left[\left\{1 - \frac{q_{Xa}}{\alpha} - \frac{q_A + q_{Xa}}{\alpha} == 0,\ 1 - c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{Xa}}{\alpha} == 0\right\},\ \{q_{Xa},\, q_A\}\right]$$

$$\left\{\left\{q_{Xa} \to \frac{1}{3}\,(\alpha + \alpha\, c_A),\ q_A \to \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A)\right\}\right\}$$

$$\text{Solve}[\{\lambda\,(1 - q_{Ab} - q_{Xb}) - \lambda\, q_{Xb} == 0,\ -\lambda\, q_{Ab} + \lambda\,(1 - c_A - q_{Ab} - q_{Xb}) == 0\},\ \{q_{Xb},\, q_{Ab}\}]$$

$$\left\{\left\{q_{Xb} \to \frac{1}{3}\,(1 + c_A),\ q_{Ab} \to \frac{1}{3}\,(1 - 2\, c_A)\right\}\right\}$$

$$\text{ReplaceAll}\left[\left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa})\right) q_{Xa} - f_B * \lambda + (1 - q_{Ab} - q_{Xb})\, q_{Xb} * \lambda,\right.$$
$$\left.\left\{q_{Xa} \to \frac{1}{3}\,(\alpha + \alpha\, c_A),\ q_A \to \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A),\ q_{Xb} \to \frac{1}{3}\,(1 + c_A),\ q_{Ab} \to \frac{1}{3}\,(1 - 2\, c_A)\right\}\right]$$

$$\frac{1}{3}\,\lambda\,(1 + c_A)\left(1 + \frac{1}{3}\,(-1 - c_A) + \frac{1}{3}\,(-1 + 2\, c_A)\right) + \frac{1}{3}\,(\alpha + \alpha\, c_A)\left(1 - \frac{\frac{1}{3}\,(\alpha - 2\,\alpha\, c_A) + \frac{1}{3}\,(\alpha + \alpha\, c_A)}{\alpha}\right) - \lambda\, f_B$$

$$\text{FullSimplify}\left[\frac{1}{3}\,\lambda\,(1 + c_A)\left(1 + \frac{1}{3}\,(-1 - c_A) + \frac{1}{3}\,(-1 + 2\, c_A)\right) + \frac{1}{3}\,(\alpha + \alpha\, c_A)\left(1 - \frac{\frac{1}{3}\,(\alpha - 2\,\alpha\, c_A) + \frac{1}{3}\,(\alpha + \alpha\, c_A)}{\alpha}\right) - \lambda\, f_B\right]$$

$$\pi_{XB} = \frac{1}{9}\,(\alpha + \lambda)\,(1 + c_A)^2 - \lambda\, f_B$$

$$\text{ReplaceAll}\left[\left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa}) - c_A\right) q_A + (1 - q_{Ab} - q_{Xb} - c_A)\, q_{Ab} * \lambda,\right.$$
$$\left.\left\{q_{Xa} \to \frac{1}{3}\,(\alpha + \alpha\, c_A),\ q_A \to \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A),\ q_{Xb} \to \frac{1}{3}\,(1 + c_A),\ q_{Ab} \to \frac{1}{3}\,(1 - 2\, c_A)\right\}\right]$$

$$\frac{1}{3}\,\lambda\,(1 - 2\, c_A)\left(1 + \frac{1}{3}\,(-1 - c_A) - c_A + \frac{1}{3}\,(-1 + 2\, c_A)\right) + \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A)\left(1 - c_A - \frac{\frac{1}{3}\,(\alpha - 2\,\alpha\, c_A) + \frac{1}{3}\,(\alpha + \alpha\, c_A)}{\alpha}\right)$$

$$\text{FullSimplify}\left[\frac{1}{3}\ \lambda\ (1-2\ c_A)\ \left(1+\frac{1}{3}\ (-1-c_A)-c_A+\frac{1}{3}\ (-1+2\ c_A)\right)+\frac{1}{3}\ (\alpha-2\ \alpha\ c_A)\ \left(1-c_A-\frac{\frac{1}{3}\ (\alpha-2\ \alpha\ c_A)+\frac{1}{3}\ (\alpha+\alpha\ c_A)}{\alpha}\right)\right]$$

$$\pi_A=\frac{1}{9}\ (\alpha+\lambda)\ (1-2\ c_A)^2$$

$$\text{FullSimplify}\left[\frac{1}{3}\ (\alpha+\alpha\ c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_B>0\}\right]$$

True

$$\text{FullSimplify}\left[\frac{1}{3}\ (\alpha-2\ \alpha\ c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_B>0\}\right]$$

$2\ c_A<1$

$$\text{FullSimplify}\left[\frac{1}{3}\ (1+c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_B>0\}\right]$$

True

$$\text{FullSimplify}\left[\frac{1}{3}\ (1-2\ c_A)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ f_B>0\}\right]$$

$2\ c_A<1$

--Comparison of two cases:

$$\text{FullSimplify}\left[\frac{1}{9}\ (\alpha+\lambda)\ (-1+(-1+\phi)\ c_A)^2-f_A-\left(\frac{1}{9}\ (\alpha+\lambda)\ (1+c_A)^2-\lambda\ f_B\right)>0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ 2\ c_A<1,\ 1+2\ (-1+\phi)\ c_A>0,\ f_A>0,\ f_B>0\}\right]$$

$(\alpha+\lambda)\ \phi\ c_A\ (-2+(-2+\phi)\ c_A)+9\ \lambda\ f_B>9\ f_A$

$$\text{D}[(\alpha+\lambda)\ \phi\ c_A\ (-2+(-2+\phi)\ c_A)+9\ \lambda\ f_B-9\ f_A,\ \phi]$$

$(\alpha+\lambda)\ \phi\ c_A^2+(\alpha+\lambda)\ c_A\ (-2+(-2+\phi)\ c_A)$

$$\text{FullSimplify}\left[(\alpha+\lambda)\ \phi\ c_A^2+(\alpha+\lambda)\ c_A\ (-2+(-2+\phi)\ c_A)<0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ 2\ c_A<1,\ 1+2\ (-1+\phi)\ c_A>0\}\right]$$

True

$$\text{D}[(\alpha+\lambda)\ \phi\ c_A\ (-2+(-2+\phi)\ c_A)+9\ \lambda\ f_B-9\ f_A,\ \alpha]$$

$\phi\ c_A\ (-2+(-2+\phi)\ c_A)$

$$\text{FullSimplify}[\phi\ c_A\ (-2+(-2+\phi)\ c_A)<0,\ \{\alpha>1,\ 0<\phi<1,\ c_A>0,\ \lambda>0,\ 2\ c_A<1,\ 1+2\ (-1+\phi)\ c_A>0\}]$$

True

$$\text{Solve}\left[\frac{1}{9}\ (\alpha+\lambda)\ (-1+(-1+\phi)\ c_A)^2-f_A==\frac{1}{9}\ (\alpha+\lambda)\ (1+c_A)^2-\lambda\ f_B,\ \lambda\right]$$

$$\left\{\left\{\lambda\to\frac{2\ \alpha\ \phi\ c_A+2\ \alpha\ \phi\ c_A^2-\alpha\ \phi^2\ c_A^2+9\ f_A}{-2\ \phi\ c_A-2\ \phi\ c_A^2+\phi^2\ c_A^2+9\ f_B}\right\}\right\}$$

II. CASE

profit of MNC if invests in country A

$$\pi_{XA} = \left(1 - \frac{1}{\alpha}(q_A + q_{XA})\right) q_{XA} - f_A + (1 - q_{Xb} - q_{Ab} - q_B)\, q_{Xb} * \lambda;$$

D[π_{XA}, q_{XA}]

D[π_{XA}, q_{Xb}]

$$1 - \frac{q_{XA}}{\alpha} - \frac{q_A + q_{XA}}{\alpha}$$

$$\lambda\,(1 - q_{Ab} - q_B - q_{Xb}) - \lambda\, q_{Xb}$$

profit of firm A if MNC invests in country A

$$\pi_A = \left(1 - \frac{1}{\alpha}(q_A + q_{XA}) - (1-\phi)\, c_A\right) q_A + (1 - q_{Xb} - q_{Ab} - q_B - (1-\phi)\, c_A)\, q_{Ab} * \lambda;$$

D[π_A, q_A]

D[π_A, q_{Ab}]

$$1 - (1-\phi)\, c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{XA}}{\alpha}$$

$$-\lambda\, q_{Ab} + \lambda\,(1 - (1-\phi)\, c_A - q_{Ab} - q_B - q_{Xb})$$

profit of firm B, if MNC invests in country A

$$\pi_{Ba} = (1 - q_{Xb} - q_{Ab} - q_B - c_B)\, q_B * \lambda;$$

D[π_{Ba}, q_B]

$$-\lambda\, q_B + \lambda\,(1 - c_B - q_{Ab} - q_B - q_{Xb})$$

$$\text{Solve}\left[\left\{1 - \frac{q_{XA}}{\alpha} - \frac{q_A + q_{XA}}{\alpha} == 0,\ 1 - (1-\phi)\, c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{XA}}{\alpha} == 0\right\}, \{q_{XA}, q_A\}\right]$$

$$\left\{\left\{q_{XA} \to \frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A),\ q_A \to \frac{1}{3}(\alpha - 2\,\alpha\, c_A + 2\,\alpha\,\phi\, c_A)\right\}\right\}$$

$$\text{Solve}[\{\lambda\,(1 - q_{Ab} - q_B - q_{Xb}) - \lambda\, q_{Xb} == 0,\ -\lambda\, q_{Ab} + \lambda\,(1 - (1-\phi)\, c_A - q_{Ab} - q_B - q_{Xb}) == 0,$$
$$-\lambda\, q_B + \lambda\,(1 - c_B - q_{Ab} - q_B - q_{Xb}) == 0\}, \{q_{Ab}, q_B, q_{Xb}\}]$$

$$\left\{\left\{q_{Ab} \to \frac{1}{4}(1 - 3\, c_A + 3\,\phi\, c_A + c_B),\ q_B \to \frac{1}{4}(1 + c_A - \phi\, c_A - 3\, c_B),\ q_{Xb} \to \frac{1}{4}(1 + c_A - \phi\, c_A + c_B)\right\}\right\}$$

$$\text{ReplaceAll}\left[\left(1 - \frac{1}{\alpha}(q_A + q_{XA})\right) q_{XA} - f_A + (1 - q_{Xb} - q_{Ab} - q_B)\, q_{Xb} * \lambda,\right.$$
$$\left\{q_{XA} \to \frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A),\ q_A \to \frac{1}{3}(\alpha - 2\,\alpha\, c_A + 2\,\alpha\,\phi\, c_A),\ q_{Ab} \to \frac{1}{4}(1 - 3\, c_A + 3\,\phi\, c_A + c_B),\right.$$
$$\left.\left. q_B \to \frac{1}{4}(1 + c_A - \phi\, c_A - 3\, c_B),\ q_{Xb} \to \frac{1}{4}(1 + c_A - \phi\, c_A + c_B)\right\}\right]$$

$$\frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A)\left(1 - \frac{\frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A) + \frac{1}{3}(\alpha - 2\,\alpha\, c_A + 2\,\alpha\,\phi\, c_A)}{\alpha}\right) +$$
$$\frac{1}{4}\lambda\,(1 + c_A - \phi\, c_A + c_B)\left(1 + \frac{1}{4}(-1 + 3\, c_A - 3\,\phi\, c_A - c_B) + \frac{1}{4}(-1 - c_A + \phi\, c_A - c_B) + \frac{1}{4}(-1 - c_A + \phi\, c_A + 3\, c_B)\right) - f_A$$

$$\text{FullSimplify}\left[\frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A)\left(1 - \frac{\frac{1}{3}(\alpha + \alpha\, c_A - \alpha\,\phi\, c_A) + \frac{1}{3}(\alpha - 2\,\alpha\, c_A + 2\,\alpha\,\phi\, c_A)}{\alpha}\right)\right]$$

$$\frac{1}{9}\alpha\,(-1 + (-1+\phi)\, c_A)^2$$

$$\text{FullSimplify}\left[\frac{1}{4}\lambda\,(1 + c_A - \phi\, c_A + c_B)\left(1 + \frac{1}{4}(-1 + 3\, c_A - 3\,\phi\, c_A - c_B) + \frac{1}{4}(-1 - c_A + \phi\, c_A - c_B) + \frac{1}{4}(-1 - c_A + \phi\, c_A + 3\, c_B)\right)\right]$$

$$\frac{1}{16}\lambda\,(1 - (-1+\phi)\, c_A + c_B)^2$$

$$\pi_{XA} = \frac{1}{9}\alpha\,(-1 + (-1+\phi)\, c_A)^2 + \frac{1}{16}\lambda\,(1 - (-1+\phi)\, c_A + c_B)^2 - f_A$$

```
ReplaceAll[(1 - 1/α (qA + qXA) - (1 - φ) cA) qA + (1 - qXb - qAb - qB - (1 - φ) cA) qAb * λ,
 {qXA → 1/3 (α + α cA - α φ cA), qA → 1/3 (α - 2 α cA + 2 α φ cA), qAb → 1/4 (1 - 3 cA + 3 φ cA + cB),
  qB → 1/4 (1 + cA - φ cA - 3 cB), qXb → 1/4 (1 + cA - φ cA + cB)}]

1/3 (α - 2 α cA + 2 α φ cA) (1 - (1 - φ) cA - (1/3 (α + α cA - α φ cA) + 1/3 (α - 2 α cA + 2 α φ cA))/α) +
 1/4 λ (1 - 3 cA + 3 φ cA + cB)
  (1 - (1 - φ) cA + 1/4 (-1 + 3 cA - 3 φ cA - cB) + 1/4 (-1 - cA + φ cA - cB) + 1/4 (-1 - cA + φ cA + 3 cB))

FullSimplify[1/3 (α - 2 α cA + 2 α φ cA) (1 - (1 - φ) cA - (1/3 (α + α cA - α φ cA) + 1/3 (α - 2 α cA + 2 α φ cA))/α)] +
 FullSimplify[1/4 λ (1 - 3 cA + 3 φ cA + cB)
   (1 - (1 - φ) cA + 1/4 (-1 + 3 cA - 3 φ cA - cB) + 1/4 (-1 - cA + φ cA - cB) + 1/4 (-1 - cA + φ cA + 3 cB))]

1/9 α (1 + 2 (-1 + φ) cA)^2 + 1/16 λ (1 + 3 (-1 + φ) cA + cB)^2

ReplaceAll[(1 - qXb - qAb - qB - cB) qB * λ,
 {qXA → 1/3 (α + α cA - α φ cA), qA → 1/3 (α - 2 α cA + 2 α φ cA), qAb → 1/4 (1 - 3 cA + 3 φ cA + cB),
  qB → 1/4 (1 + cA - φ cA - 3 cB), qXb → 1/4 (1 + cA - φ cA + cB)}]

1/4 λ (1 + cA - φ cA - 3 cB) (1 + 1/4 (-1 + 3 cA - 3 φ cA - cB) + 1/4 (-1 - cA + φ cA - cB) - cB + 1/4 (-1 - cA + φ cA + 3 cB))

FullSimplify[
 1/4 λ (1 + cA - φ cA - 3 cB)
  (1 + 1/4 (-1 + 3 cA - 3 φ cA - cB) + 1/4 (-1 - cA + φ cA - cB) - cB + 1/4 (-1 - cA + φ cA + 3 cB))]

1/16 λ (-1 + (-1 + φ) cA + 3 cB)^2

-----quantitities should be greater than zero.

FullSimplify[1/3 (α + α cA - α φ cA) > 0, {α > 1, 0 < φ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]

True

FullSimplify[1/3 (α - 2 α cA + 2 α φ cA) > 0, {α > 1, 0 < φ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]

1 + 2 (-1 + φ) cA > 0

FullSimplify[1/4 (1 - 3 cA + 3 φ cA + cB) > 0, {α > 1, 0 < φ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]

1 + 3 (-1 + φ) cA + cB > 0

FullSimplify[1/4 (1 + cA - φ cA - 3 cB) > 0, {α > 1, 0 < φ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]

(-1 + φ) cA + 3 cB < 1

FullSimplify[1/4 (1 + cA - φ cA + cB) > 0, {α > 1, 0 < φ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]

True
```

profits of MNC if it invests in country B

$$\pi_{XB} = \left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa})\right) q_{Xa} - f_B * \lambda + (1 - q_{XB} - q_{Ab} - q_B)\, q_{XB} * \lambda;$$

$D[\pi_{XB}, q_{Xa}]$

$D[\pi_{XB}, q_{XB}]$

$$1 - \frac{q_{Xa}}{\alpha} - \frac{q_A + q_{Xa}}{\alpha}$$

$$\lambda\,(1 - q_{Ab} - q_B - q_{XB}) - \lambda\, q_{XB}$$

profits of firm A, if MNC invets in country B

$$\pi_A = \left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa}) - c_A\right) q_A + (1 - q_{XB} - q_{Ab} - q_B - c_A)\, q_{Ab} * \lambda;$$

$D[\pi_A, q_A]$

$D[\pi_A, q_{Ab}]$

$$1 - c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{Xa}}{\alpha}$$

$$-\lambda\, q_{Ab} + \lambda\,(1 - c_A - q_{Ab} - q_B - q_{XB})$$

profits of firm B, if MNC invets in country B

$$\pi_B = (1 - q_{XB} - q_{Ab} - q_B - c_B)\, q_B * \lambda;$$

$D[\pi_B, q_B]$

$$-\lambda\, q_B + \lambda\,(1 - c_B - q_{Ab} - q_B - q_{XB})$$

$$\text{Solve}\left[\left\{1 - \frac{q_{Xa}}{\alpha} - \frac{q_A + q_{Xa}}{\alpha} == 0,\ 1 - c_A - \frac{q_A}{\alpha} - \frac{q_A + q_{Xa}}{\alpha} == 0\right\}, \{q_{Xa}, q_A\}\right]$$

$$\left\{\left\{q_{Xa} \to \frac{1}{3}\,(\alpha + \alpha\, c_A),\ q_A \to \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A)\right\}\right\}$$

$$\text{Solve}[\{\lambda\,(1 - q_{Ab} - q_B - q_{XB}) - \lambda\, q_{XB} == 0,\ -\lambda\, q_{Ab} + \lambda\,(1 - c_A - q_{Ab} - q_B - q_{XB}) == 0,$$
$$-\lambda\, q_B + \lambda\,(1 - c_B - q_{Ab} - q_B - q_{XB}) == 0\}, \{q_{Ab}, q_B, q_{XB}\}]$$

$$\left\{\left\{q_{Ab} \to \frac{1}{4}\,(1 - 3\, c_A + c_B),\ q_B \to \frac{1}{4}\,(1 + c_A - 3\, c_B),\ q_{XB} \to \frac{1}{4}\,(1 + c_A + c_B)\right\}\right\}$$

$$\text{ReplaceAll}\left[\left(1 - \frac{1}{\alpha}\,(q_A + q_{Xa})\right) q_{Xa} - f_B * \lambda + (1 - q_{XB} - q_{Ab} - q_B)\, q_{XB} * \lambda,\right.$$
$$\left\{q_{Xa} \to \frac{1}{3}\,(\alpha + \alpha\, c_A),\ q_A \to \frac{1}{3}\,(\alpha - 2\,\alpha\, c_A),\ q_{Ab} \to \frac{1}{4}\,(1 - 3\, c_A + c_B),\ q_B \to \frac{1}{4}\,(1 + c_A - 3\, c_B),\right.$$
$$\left.\left. q_{XB} \to \frac{1}{4}\,(1 + c_A + c_B)\right\}\right]$$

$$\frac{1}{3}\,(\alpha + \alpha\, c_A)\left(1 - \frac{\frac{1}{3}\,(\alpha - 2\,\alpha\, c_A) + \frac{1}{3}\,(\alpha + \alpha\, c_A)}{\alpha}\right) +$$
$$\frac{1}{4}\,\lambda\,(1 + c_A + c_B)\left(1 + \frac{1}{4}\,(-1 - c_A - c_B) + \frac{1}{4}\,(-1 + 3\, c_A - c_B) + \frac{1}{4}\,(-1 - c_A + 3\, c_B)\right) - \lambda\, f_B$$

$$\text{FullSimplify}\left[\frac{1}{3}\,(\alpha + \alpha\, c_A)\left(1 - \frac{\frac{1}{3}\,(\alpha - 2\,\alpha\, c_A) + \frac{1}{3}\,(\alpha + \alpha\, c_A)}{\alpha}\right)\right] +$$
$$\text{FullSimplify}\left[\frac{1}{4}\,\lambda\,(1 + c_A + c_B)\left(1 + \frac{1}{4}\,(-1 - c_A - c_B) + \frac{1}{4}\,(-1 + 3\, c_A - c_B) + \frac{1}{4}\,(-1 - c_A + 3\, c_B)\right)\right] -$$
$$\lambda\, f_B$$

$$\frac{1}{9}\,\alpha\,(1 + c_A)^2 + \frac{1}{16}\,\lambda\,(1 + c_A + c_B)^2 - \lambda\, f_B$$

$$\pi_{XB} = \frac{1}{9}\,\alpha\,(1 + c_A)^2 + \frac{1}{16}\,\lambda\,(1 + c_A + c_B)^2 - \lambda\, f_B$$

```
ReplaceAll[(1 - qXB - qAb - qB - cB) qB * λ,
 {qXa → 1/3 (α + α cA), qA → 1/3 (α - 2 α cA), qAb → 1/4 (1 - 3 cA + cB), qB → 1/4 (1 + cA - 3 cB),
  qXB → 1/4 (1 + cA + cB)}]
```

$\frac{1}{4}\lambda(1+c_A-3c_B)\left(1+\frac{1}{4}(-1-c_A-c_B)+\frac{1}{4}(-1+3c_A-c_B)-c_B+\frac{1}{4}(-1-c_A+3c_B)\right)$

```
FullSimplify[1/4 λ (1 + cA - 3 cB) (1 + 1/4 (-1 - cA - cB) + 1/4 (-1 + 3 cA - cB) - cB + 1/4 (-1 - cA + 3 cB))]
```

$\pi_B = \frac{1}{16}\lambda(1+c_A-3c_B)^2$

quantities should be larger than zero

```
FullSimplify[1/3 (α + α cA) > 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]
```

True

```
FullSimplify[1/3 (α - 2 α cA) > 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]
```

$2c_A < 1$

```
FullSimplify[1/4 (1 - 3 cA + cB) > 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]
```

$1 + c_B > 3c_A$

```
FullSimplify[1/4 (1 + cA - 3 cB) > 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]
```

$1 + c_A > 3c_B$

```
FullSimplify[1/4 (1 + cA + cB) > 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0}]
```

True

comparison of two profits;

```
FullSimplify[1/9 α (-1 + (-1 + ϕ) cA)^2 + 1/16 λ (1 - (-1 + ϕ) cA + cB)^2 - fA >
  1/9 α (1 + cA)^2 + 1/16 λ (1 + cA + cB)^2 - λ fB,
 {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0,
  1 + 2 (-1 + ϕ) cA > 0, 1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

$\phi c_A((16\alpha+9\lambda)(-2+(-2+\phi)c_A)-18\lambda c_B)+144\lambda f_B > 144 f_A$

```
D[ϕ cA ((16 α + 9 λ) (-2 + (-2 + ϕ) cA) - 18 λ cB) + 144 λ fB - 144 fA, ϕ]
```

$(16\alpha+9\lambda)\phi c_A^2 + c_A((16\alpha+9\lambda)(-2+(-2+\phi)c_A)-18\lambda c_B)$

```
FullSimplify[(16 α + 9 λ) ϕ cA^2 + cA ((16 α + 9 λ) (-2 + (-2 + ϕ) cA) - 18 λ cB) < 0,
 {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0,
  1 + 2 (-1 + ϕ) cA > 0, 1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

$(16\alpha+9\lambda)(-1+(-1+\phi)c_A) < 9\lambda c_B$

Since the left of the inequality is always negative and right is positive,
this inequality holds with our conditions.

```
D[ϕ cA ((16 α + 9 λ) (-2 + (-2 + ϕ) cA) - 18 λ cB) + 144 λ fB - 144 fA, α]
```

$16\phi c_A(-2+(-2+\phi)c_A)$

```
FullSimplify[16 ϕ cA (-2 + (-2 + ϕ) cA) < 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0,
  1 + 2 (-1 + ϕ) cA > 0, 1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

True

we compare profits for case II

```
FullSimplify[1/9 α (-1 + (-1 + ϕ) cA)^2 + 1/16 λ (1 - (-1 + ϕ) cA + cB)^2 - fA >
  1/9 α (1 + cA)^2 + 1/16 λ (1 + cA + cB)^2 - λ fB,
  {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0, fA > 0, fB > 0, 1 + 2 (-1 + ϕ) cA > 0,
   1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

$\phi c_A ((16 \alpha + 9 \lambda) (-2 + (-2 + \phi) c_A) - 18 \lambda c_B) + 144 \lambda f_B > 144 f_A$

```
Solve[ϕ cA ((16 α + 9 λ) (-2 + (-2 + ϕ) cA) - 18 λ cB) + 144 λ fB - 144 fA == 0, λ]
```

$$\left\{\left\{\lambda \to -\frac{16 (-2 \alpha \phi c_A - 2 \alpha \phi c_A^2 + \alpha \phi^2 c_A^2 - 9 f_A)}{9 (-2 \phi c_A - 2 \phi c_A^2 + \phi^2 c_A^2 - 2 \phi c_A c_B + 16 f_B)}\right\}\right\}$$

```
FullSimplify[-(16 (-2 α ϕ cA - 2 α ϕ cA^2 + α ϕ^2 cA^2 - 9 fA))/(9 (-2 ϕ cA - 2 ϕ cA^2 + ϕ^2 cA^2 - 2 ϕ cA cB + 16 fB)),
  {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0, fA > 0, fB > 0, 1 + 2 (-1 + ϕ) cA > 0,
   1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

$$\frac{-16 \alpha \phi c_A (-2 + (-2 + \phi) c_A) + 144 f_A}{9 \phi c_A ((-2 + \phi) c_A - 2 (1 + c_B)) + 144 f_B}$$

In[22]:=

```
D[ϕ cA ((16 α + 9 λ) (-2 + (-2 + ϕ) cA) - 18 λ cB) + 144 λ fB - 144 fA, cB]
-18 λ ϕ cA
FullSimplify[-18 λ ϕ cA < 0, {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0, fA > 0, fB > 0,
   1 + 2 (-1 + ϕ) cA > 0, 1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
True
```

---Comparison of two cases

λ* and λ** are compared

In[26]:=

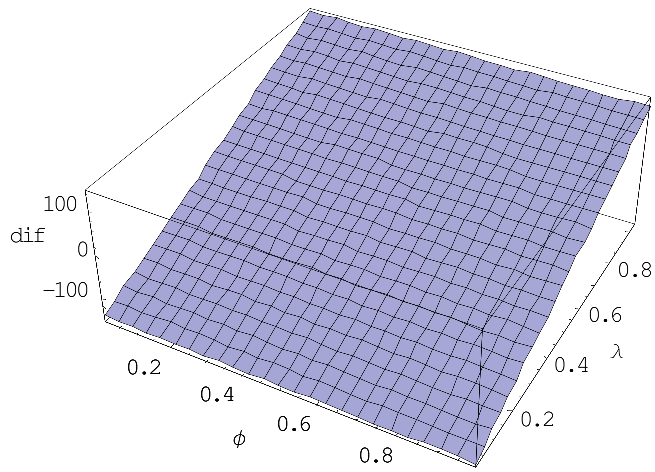
```
FullSimplify[(α ϕ cA (2 - (-2 + ϕ) cA) + 9 fA)/(ϕ cA (-2 + (-2 + ϕ) cA) + 9 fB) - ((-16 α ϕ cA (-2 + (-2 + ϕ) cA) + 144 fA)/(9 ϕ cA ((-2 + ϕ) cA - 2 (1 + cB)) + 144 fB)) > 0,
  {α > 1, 0 < ϕ < 1, cA > 0, cB > 0, cA < cB, λ > 0, fA > 0, fB > 0.09, 1 + 2 (-1 + ϕ) cA > 0,
   1 + 3 (-1 + ϕ) cA + cB > 0, (-1 + ϕ) cA + 3 cB < 1, 2 cA < 1, 1 + cB > 3 cA, 1 + cA > 3 cB}]
```

Out[26]= True

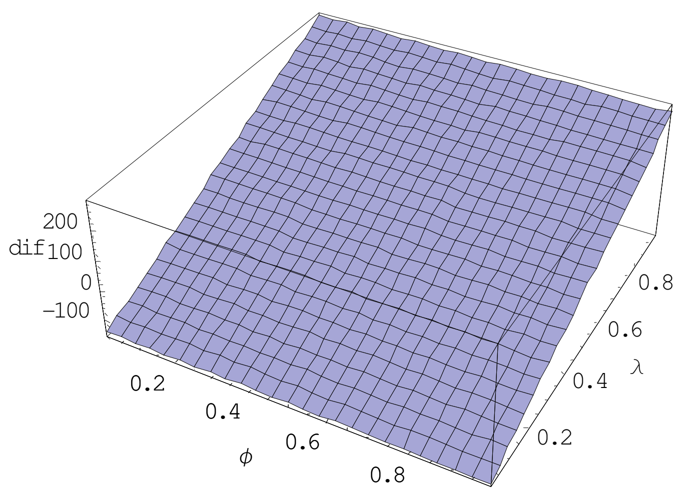
APPENDIX-B

NUMERICAL APPLICATIONS

In the case $\pi_{XA-XB} = \phi c_A \left((16\alpha + 9\lambda)(-2 + (-2+\phi)c_A) - 18\lambda c_B \right) + 144\lambda f_B - 144 f_A$, the variables taking the values of α=1.5, c_A=1/5, c_B=1/3, f_A=1, generate results for changing values of f_B with $0<\phi<1$ and $0<\lambda<1$.



f_B=2



f_B=3

Figure C.1: Numerical Applications (f_B=2,3)

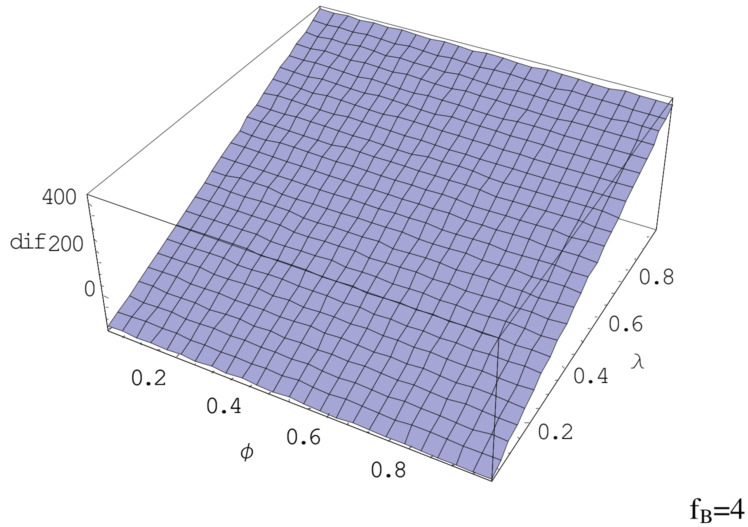


Figure C.2: Numerical Applications (f_B=4)

From the analysis above, it can be seen that the difference between profit levels are increasing with the exchange rate obviously. However, the effects of technological spillover are rather less obvious for the assigned values for the parameters.

If we keep setup cost in country B stable and increase market size, for the values of, c_A=1/5, c_B=1/3, f_A=1, f_B=2 we get the following graphical representations:

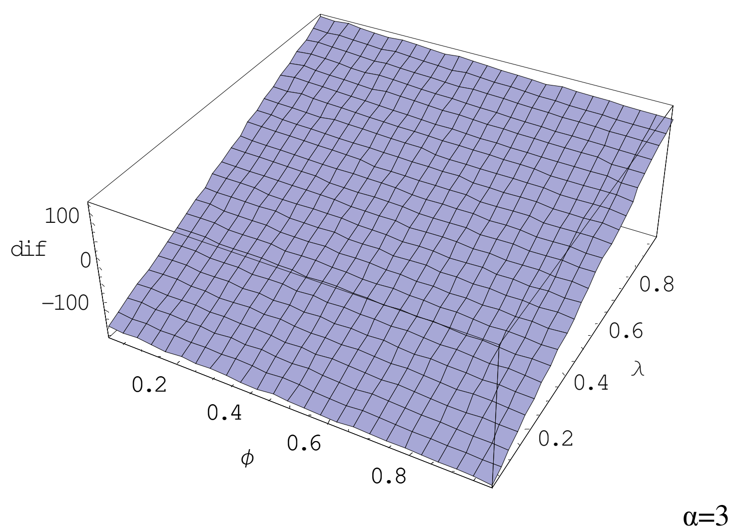
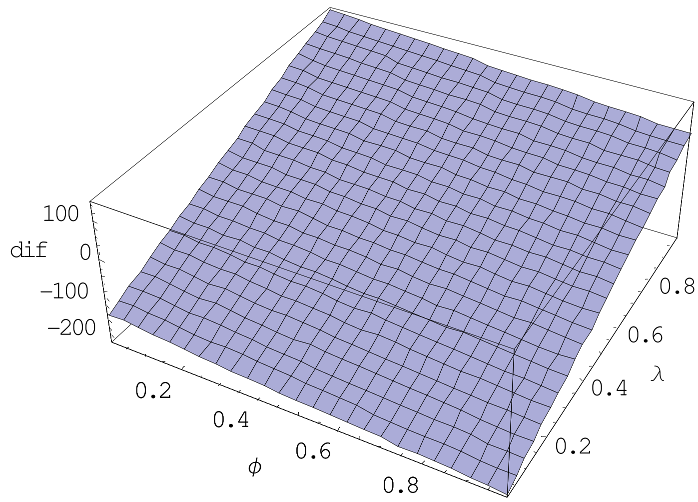


Figure C.3: Numerical Applications (α=3)



α=10

Figure C.4: Numerical Applications (α=10)

As market gets larger, the effects of technological spillover become more obvious and the attractiveness of developing country increases.

CURRICULUM VITAE

Suna GÖNÜLTAŞ was born in 1980, Istanbul. She graduated from Halide Edip Adıvar High School in 1998 and the same year started her BA degree in the Department of Economics at Boğaziçi University. She completed her degree in 2003 with honor. She continues her master degree at Istanbul Technical University and works as a research assistant at the Economics and Finance Department of Dogus University.