The Multinational Enterprise:

Foreign Market Entry, Transfer of Technology, and Technology Spillovers

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Chapter 1

Introduction

1.1 Foreign Direct Investment: Definitions, Recent Trends, and Issues of Concern

Over the last two decades worldwide production and consumption of goods and services have become increasingly internationalized. Globalization is characterized by an increase in foreign direct investment (FDI) and international trade. FDI by multinational enterprises is one of its most striking signs growing both in absolute terms and relative to trade. The increasing importance of FDI is reflected, furthermore, in the fact that it grew by 18 per cent in the year 2000 as highlighted in the United Nations' 2001 *World Investment Report* (UNCTAD [2001]). This trend is accompanied by a growing interest of economists in the determinants of foreign direct investment. Different branches of economics aim to explain its causes and consequences. From an international finance and macroeconomic perspective, FDI is seen as a particular form of the flow of capital across national borders. Therefore, the determinants of the flows of investment and the stock of capital controlled by a foreign investor in another country are of profound interest. On the other hand, the motivation for direct investment in a foreign country from the investor's point of view is analyzed on a microeconomic level. The consequences to the investor, as well as to home and host country, are the focus of the present examinations.

Before coming to the main empirical observations and theoretical findings, as regards foreign direct investment, it is useful to define the term FDI. There does not exist a general definition of what foreign direct investment specifies. However, most definitions share common features that distinguish FDI from portfolio investment and other arrangements. "Foreign direct investment reflects the objective of obtaining a lasting interest by a resident entity in one economy ("direct investor") in an entity resident in an economy other than that of the investor ("direct investment enterprise"). The lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence on the management of the enterprise", (IMF [1993] and OECD [1996]). The United Nations' 2001 *World Investment Report* defines FDI as "an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in one economy (foreign direct investor or parent enterprise) in an enterprise resident in an economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate)".[1] Common to both kinds of definitions are the terms degree of influence and control. Both are important aspects that distinguish foreign direct investment from portfolio investment. In contrast, a portfolio investment which typically is undertaken by pension funds or trust funds involves a smaller share of ownership and, mostly, a short term time horizon. These investors usually do not directly take part in the management of the company of investment and are in this sense passive. On the other hand, exercising control over its local subsidiary is the main interest of the investor of a foreign direct investment.

To give an overview of the recent trends in foreign direct investment and an impression of its volume and importance, let us report on the FDI flows and stocks. FDI *flows* comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to an FDI enterprise, or capital received from an FDI enterprise by a foreign direct investor. Flows

[1] A "lasting interest" is identified with at least 10 per cent ownership by the foreign direct investor.

consist of three components: Equity capital, reinvested earnings, and intra-company loans. FDI *stocks* represent the value of the share of their capital and reserves (including retained profits) attributable to the parent enterprise, plus the net indebtedness of affiliates to the parent enterprise.[2]

Table 1.1 shows FDI inflows and outflows for selected regions during the period 1995-2000 and an average number for the period 1989-1994.[3]

Table 1.1: FDI inflows and outflows (Billions of US dollars)

Region/country	1989-94*	1995	1996	1997	1998	1999	2000
Inflows							
European Union	76.6	113.5	109.6	127.6	261.1	467.2	617.3
USA	42.5	58.8	84.5	103.4	174.4	295.0	281.1
Developing countries	59.6	113.3	152.5	187.4	188.4	222.0	240.2
Japan	1.0	0.0	0.2	3.2	3.3	12.7	8.2
CEE	3.4	14.3	12.7	19.2	21.0	23.2	25.4
World	200.2	331.1	384.9	477.9	692.5	1075.1	1270.8
Outflows							
European Union	105.2	159.0	183.2	220.4	454.3	720.1	773.0
USA	49.0	92.1	84.4	95.8	131.0	142.6	139.3
Developing countries	24.9	49.0	57.6	65.8	37.8	58.0	99.6
Japan	29.6	22.5	23.4	26.1	24.2	22.7	32.9
CEE	0.1	0.5	1.1	3.4	2.1	2.1	4.0
World	228.3	355.3	391.6	466.0	711.9	1005.8	1149.9

Note: *Annual average.

Source: UNCTAD [2001].

The first thing to note is the rapid growth of FDI flows. Between 1995 and 2000 total FDI inflows nearly quadrupled, reaching a maximum value of

[2]UNCTAD [2001].

[3]The numbers are on a net basis, i.e. as capital transactions' credits less debits between direct investors and their foreign affiliates. Net decreases in assets (FDI outward) or net increases in liabilities (FDI inward) are recorded as credits (recorded with a positive sign in the balance of payments), while net increases in assets or net decreases in liabilities are recorded as debits (recorded with a negative sign in the balance of payments). The negative signs are deleted for convenience, (UNCTAD [2001]).

close to 1.3 trillion US dollars.[4] A second striking fact is that the majority of foreign direct investment takes place between developed countries. Within this group the European Union, USA, and Japan accounted for 71.3 per cent of world inflows and 82.2 per cent of world outflows in 2000. The share of inflows to developing countries decreased slightly to 19 per cent in 2000. The countries in Central and Eastern Europe (CEE) received 25.4 billion US dollars, retaining a share of roughly 2 per cent of world inflows.

Table 1.2 reports on the stocks of FDI for various years.[5]

Table 1.2: FDI inward and outward stocks (Billions of US dollars)

Region/country	1980	1985	1990	1995	1999	2000
Inward stocks						
European Union	185.7	236.5	739.6	1131.4	1835.1	2376.2
USA	83.1	184.6	394.9	535.6	965.6	1238.6
Developing countries	240.8	347.2	487.7	849.4	1740.4	1979.3
Japan	3.3	4.7	9.9	33.5	46.1	54.3
CEE	-	0.1	3.0	36.4	102.0	124.7
World	615.8	893.6	1888.7	2937.5	5196.1	6314.3
Outward stocks						
European Union	213.0	293.1	790.3	1312.5	2448.7	3110.9
USA	220.2	251.0	430.5	699.0	1130.8	1244.7
Developing countries	16.5	32.6	79.8	252.9	611.4	710.3
Japan	19.6	44.0	201.4	238.5	248.8	281.7
CEE	0.0	0.0	0.4	5.4	13.5	17.4
World	523.9	707.8	1717.4	2879.4	5004.8	5976.2

Source: UNCTAD [2001].

The observed trends for FDI flows are reflected in the stocks of FDI, too. The European Union, USA, and Japan accounted for 58.1 per cent of inward

[4]The discrepancy between the total numbers for world inflows and outflows, which should theoretically be the same, arises due to measurement errors.

[5]FDI stocks are estimated by either cumulating FDI flows over a period of time, or adding flows to an FDI stock that has been obtained for a particular year from national official sources or the IMF data series on assets and liabilities of direct investment (UNCTAD [2001]).

and 77.6 per cent of outward stocks. The share of inward FDI stocks in developing countries is 20.2 per cent and for countries in CEE 2 per cent.

Foreign Direct Investment may either involve the establishment of a new facility, a so-called greenfield investment, or the acquisition (of shares) of an existing company. Acquisitions are generally subsumed with mergers under the title mergers and acquisitions (M&A). However, the major part of M&A are classified as acquisitions, while only about 3 per cent are mergers.[6]

Table 1.3: Cross-border mergers and acquisitions (Billions of US dollars)

Region/country	1994	1995	1996	1997	1998	1999	2000
Sales							
European Union	55.3	75.1	81.9	114.6	187.9	357.3	586.5
USA	44.7	53.2	68.1	81.7	209.6	251.9	324.4
Developing countries	14.9	16.0	34.7	64.6	80.8	73.6	69.7
Japan	0.8	0.5	1.7	3.1	4.0	16.4	15.5
CEE	1.3	5.9	3.6	5.5	5.1	9.2	16.9
World	127.1	186. 6	227.0	304.9	531.7	766.0	1143.8
Purchases							
European Union	63.9	81.4	96.7	142.1	284.4	517.2	801.8
USA	28.5	57.3	60.7	80.9	137.4	120.3	159.3
Developing countries	10.2	12.8	28.1	32.5	19.2	57.7	42.1
Japan	1.1	3.9	5.7	2.8	1.3	10.5	20.9
CEE	0.3	0.1	0.5	0.2	1.0	1.5	1.7
World	127.1	186.6	227.0	304.9	531.7	766.0	1143.8

Source: UNCTAD [2001].

As can be seen from Table 1.3, cross-border M&A have been tremendously increasing. The value of M&A in 2000 was almost 9 times the one of 1994.[7] Moreover, M&A seem to be the main stimulus behind foreign direct investment, as a comparison of Table 1.1 and Table 1.3 reveals. For the year 2000 worldwide M&A accounted for over 90 per cent of FDI inflows as well as outflows. However, it should be noted that the value of cross-border M&A and

[6] See UNCTAD [2000], p. xix.

[7] For a more detailed overview on trends in cross-border M&A and strategic alliances see OECD [2001].

FDI flows are not exactly comparable due to different measuring methodologies and statistical reasons.[8] For example, payments for M&A can be phased over several years.[9] Nevertheless, the statistics indicate a clear trend.

In contrast, the picture is very different for developing and CEE countries. For developing countries in 2000 M&A sales, as a percentage of FDI inflows, accounted for 29 per cent and M&A purchases for 42.3 per cent of FDI outflows. For CEE countries M&A sales made up 39.7 per cent in 1999 and 66.5 per cent in 2000 of FDI inflows. For German FDI in Eastern Europe Marin, Lorentowicz and Raubold [2002] report a similar pattern based on a survey of 1050 investment projects. They further find that in 1997 about 44 per cent of FDI flows were accounted for by M&A, 56 per cent by greenfield investments. However, independently of the country of origin a clear shift away from greenfield investment towards M&A over time can be observed. Meyer [1998] also finds that greenfield investment is the most common mode of entry into CEE countries, accounting for about 53 per cent of all projects in his 1994 sample. Interestingly, he finds that entry into fast-growing industries in CEE takes place via greenfield investment but not via acquisition. This is particularly surprising, since for entry into fast-growing industries M&A are expected to be more attractive due to providing a fast entry opportunity. In contrast to this observation Caves and Mehra [1986] find the opposite result for entry into the US which lends support to the fast access argument. Thus, it becomes obvious that the mode of foreign entry in choosing between greenfield investment and acquisition depends on country or regional characteristics such as the level of development. The remaining question is, what determines the choice of entry mode? And moreover, how do various market or country characteristics affect this choice?

The increasing general interest of economists in FDI is, on the one hand, stimulated by the rapid growth and high volume: Foreign direct investment seems to be an important stimulus for economic growth, and it acts as a

[8]See OECD [2001], p. 19 or UNCTAD [2001], p. 289.

[9]For an example see UNCTAD [1999], p. 8.

channel for transfer of technology and know-how. By attracting FDI host countries hope to gain access to advanced technologies and skills. FDI may result in benefits to the host country, even if the multinational retains full control over its foreign subsidiary. On the other hand, there are various issues of concern on both sides of the investment, i.e. home country and the host country. These concerns are of economic, social, political, and cultural nature. In particular, the strong involvement of M&A has raised a number of worries.[10] Cross-border M&A are often viewed differently than purely national arrangements from a policy making point of view. Most countries prefer to retain local control of domestic firms. Some countries therefore restricted inward FDI in several ways. Greenfield investments seem to be more welcomed than acquisitions. The conventional argument in this respect is that acquisitions are a less beneficial mode of entry with respect to the economic development of a country since they do not add up to local capacity. From a home country perspective the concerns center around worries that outward FDI may substitute for domestic investment and for domestic workforce. Thus, foreign direct investment can generate inequalities and unemployment in the home country. Moreover, it is feared that foreign direct investment results in a loss of technological leadership of the host country. On the other hand, it is sometimes argued that multinationals must invest abroad in order to stay competitive in a world of increasing globalization.

All of these considerations emphasize the necessity of a sound economic analysis which helps to assess the validity of the various concerns.[11] Therefore, the driving forces behind FDI and the chosen organizational form, i.e. joint ventures versus wholly owned subsidiaries and greenfield investment versus acquisition, need a careful examination.

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[10]The *World Investment Report 2000* (UNCTAD [2000]) provides an overview of the effects of different entry modes on economic development and concerns of host and home countries towards FDI.

[11]Recent experiences with financial crises in some developing countries have also lead to a controversial discussion about the risks and benefits of FDI. See for instance Albuquerque [2000], Hausmann and Fernández-Arias [2000], Krugman [2000] and Lipsey [2001].

1.2 Theories of Foreign Direct Investment and Empirical Evidence

Whenever a multinational enterprise (MNE) invests in a foreign country it faces several obstacles and disadvantages of doing business abroad, i.e. the MNE has to incur certain costs attributable to its foreign operation.[12] These costs of business in a foreign country are caused, for example, by communication costs, transportation costs, cultural differences or lack of local experience. Therefore, the MNE must, on the other hand, possess certain advantages over the domestic firms which more than outweigh these costs. This argument dates back to Hymer [1976]. More formally Dunning [1977] introduced a framework to identify the advantages and conditions under which FDI should occur.[13] According to the "eclectic paradigm" three conditions have to be met for a foreign direct investment to be an advantageous arrangement: Ownership, location, and internalization (OLI) advantages.[14] A firm's *ownership advantage* could be a product or a superior production process. Thus, the firm owns a value creating asset or possesses a particular skill which is superior to domestic firms. The *location advantage* makes it more profitable for the firm to produce in the foreign country instead of, for example, producing in the home country and exporting its products. Moreover, there must exist some *internalization advantage* such that it is preferable to have production integrated within the firm rather than choosing armth-length agreements such as licensing or strategic alliances.

The OLI approach provides a useful framework to analyze some of the main economic mechanisms behind FDI, and it helps to explain the emergence of FDI. Two types of foreign direct investment can be distinguished by their different motivations. A *horizontal* FDI involves the duplication of

[12] Caves [1996] provides a thorough review of the literature on the MNE. See also Moosa [2002] for an overview of theory and evidence of FDI.

[13] See also Dunning [1981] for a full account of the "eclectic paradigm". Dunning [1988] and Dunning [1993] provide a re-statement and possible extensions.

[14] See Markusen [1995] for an overview and a discussion of the OLI framework.

production sites in more than one country with the purpose of serving the respective market in the country of investment.[15] The other possible investment form is *vertical* FDI. A vertical foreign direct investment is carried out to exploit factor price differences between countries.[16] It thus involves a fragmentation of the production process across countries. Most of the foreign direct investment seems to be horizontal in the sense that output of foreign affiliates is predominantly sold in the foreign country as shown by Brainard [1997].[17] Both types of FDI are usually analyzed in separate frameworks. Only recently, there have been attempts to incorporate both approaches within a unified framework called the "knowledge-capital model".[18] The OLI framework does not explicitly differentiate between both types of FDI but it is applicable to both of them.

Brainard [1997] moreover reports that multinational activity is more likely, the more similar the markets of home country and host country. Industrialized countries predominantly serve as source and destination markets for FDI simultaneously.[19] These empirical observations stand in contrast to earlier explanations of FDI in the line of traditional trade theory which argued that firms integrate production vertically across borders to take advantage of factor price differentials (e.g. Helpman [1984], Helpman and Krugman [1985], Ethier and Horn [1990]). However, it is not surprising that in transition economies and CEE countries vertical FDI plays a prominent role.[20] Nevertheless, most of foreign direct investment seems to be explained by a horizontal expansion of production across borders that is more likely, the higher transport costs and trade barriers, the lower investment barriers, and the lower scale economies at the plant level.

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[15] Horstmann and Markusen [1992], Markusen and Venables [1998], and Markusen and Venables [2000] offer theoretical models with endogenous formation of horizontal MNEs.

[16] See Helpman [1984] and Helpman and Krugman [1985] for theories of vertical FDI.

[17] See also the earlier version of Brainard [1993].

[18] See Carr, Markusen and Maskus [2001] and the literature cited therein.

[19] This pattern is also reported in Julius [1990].

[20] Marin et al. [2002] report evidence for vertical FDI for German investors in CEE.

The choice between FDI and other ways of serving a foreign market has been the focus of examination in a series of studies. Horstmann and Markusen [1987] analyze the choice between exporting, licensing, and FDI. They show how a reputation argument may serve in favor of FDI. Other studies on the choice among alternative ways of serving a foreign market include Ethier [1986] and Ethier and Markusen [1996].[21] Motta [1992] shows in a game-theoretic model that a tariff may cause a shift away from FDI or otherwise induce a tariff-jumping investment, depending on the host country's market size.[22] Whether or not it is in the interest of a country to impose tariffs or quotas strongly depends on the market conditions which may lead to ambiguous welfare effects. Opposed to tariffs, it is frequently observed that countries offer tax incentives or subsidies as a means to induce import substituting FDI.[23]

Despite the fact that by far the largest part of FDI takes the form of M&A, the question of the choice of entry mode has received relatively little attention in the economic literature. This is even more surprising in the light of some of the public concerns related to the expansion strategies of MNEs, and in the light of differing trends in different regions of the world. Empirically a number of important factors that determine the choice of entry mode have been identified as statistically significant: R&D intensity, firm size and diversification, foreign experience and cultural distance, and relative size of investment. Hennart and Park [1993] and Andersson and Svensson [1994] found that firms with higher R&D intensity are more likely to choose greenfield investment. Large and diversified firms prefer acquisitions as Caves and Mehra [1986] and Zejan [1990] showed. Kogut and Singh [1988] found that with a greater cultural distance between home and host country of the

[21]See also Horstmann and Markusen [1992].

[22]The model is essentially an extension of Smith [1987] who also showed that a tariff may, under certain conditions, deter FDI.

[23]For theoretical models see, for example, Haaparanta [1996], Haaland and Wooton [1999], and Haufler and Wooton [1999]. Schnitzer [1999] presents a rational for the phenomenon of tax holidays in a dynamic model of FDI.

investor, the firm will more likely choose greenfield investment. Another finding states that the relative size of investment compared to the size of the investing company makes acquisition more favorable as shown in Caves and Mehra [1986], Kogut and Singh [1988], and Hennart and Park [1993]. Finally, a positive time trend towards acquisitions has been stated in the literature (Caves and Mehra [1986], Zejan [1990], and Andersson and Svensson [1994]).

While some empirical studies have been done on this issue, there exist relatively few theoretical models that deal with the choice of entry mode. Buckely and Casson [1998] and Görg [2000] argue that the market structure and the intensity of competition in a particular market are important determinants of the decision between greenfield investment and acquisition.[24] Mattoo, Olarreaga and Saggi [2001] analyze how the choice of entry mode affects the extent of technology transfer and the degree of competition in the host country. Horn and Persson [2001a] analyze the equilibrium market structure in an international oligopoly and focus on the question under which circumstances cross-border M&A or domestic M&A evolve. They do not, however, consider greenfield investment as an alternative mode of entry.[25] Norbäck and Persson [2001] consider privatization allowing for greenfield investment as an option.[26] Their model suggests that low greenfield costs and low trade costs induce foreign acquisitions.[27] This seems to be counterintuitive on first sight but the result hinges on the fact that the acquisition price is endogenously determined and negatively related to the aforementioned costs.

The second strategic decision regarding the organizational form of FDI

[24] Sometimes the term "brownfield investment" is used to describe a situation where the investment is formally an acquisition but resembles a greenfield investment. Meyer and Estrin [2001] argue that this concept is useful to describe acquisitions in transition economies.

[25] See also Horn and Persson [2001b] for a game-theoretic analysis of merger formation.

[26] For overviews of the privatization literature see, for example, Schmidt and Schnitzer [1997] or Megginson and Netter [2001].

[27] See also Bjorvatn [2001] for a theoretical model of the choice between exports, greenfield investment or acquisition. Norbäck and Persson [2002] analyze the choice between cross-border acquisitions and greenfield entry in a multi-firm setting.

is related to the question of ownership structure and control. In principle, multinational firms prefer to have a wholly owned or majority-owned subsidiary since that inhibits several advantageous features such as better protection of specific knowledge. However, there are good reasons why a MNE would voluntarily agree to share ownership in a joint venture. The local partner might, for example, provide valuable assets. Joint ventures are also used as a means of mitigating the problem of sovereign risk.[28] Moreover, governments sometimes simply restrict entry to joint ventures and sharing of foreign ownership.[29]

The existing theories of the determinants of ownership structures are based on three approaches: the transaction costs approach, the property rights approach, and the bargaining approach. The transaction costs approach pioneered in Klein, Crawford and Alchian [1978], Williamson [1975] and Williamson [1985] stresses the possibility of opportunistic behavior once an investment is sunk. This in turn has negative effects on the incentives to invest in the beginning. Anderson and Gatignon [1986] argue that a greater level of control is more efficient for highly transaction-specific assets.[30] Empirical evidence for a negative correlation between intangible assets and the probability of shared ownership is found, for example, in Gatignon and Anderson [1988] or Asiedu and Esfahani [2001].

The property rights approach developed by Grossman and Hart [1986] and Hart and Moore [1990] formalizes the notion of asset specificity and analyzes the effect of ownership structures on investment incentives. Joint ownership is in this framework usually suboptimal due to sharing of residual control rights.

The bargaining approach, which was put forward by Svejnar and Smith

[28]Schnitzer [2002] gives a rational for this phenomenon.

[29]Mattoo, Olarreaga and Saggi [2001] provide an argument for host country intervention, in order to induce the MNE to choose the socially preferred entry mode, and to transfer appropriate technology.

[30]See also Gomes-Casseres [1989] and Asiedu and Esfahani [2001] for transaction cost approaches to ownership structures in foreign subsidiaries.

[1984] and extended in Al-Saadon and Das [1996], analyzes how the ownership distribution depends on the bargaining power of the MNE and the host country (partners). Svejnar and Smith [1984] show that the distribution of profits in a joint venture is independent of actual ownership shares, though depending on the bargaining powers of the parties. Gatignon and Anderson [1988], Gomes-Casseres [1990] and Henisz [2000] found evidence that joint ownership is likely to be chosen in bargains with host country governments. In particular, the probability of joint ownership is increasing in the political risk associated with a foreign country.

FDI generally involves the transfer of financial capital and/or of technology. It therefore may have positive as well as negative effects on the home and host country.[31] One important aspect of why countries try to attract FDI is the prospect of getting access to advanced technologies. The benefits to host countries may inhibit various kinds of externalities, often referred to as spillovers. The effects on home countries are usually not called spillovers, even though there exist similarities to host country effects. The literature on home country effects of FDI is somewhat limited.[32] Probably the most important question in this field is the effect of foreign production on home country production and on labor demand. The evidence on both topics is ambiguous. As Blomström, Fors and Lipsey [1997] argue, it is very difficult to judge whether production by foreign subsidiaries is actually a substitute or a complement to domestic production. However, there exists some evidence of substitutional effects of foreign production.[33] There exists a large and growing literature concerning the transfer of technologies across countries through

[31] See Blomström and Kokko [1998] for a recent survey on multinational corporations and spillovers. For a broader view and an assessment of the costs and benefits of FDI see Dunning [2000].

[32] See Blomström and Kokko [1994] for a survey.

[33] Blomström et al. [1997] found opposing results for Swedish or US firms. Brainard and Riker [1997] conclude that there is only a modest substitution between foreign affiliate employment and parent company employment.

FDI and its impact on foreign production.[34] Theoretical studies include, for example, Findlay [1978], Das [1987], Wang [1990] and Wang and Blomström [1992]. The empirical evidence on the impact of FDI on the productivity of domestic firms is mixed. Evidence for positive spillovers is found in Kokko [1994], Borensztein, De Gregorio and Lee [1998] and Xu [2000]. Other studies found significant negative effects, e.g. Haddad and Harrison [1993], Aitken and Harrison [1999] or Djankov and Hoekman [2000].

This thesis contributes to the existing theoretical literature in several ways: In particular, we ask in chapter 2 how the choice of entry mode is affected by the market structure and the competition intensity within a market. In chapter 3, we analyze the impact of technology spillovers on the entry mode choice. Furthermore, we ask how asymmetric information over potential technology spillovers affects the decision between greenfield investment and acquisition. Finally, chapter 4 examines the effect of technology spillovers on the incentives to transfer technology and on the host country policy incentives. In more detail, we ask how these incentives can be controlled via the ownership structure in an international joint venture. The following sections give a brief introduction to each of the remaining chapters of the present work.

1.3 Modes of Foreign Entry: Greenfield Investment versus Acquisition

When a multinational firm enters a new market by foreign direct investment, it faces two strategic decisions concerning the organizational form: 1. The level of control over the local subsidiary has to be determined. Therefore, the MNE can choose between a wholly owned subsidiary or a joint venture agreement with a local partner. Both types of ownership structures differ considerably in their level of control, resource commitment, and risk. 2. The mode of foreign entry has to be determined: The MNE can choose between

[34] See also Saggi [2002] for a survey on international technology transfer and spillovers.

a greenfield investment or the acquisition of an existing company.

Chapter 2 analyzes the choice of entry mode between setting up a new venture by greenfield investment or the acquisition of a local competitor. We therefore abstract from the other strategic entry choice and assume a wholly owned arrangement to be the desired ownership structure of the multinational enterprise.[35] In particular, we analyze the effects of different market parameters on the entry mode choice. Among other parameters, the market structure and the competition intensity in a market have already been identified as being crucial for the decision in the preceding literature.[36] The market structure is determined by the number of firms active in a market. Competition intensity, on the other hand, reflects the strength of competition which in turn may depend on the nature of competition, i.e. price or quantity competition. In contrast to existing approaches, chapter 2 exactly analyzes how the entry mode decision is affected by these parameters. Therefore, the acquisition price and the profits under both entry modes are endogenously determined in this model.

Our conclusion from this chapter is that the competition intensity within a market is indeed a crucial factor for the entry mode choice. In particular, we show that the decision might be affected by the competition intensity in a non-monotonic way. When markets are very much or very little competitive, greenfield investment is the optimal entry mode, while for intermediate values it is acquisition. Moreover, we find that greenfield investment is the optimal mode of entry only if the technology gap between the domestic firm and the MNE is sufficiently large.

Regarding the empirically observed behavior, the conclusions of chapter 2 can help to understand some of the underlying economic mechanisms. Empirical evidence highlights that entry into countries in Central and Eastern Europe mainly takes place by greenfield investment, which contrasts the worldwide trend towards M&A. Companies within these countries certainly

[35] However, our results still hold for shared ownership arrangements as long as the sharing rule for the profits is the same for both entry modes.

[36] See, for example, Buckely and Casson [1998] or Görg [2000].

often possess inferior technologies. In this case our model predicts that greenfield investment is the optimal mode of entry and vice versa for entry into developed countries. Moreover, concerning the observation that for entry into fast-growing industries in CEE countries greenfield investment is the preferred entry mode, one could argue that these industries can be associated with low competition intensity. Therefore, greenfield investment should indeed be the optimal mode of entry.

1.4 Modes of Foreign Entry under Potential Technology Spillovers

Entry into a foreign market by a multinational enterprise may have a direct effect on domestic firms by inducing a spillover. Foreign direct investment might thereby benefit direct competitors to the MNE or companies in related industries. In fact from the point of view of the host country the possibility of technology spillovers is often seen as one of the major motivations to attract FDI. If such a spillover benefits a competing company, it hurts in turn the MNE. In this case the possibility of a technology spillover may have an impact on the strategic entry decision. This is certainly the case if the extent of the spillover depends on the choice of entry mode.

In chapter 3, we analyze the effect of technology spillovers on the entry mode choice. Again, the acquisition price and the profits for the multinational enterprise under both modes of entry are derived endogenously in the model. The multinational enterprise can choose between a greenfield investment or the acquisition of its single competitor in the foreign market. In case of greenfield investment the MNE may induce a spillover on its competitor, thereby weakening its very own competitive position. On the other hand, if the MNE chooses acquisition no spillover occurs, since there is no other "recipient" firm in the same market.[37] Therefore, by choosing acquisition

[37] A spillover might benefit a company in another industry, which would in our model have no effect on the decisions of the MNE.

the MNE can avoid a potential spillover. Thus, one might expect that the prospect of a potential spillover has the effect that acquisition becomes more attractive relative to greenfield investment. Interestingly, however, a first conclusion from chapter 3 is that the general effect of a potential technology spillover on the entry mode choice crucially depends on the nature of competition. With quantity competition a spillover is a hindrance to acquisitions and has thus exactly the opposite effect as expected. For price competition and horizontally differentiated products we show that the existence of a spillover has the expected impact on the choice of entry mode.

In the context of spillovers of know-how and technology it seems natural to assume that the parties involved may have asymmetric information about the potential for a spillover. How does this affect the choice of entry mode? In the second part of chapter 3, we show that asymmetric information has a negative effect on the overall acquisition activity. Furthermore, this result is independent of the form of competition. However, under certain conditions private information about a potential spillover may result in acquisitions which would otherwise not have taken place under perfect information. A comparison of different informational scenarios additionally reveals that from an ex ante view the entering multinational firm always prefers full information rather than being privately informed. The domestic firm, on the other hand, is better off with private information about the potential technology spillover.

The results of chapter 3 are consistent with empirical evidence which suggests that greenfield investment is the more efficient mode of entry for investors with strong competitive advantages.[38] Furthermore, it is observed that spillovers are more likely generated if the technology gap between the MNE and domestic firms is not too large.[39] In our model a spillover occurs only in case of greenfield investment. As we can show, greenfield investment is the optimal mode of entry for intermediate technology differences if the probability of a spillover is high.

[38]Hennart and Park [1993] and Andersson and Svensson [1994] found evidence that more R&D intensive firms, i.e. firms with technological skills, favor greenfield investment.

[39]See Borensztein, De Gregorio and Lee [1998] and Xu [2000].

1.5 Technology Transfer and Spillovers in International Joint Ventures

Choosing the appropriate ownership structure for the foreign engagement is an important strategic decision for the multinational enterprise. Foreign direct investment can either take the form of a wholly owned subsidiary or of a joint venture agreement with local partners. Since FDI is seen as an important channel for the transfer of technology and know-how, and as a source for the diffusion of technology, governments sometimes restrict FDI to joint ventures. This has been prominent, for example, in transition economies and CEE countries.

The ownership structure is particularly important when the multinational enterprise possesses valuable intangible assets or superior production technologies. Sharing of ownership can in this case give rise to the possibility of technology spillovers. As Blomström and Sjöholm [1999] point out, it is generally believed that local participation with multinationals reveals the MNE's proprietary knowledge and in that way facilitates spillovers. This in turn could have negative effects on the incentives to transfer technology for the MNE.[40] But, on the other hand, there exist good reasons why it might be in the interest of the multinational to voluntarily form a joint venture with a local partner. It might be the case that the local partner is able to provide valuable assets, market informations or linkages with related industries. Another issue which is important for entry into transition economies and CEE countries is the fact that direct investments are subject to sovereign risks. After the investment is sunk the government of the host country may be tempted to expropriate the assets of the FDI either directly or indirectly through excessive taxation. As a direct result of this the incentives to invest at all or to transfer technology are reduced for the MNE.[41] However, if the

[40] Ramachandran [1993] shows that with a greater level of control over the foreign affiliate a more sophisticated technology would be transferred.

[41] Huizinga [1995] shows that in order to reduce the benefit of expropriation, the MNE transfers an inferior technology, even if the technology transfer itself is costless.

ownership is shared with a local firm the MNE might be able to mitigate the sovereign risk problem as shown in Schnitzer [2002].

In the final chapter of the present work, we analyze the effects of a potential spillover on the incentives for a multinational firm to transfer technology and on the host country policy. Moreover, we ask how these incentives can be controlled through the ownership structure in an international joint venture. In contrast to existing arguments we can conclude from chapter 4 that a spillover need not in general have a negative effect on the incentive to transfer technology. As we show, a spillover can even have positive effects on the technology transfer and on the efficiency of the investment project. Additionally, we find that independently of the effect of a spillover sharing of ownership may sometimes be beneficial for the MNE. On the contrary, however, we show that a joint venture agreement is not always in the interest of the host country. This finding is particularly interesting in the light of the frequently imposed restrictions on foreign ownership. As we can conclude from our analysis these restrictions need not in general have the desired effects but may result instead in adverse effects on the incentives to transfer technology. This in turn lowers also the potential for technology spillovers.

The results of chapter 4 shed some light on the empirical evidence which suggests that spillovers from foreign direct investment may be significant, but they are by no means guaranteed in their extent. The empirical evidence on the impact of the degree of foreign ownership on the degree of spillovers to the domestic sector is ambiguous.[42] Our model indicates that the extent of spillovers not only depends on the ownership structure but also on the incentives to transfer technology and on the host country's policy incentives. Hence, whether or not a larger ownership share of a domestic firm results in stronger spillovers is a priori not clear and can differ across countries and industries.

[42]While Blomström and Sjöholm [1999] found no effect, Dimelis and Louri [2002] found evidence that the degree of foreign ownership indeed matters concerning the potential for spillovers.

Chapter 2

Analyzing Modes of Foreign Entry: Greenfield Investment versus Acquisition

2.1 Introduction

A multinational enterprise considering entry into a foreign market faces two fundamental decisions. First, it has to choose the level of control over its local engagement. Equity-based entry could take the form of partially owned subsidiaries, as in joint ventures, or wholly owned subsidiaries, while non-equity entry would be licensing for example. Second, the MNE has to decide which mode of foreign entry to carry out. It can choose between the acquisition of an existing company or setting up a new venture via greenfield investment. Why would a multinational firm choose to enter one market via acquisition and another one through greenfield investment, while in principle for either market both alternatives are present?

This chapter contributes to answering this question by providing a simple model to analyze determinants of the optimal entry mode. For this purpose we consider the decision to enter a market either via a greenfield investment or the acquisition of a single local competitor. While a general analysis of this strategic choice is provided, the specifications of the model especially allow us to apply its implications to the decision to enter a market in Central and Eastern Europe.

Most of the literature on foreign entry has focused on the first decision in considering the choice of ownership type between licensing, a wholly owned subsidiary, and a joint venture. These modes of entry differ considerably in their level of control, resource commitment, and risk. Anderson and Gatignon [1986], for example, analyze the tradeoff between control and the cost of resource commitment in a transaction cost framework. They argue that a greater level of control is more efficient for highly transaction-specific assets. Hill, Hwang and Kim [1990] present a wider approach which additionally takes into account global strategies of the MNE and the risk of dissemination of firm specific knowledge as factors influencing the control decision. Firms will prefer high control entry modes if they persue global strategies or possess a highly firm-specific know-how.

Relatively few studies have addressed the choice between greenfield investment and acquisition as modes of foreign entry. Empirically a variety of potential factors influencing the choice of entry mode have been studied. Kogut and Singh [1988], for example, study the influence of cultural distance on the choice between greenfield investment, acquisition and joint venture. The greater the cultural distance between the country of the investor and the country of entry, the more likely a firm will choose a joint venture or a greenfield investment over an acquisition. Other work considers additional firm-specific factors like international experience, firm size or R&D. Caves and Mehra [1986] find evidence for investment in the US that large and diversified companies prefer acquisition. Besides that acquisition is favored for entry into rapidly growing or very slow growing markets. Hennart and Park [1993] show that greenfield investment is the preferred mode of entry for R&D intensive Japanese firms entering into the US.

Focusing on the specific conditions in transition economies Estrin, Hughes and Todd [1997] and Meyer [1998] empirically analyze the choices of ownership form and mode of entry into CEE. Estrin et al. [1997] find that most of the MNEs in their sample aimed to achieve 100 per cent ownership even if initially, e.g. for political reasons, not possible. Meyer [1998] tests a number of hypotheses for CEE entry, which are based on previous work in the international business literature. Surprisingly, he finds that entry into fast-growing industries takes place via wholly owned greenfield investments, but not via acquisition. This is in contrast to the well known argument that a speedy entry, which is assumed important in fast-growing industries, can be achieved by acquisition and not via greenfield investment. It also contrasts the empirical findings by Caves and Mehra [1986] for US entry. Therefore, it suggests that industrial growth in transition economies creates specific conditions for competition that are different from other markets. The study also shows that greenfield investments are the most common mode of entry into CEE, accounting for more than 50 per cent of all projects in the sample. This is particularly surprising in the light of a worldwide trend towards acquisition and it underlines the need for a theoretical analysis.[1]

While some empirical work on the determinants of entry has been done, apart from Buckley and Casson [1998], there is no comprehensive theoretical model. In their study the choice between a variety of alternative entry modes is analyzed. One important conclusion is that the market structure as well as the strength of competition in the market each have a crucial impact on the entry decision. Entry through greenfield investment contributes to the local capacity and intensifies competition, while acquisition entry does not. The existence of a high cost of competition associated with high monopoly rents makes acquisition favorable over greenfield investment. A highly specific production technology of the entrant resulting in higher adaptation costs, on the other hand, discourages acquisition and favors greenfield investment.

Görg [2000] builds on their approach in analyzing the effect of market structure on the choice between greenfield investment and acquisition in a Cournot-type setting. He shows that in general acquisition may be the preferred mode of entry, while only with a high cost of adaptation greenfield investment may be an optimal choice.

[1] Mergers and acquisitions constitute an important mode of entry and their importance has increased over time (UNCTAD [2000]).

While Buckley and Casson [1998] determine market structure and strength of competition as important factors, they are not able to specify exactly how these factors affect the entry mode decision. In contrast to their approach the present model does so. We study the choice of entry mode of a MNE between setting up a new venture via greenfield investment or acquisition of the single local competitor. A greenfield investment enables the MNE to specify the subsidiary according to its technological capabilities, while acquisition allows at first only to use the given facilities. In the model presented below this fact is reflected in that the MNE possesses a superior technology, but can only make use of it when entering via greenfield. In case of acquisition it is restricted to the acquired firm's technological capabilities. After the acquisition of the only competitor the MNE can act as a monopolist, while greenfield investment in general leads to a competitive situation. In addition to the endogenous effect of the market structure associated with the entry mode, the influence of an exogenous change in the competition intensity on the entry decision is analyzed. Contrasting Buckley and Casson [1998] or Görg [2000], we derive the acquisition price for an existing domestic firm as well as the profits for the alternative entry modes endogenously. These values obviously depend on the market structure, the competition intensity in the market and differentials in the production cost of the competing firms.

The effects of the different exogenous variables defined in the model on the entry decision are analyzed in detail. Increasing the investment cost of greenfield entry obviously makes acquisition more attractive. We show that this effect only holds up to a certain amount. If it gets too large, however, acquisition becomes unattractive and no entry will be an optimal choice. A higher technological backwardness of the domestic firm leads to a higher profit for the MNE in competition, a lower acquisition price and a lower monopoly profit for acquisition entry. Whether or not one of these effects dominates is a priori not clear. But we can show that greenfield investment is the optimal mode of entry only if the technological gap between the competitors is sufficiently large. Surprisingly, we furthermore find that the competition intensity within a market can influence the choice of entry mode in a non-monotonic fashion. When the market is very much or very little competitive, greenfield investment is the optimal entry mode, while for intermediate values it is acquisition.

With respect to the unusual empirical observations of entry mode decisions into countries in Central and Eastern Europe, the results presented in the model have some explanatory power. As the analysis shows greenfield investment is the optimal mode of entry only if the technological gap between the domestic firm and the MNE is sufficiently large. This is certainly the case in many markets in CEE, which might explain why entry into these countries foremost takes place via greenfield investment - in opposition to the world-wide trend. Moreover, it is observed that entry into fast-growing industries surprisingly takes place via greenfield investment, but not via acquisition. Since one can associate fast-growing industries with less intense competition the model exactly predicts that greenfield investment is the optimal mode of entry in this situation.

The rest of this chapter is organized as follows. The next section sets up the model. Section 2.3 considers the decision between greenfield investment and acquisition and presents the main results. Section 2.4 discusses some of the empirical observations and concludes.

2.2 The Model

In this section, we develop a theoretical framework to analyze the choice of entry mode for a multinational enterprise entering into a foreign country. Therefore, the focus is on the second decision a MNE faces, while 100 per cent ownership is assumed to be the desired level of control. We consider a model of horizontal product differentiation à la Hotelling [1929] with firms competing in prices.[2] Consumers are assumed to be uniformly distributed along the unit interval [0,1] with density 1. Thus, the total number of consumers is equal to 1.

[2]However, in contrast to the basic Hotelling model, we introduce cost asymmetry among firms.

The model consists of two periods. In period 1, the domestic firm 1 located at $x = 0$ serves (at least part of) the market. The foreign firm 2 considers whether or not to enter the market and, in case of entry, which entry mode to employ. The market is assumed to be stable in the sense that firm 1 cannot adopt a different production technology or set up a new venture and there is no other potential entrant besides firm 2. To enter the market firm 2 can either acquire firm 1 at location $x = 0$ or set up a new venture at $x = 1$ through a greenfield investment. In period 2, firms simultaneously compete in prices if firm 2 entered via greenfield investment. Otherwise firm 2 will employ its monopoly pricing strategy.

Firm $i = 1, 2$ produces with constant marginal cost c_i. Production takes place without any fixed cost. The entering MNE employs a superior technology than the domestic firm ($c_1 > c_2 \geq 0$). Without this assumption the results would be trivial as will become clear in what follows. But besides that, it nicely fits the common observation that domestic firms in CEE possess less efficient technologies compared to MNEs. When entering by acquisition it is assumed that the entrant can only make use of the acquired firm's technology c_1.[3] On the other hand, when setting up a new venture, firm 2 can obviously implement its own technology c_2.

Entry is viable if the entrant can earn a post-entry profit at least covering the cost of entry. Foreign market entry requires a substantial investment into physical capital, marketing etc., especially a greenfield entry. The cost of entry via greenfield investment is denoted by $k \geq 0$. The entry cost in case of acquisition is equal to the acquisition price because of the assumption that the entrant uses technology c_1 and does not bear any adaptation cost or restructuring cost. The acquisition price, denoted by P_A, is determined endogenously. To keep things simple it is assumed the entrant can make a

[3] It could also be assumed that the entrant can implement its own technology at a certain adaptation cost. This would not alter the results but make the model more complicated by adding extra variables. In our model, firm 2 bears some kind of adaptation cost caused by the fact that only the inferior technology can be used which in turn yields lower profits than employing the superior technology.

take-it-or-leave-it-offer to acquire firm 1.[4]

The time structure of the entry game in period 1 is the following.

At stage 1, firm 2 (MNE) can choose between making a take-it-or-leave-it offer to acquire firm 1, greenfield investment or no market entry.

At stage 2, if firm 2 has made an offer, the incumbent firm 1 can accept or reject the offer.

At stage 3, firm 2 can again choose between greenfield investment or no entry in case firm 1 has turned the offer down.

At stage 4, firms compete in prices and profits are realized.

We look for a sub-game perfect equilibrium of the bargaining game just described and therefore solve by backwards induction. If the entrant can credibly commit to greenfield entry if its offer is rejected, then the acquisition price P_A will clearly be equal to firm 1's post-greenfield profit. The entrant can only credibly commit to a greenfield entry if this yields a non-negative net profit. To put it in other words, k must not be too large. Otherwise the entrant cannot commit to greenfield entry. Thus, the acquisition price will be equal to firm 1's monopoly profit in this case.

Consumers incur a linear transportation cost t if they buy the good from one of the firms. The higher the transportation cost, the more differentiated are the goods and the less intense is the price competition. The parameter t can be interpreted as a measure of competition intensity in the market. The larger the value of t, the less intense is the competition and vice versa. If $t = 0$ we essentially have Bertrand competition. Each consumer wants to buy exactly one unit of the good in every period if its price is not too high.

[4]The acquisition price obviously depends on the bargaining power of the entrant and the incumbent. Other bargaining solutions, where the domestic firm has some bargaining power, would lead to a higher acquisition price and therefore shift preferences of the MNE in favor of greenfield investment. The other extreme case would be a situation, as argued by Grossman and Hart [1980], where shareholders would not tender their share below the post acquisition value of the firm. Thus, the free rider problem would render the acquisition infeasible unless the acquiring firm initially holds some of the shares. Assuming full bargaining power of the entrant instead, at least constitutes a lower bound for the acquisition price.

Consumers' surplus from consumption is denoted by s. Let p_i denote the price charged by firm $i = 1, 2$. Hence, in case of a greenfield investment the net utility of a consumer located at x is

$$U = \begin{cases} s - xt - p_1 & \text{if good is bought from firm 1,} \\ s - (1-x)t - p_2 & \text{if good is bought from firm 2,} \\ 0 & \text{if good is not bought.} \end{cases}$$

In case of acquisition the net utility of a consumer located at x becomes

$$U = \begin{cases} s - xt - p_2 & \text{if good is bought from firm 2,} \\ 0 & \text{if good is not bought.} \end{cases}$$

Two additional assumptions are made concerning the consumers' surplus:

1. The consumers' surplus is sufficiently large such that firm 2 would like to serve the entire market when using its own technology: $s \geq c_2 + 2t$.

2. For $c_1 \geq s$, firm 1 is not in the market from the beginning.

The first assumption excludes cases that are characterized by very weak competition intensity. Since we would like to analyze the effect of competition intensity these situations are of little interest.[5] The second assumption is on the one hand very intuitive in that a firm operating with a loss for certain will not be in the market.[6] On the other hand, it enriches the analysis by considering the observation that the entry decision is also restricted by a limited supply of potential acquisition targets. In this situation the entrant can only choose to enter the market through greenfield investment or not to enter the market at all.

[5] However, as will become clear shortly, for very weak competition intensity either greenfield investment or no entry is the optimal choice.

[6] In the case of state-owned firms, especially for CEE countries, it could be argued that a firm would even be in the market when making a loss for sure and the state had carried this loss. Within the assumptions of this model the entrant would never acquire such a firm. In a post-greenfield situation this firm would no longer be in the market unless the state would bear an even higher loss. This scenario is not part of our analysis.

As argued before, entry is viable if the post-entry profit at least covers the cost of entry. Acquisition is a better alternative than greenfield investment if the net post-entry profit of the former is higher than of the latter entry mode. In what follows we consider the effects of the models parameters on the optimal entry mode decision. The profits for the alternative entry modes and the optimal decision are determined in the Appendix.

2.3 Greenfield Investment versus Acquisition

What are the driving forces determining the optimal entry mode decision? All of the model's parameters enter into the decision function. In principle, there are three crucial values that are essential for the decision. These values are the acquisition price, the monopoly profit in case of acquisition, and the net greenfield profit. As will be seen below, there are some fairly obvious results concerning the impact of certain parameters on these values, while others enter into the decision in a non-trivial fashion.

We now look at the different exogenous variables that affect the choice of greenfield investment versus acquisition in turn. We start with considering the investment cost k. The investment cost is crucial for the determination of the acquisition price and therefore the achievable profit under both alternative entry modes. It is straightforward to see that, as k increases, acquisition becomes relatively more attractive. Surprisingly, however, if k gets too large, acquisition becomes unattractive and the entrant prefers not to enter the market at all. What is the reason for this counterintuitive result? The greenfield profit π_2^G is strictly decreasing in k. Note that for a certain investment cost $k = \bar{k}$ this profit becomes equal to zero. Thus, for $k \geq \bar{k}$ greenfield investment is no longer viable. This results in an acquisition price equal to firm 1's monopoly profit. Therefore, acquisition has no advantage over no entry and the entrant chooses not to enter at all. This result is summarized in the following proposition.[7]

[7]See also Figure 2.1 in the Appendix which highlights the optimal decision for certain parameter values. The dotted line in the bottom area displays $\bar{k}$.

Proposition 2.1 *There exists a* $\bar{k}(s, c_1, c_2, t)$*, such that for* $k < \bar{k}$ *an increase in* k *makes acquisition more attractive relative to greenfield investment. For* $k \geq \bar{k}$ *the entrant prefers not to enter at all.*

This result is surprising on first sight since it states that acquisition only is an option for market entry if a greenfield entry is also profitable. In other words market entry will be an optimal decision only if greenfield investment would be viable.[8]

How does the technology parameter c_1 affect the optimal mode of entry? Since the entrant can, in case of acquisition, only make use of the inferior technology c_1, this production cost directly influences all crucial values. This means c_1 has an effect on the acquisition price P_A, the monopoly profit in case of acquisition π_1^M and the greenfield profit π_2^G.[9] A priori one might expect, that an increase in c_1 makes greenfield investment relatively more attractive compared to acquisition since the monopoly profit decreases, while the greenfield profit increases. On the other hand, the acquisition price also decreases in c_1.

Lemma 2.1 *Increasing* c_1 *has a strictly positive effect on the greenfield profit* π_2^G*, a non-positive effect on the acquisition price* P_A*, and a strictly negative effect on the monopoly profit* π_1^M*:*

$$\frac{d\pi_2^G}{dc_1} > 0; \frac{dP_A}{dc_1} \leq 0; \frac{d\pi_1^M}{dc_1} < 0.$$

Proof: See Appendix.

The positive effect on the greenfield profit is very intuitive since increasing the production cost for the incumbent leads to an improved position for the entrant in competition. Also there is certainly a non-positive effect on the acquisition price as well as a negative one on the monopoly profit. From the point of view of the entrant, a more inferior competitive position of the

[8]See the Appendix for an exact determination of $\bar{k}$ in the different parameter cases.

[9]The subscript 1 for the monopoly profit in case of acquisition indicates that technology c_1 is used.

incumbent makes greenfield investment more attractive. On the other hand, acquisition gets cheaper since the acquisition price (weakly) decreases, but at the same time the gross profit in case of acquisition π_1^M strictly decreases. A priori it is not clear if (and which) one of the effects on the crucial values dominates. However, there is an unambiguous tendency, as the following lemma states.

Lemma 2.2 *The effect of an increase in c_1 on the monopoly profit π_1^M (weakly) dominates the effect on the acquisition price P_A and therefore the net acquisition profit π_2^A (weakly) decreases in c_1:*

$$\left|\frac{d\pi_1^M}{dc_1}\right| \geq \left|\frac{dP_A}{dc_1}\right| \Leftrightarrow \frac{d\pi_2^A}{dc_1} \leq 0.$$

Proof: See Appendix.

The effect on the acquisition price P_A is equal to the effect on the gross profit π_1^M only in *Case 3* (b), since then both values are equal. In all other cases the latter effect strictly dominates the former. Therefore, except for the case in which acquisition and no entry yield the same profit, the acquisition profit strictly decreases in c_1. Given these results the following proposition can be claimed.[10]

Proposition 2.2 *For $k < \bar{k}$ there exists a $\bar{c}_1(s, c_2, t, k)$, such that*

(a) for $c_1 \leq \bar{c}_1$ acquisition is the optimal mode of entry and

(b) for $c_1 > \bar{c}_1$ greenfield investment is the optimal mode of entry.

Proof: See Appendix.

For very similar technologies ($c_1 \leq \bar{c}_1$) it is obvious that acquisition is always favorable over a greenfield investment, since then greenfield investment leads to a relatively low profit for the entrant, while the achievable monopoly profit using technology c_1 is high. When increasing c_1 for a given c_2, and

[10] See Figure 2.1 in the Appendix for an illustration of the result.

therefore increasing the technology difference, Lemma 2.2 applies. Thus, for sufficiently different technologies, greenfield investment is the optimal mode of entry. At the same time the investment cost k should not be too large, since it directly reduces the net profit for greenfield entry.

Next, we consider the effect of the consumers' surplus s on the decision of entry mode. This variable naturally has an impact on the profits that can be achieved. Obviously, the monopoly profit should increase in the value of s. On the other hand, one could expect the greenfield profit and the acquisition price to react in the same manner. However, as the following lemma shows this is not the case in general.

Lemma 2.3 *Increasing s results in*

(i) a strictly positive effect on the monopoly profit π_1^M and a (weakly) positive effect on the acquisition profit π_2^A,

$$\frac{d\pi_1^M}{ds} > 0; \frac{d\pi_2^A}{ds} \geq 0,$$

(ii) no effect on the greenfield profit π_2^G or the acquisition price P_A for $s \geq \frac{1}{2}(c_1 + c_2 + 3t)$,

$$\frac{d\pi_2^G}{ds} = 0; \frac{dP_A}{ds} = 0,$$

but strictly positive effects for $s < \frac{1}{2}(c_1 + c_2 + 3t)$,

$$\frac{d\pi_2^G}{ds} > 0; \frac{dP_A}{ds} > 0.$$

Proof: See Appendix.

The following proposition describes the effect of an increase in s on the decision of entry mode.[11]

Proposition 2.3 *For $k < \bar{k}$ there exists a finite $\bar{s}(c_1, c_2, t, k)$, such that acquisition is the optimal mode of entry for all $s \geq \bar{s}$.*

Proof: See Appendix.

[11]Figure 2.2 in the Appendix highlights the results claimed in the following three propositions for certain parameter values.

The intuition behind this result is fairly simple. The higher the gross benefit for the consumers, the higher the monopoly profit becomes. On the other hand, above a certain value of s the greenfield profit as well as the acquisition price are no longer affected by an increase in s, since these values become independent of s.[12] Thus, there exists a value $\bar{s}(c_1, c_2, t, k)$ above which acquisition will be strictly better than greenfield investment. But this result is only valid as long as a greenfield investment would be viable as well, i.e. $k < \bar{k}$.

The result presented in Proposition 2.3 is surprising since it claims that the entry mode decision depends on the consumers' surplus in an unexpected way. In particular, it implies that for two products, differing only with respect to consumers' gross benefit, in the market for one good greenfield investment might be the optimal choice, while in the other one it is acquisition. Moreover, if consumers in different regions associate the same product with different valuations, the same effect on the entry decision could apply.

How does the optimal entry mode decision change with a change in the competition intensity t? Obviously, the effect of an increase in t on the monopoly profit is always negative. The effects on the other crucial values, however, are not as clearcut. In particular, for increasing t (decreasing competition intensity) the effect on the acquisition price is inverse U-shaped, while the effect on the greenfield profit and the acquisition profit is U-shaped. A priori it is not clear how these opposing effects influence the optimal entry mode choice. As one result of this we can show that under certain conditions there is a non-monotonic relation between the competition intensity parameter t and the entry decision. When considering the effect of the competition intensity again the consumers' surplus plays an important role. Two interesting results follow for different levels of consumers' benefit. We first consider a situation with a relatively high value of consumers' surplus ($s \geq \hat{s}$) and sufficiently low investment cost ($k \leq \hat{k}$). A formal definition of $\hat{s}$ and $\hat{k}$ is given in the Appendix.

[12] As claimed in Lemma 2.3. The reason for this is the equilibrium in price strategies which is independent of s in *Case 1* and *Case 2*.

Proposition 2.4 *For $s \geq \hat{s}$ and $k \leq \hat{k}$ there exists a $\bar{t}(s, c_1, c_2, k)$, such that*

(a) for $t \leq \bar{t}$ acquisition is the optimal mode of entry and

(b) for $t > \bar{t}$ greenfield investment is the optimal mode of entry.

Proof: See Appendix.

This result claims that for a sufficiently high consumers' gross benefit s and investment cost k not too high the optimal mode of entry is acquisition for higher competition intensities, while it is greenfield investment for low competition intensity. Thus, there exists a certain cutoff value for t that determines whether one or the other entry mode constitutes an optimal choice. The first part of the result is related to Proposition 2.3, which stated that there exists a value $\bar{s}$ such that acquisition is the optimal mode of entry for all $s \geq \bar{s}$. We can find a value $\hat{s} \geq \bar{s}$ for high competition intensity. Decreasing the competition intensity (increasing t) for the very same value of $\hat{s}$ results in a negative effect on the net acquisition profit and a positive effect on the greenfield profit. The reason for the former effect is that a lower competition intensity results in a higher acquisition price and at the same time a lower monopoly profit. The latter effect is due to the fact that lower competition intensity results in higher profits. Further decreasing the competition intensity eventually leads to greenfield investment as the optimal choice.

The result suggests that for two different markets that are only distinguished by different levels of competition intensity, in one market acquisition might be the optimal choice, while it is greenfield investment in the other. This provides another possible explanation as for why entry modes should differ for entry into different markets.

Now we come to the second result concerning the effect of the competition intensity for lower values of s. The following proposition shows that the competition intensity, surprisingly, has a non-monotonic impact on the entry mode decision.

Proposition 2.5 *For* $s \in (\underline{s}, \tilde{s})$ *and* $k \in (\frac{1}{3}(c_1 - c_2), \frac{3}{5}(c_1 - c_2)]$ *there exist* $\underline{t}(s, c_1, c_2, k)$ *and* $\tilde{t}(s, c_1, c_2, k)$*, such that the optimal entry mode is*

(a) greenfield investment for very intense competition, $t \leq \underline{t}$*,*

(b) acquisition for intermediate competition intensities, $t \in (\underline{t}, \tilde{t})$*, and*

(c) greenfield investment for low competition intensity, $t \geq \tilde{t}$*,*

where $\underline{s} = c_1 + 2\sqrt{\frac{1}{3}(c_1 - c_2)(\frac{2}{3}(c_1 - c_2) - k)}$ *and* $\tilde{s} = 2c_1 - c_2 - k$*.*

Proof: See Appendix.

The proposition shows that under certain conditions the competition intensity affects the optimal entry mode decision in a non-monotonic fashion.[13] Greenfield investment is the preferred mode of entry, when the market is very much or very little competitive. For intermediate values acquisition is the optimal entry mode. To understand the intuition for this interesting result we will consider the effects of competition on the three crucial values, i.e. the acquisition price, the monopoly profit, and the greenfield profit.

If competition is very fierce, the acquisition price is equal to zero and at the same time the greenfield profit is large. The reason for this is that by greenfield investment the MNE is able to force the incumbent firm out of the market because of the technological advantage it possesses. The monopoly profit is comparably low because of the assumed low consumer surplus and the restriction to the inferior technology. Therefore, greenfield investment is the optimal entry mode even though acquisition comes at a price of zero. For intermediate values the acquisition price is still very small. But the greenfield profit becomes much smaller since with less intense competition the MNE can no longer force the incumbent out of the market. The monopoly profit remains almost the same. Thus, acquisition becomes the optimal mode of entry. When the market is very little competitive, greenfield investment

[13] For $k > \frac{3}{5}(c_1 - c_2)$ there can even exist - at least for some s within the interval - a $\hat{t}(s, c_1, c_2, k)$ such that for $t \in (\tilde{t}, \hat{t})$ greenfield investment is the optimal choice and for $t \geq \hat{t}$ it is no entry.

again becomes the optimal entry mode. The reason for this is that the firms achieve more power over their consumers and therefore larger profits. As a consequence the acquisition price as well as the greenfield profit increase.

To summarize the described effects of competition for low consumers' surplus, we can argue that it is more important to use the superior technology than to become a monopolist when the market is very little or very much competitive and vice versa for intermediate values.

2.4 Discussion and Conclusions

Although highly stylized the model presented above gives some useful new insights into the determinants that affect the strategic choice of entry mode. Our contribution to the literature on foreign entry is to establish a theoretical framework that allows an in-depth analysis of the impact of various exogenous factors in a simple setting. In particular, we are able to specify exactly how the market structure and the competition intensity in a market influence the entry decision. Even though previous work already identified both as important factors, it was not able to characterize their exact impact. While our analysis does so, it moreover shows that the influence of these factors is not as straightforward as the literature suggests.

In principle, there exist three crucial values that determine the optimal entry choice: The acquisition price, the monopoly profit when using the inferior technology, and the net greenfield profit. We examined the different exogenous variables specified in the model that affect these values.

First, we considered the cost associated with greenfield entry. Intuitively, it could be argued that increasing this cost leads to acquisition becoming more attractive. We showed that an increasing investment cost has this effect only up to a certain point. If the cost gets too large, however, acquisition becomes unattractive and the entrant prefers not to enter the market at all.

Second, for the technology parameter of the domestic competitor, the effect on the entry decision was a priori not clear since it has opposite effects on the three crucial values already mentioned. An increase in the production cost of the domestic firm has a positive effect on the entrant's greenfield profit, but negative effects on the monopoly profit and the acquisition price. Nevertheless, we could show that the effect on the monopoly profit dominates the effect on the acquisition price. Therefore, greenfield investment becomes the optimal mode of entry if the difference in technological capabilities is sufficiently large.

Third, the gross benefit for the consumers definitely has an impact on the decision since it determines how much rents can be extracted from them. The higher this benefit, the higher should become the achievable profits under both entry modes. We showed that for a given constellation of the other variables there exists a finite value for consumers' surplus such that acquisition is the optimal mode of entry for all higher values. The reason for this result is that the greenfield profit increases in the consumers benefit only up to a certain point, but beyond it remains the same. As soon as it comes to a situation where both firms cannot act as local monopolists their profits in competition remain the same for all higher values of consumers' surplus. The result implies that for two different product markets that are only distinguished by different levels of consumers' surplus, it might well be the case that in one market greenfield investment is the optimal mode, while in the other one it is acquisition. This implication can help to explain why MNEs in some markets employ the greenfield entry strategy and in others acquisition entry, while in either both opportunities are present.

Fourth, the competition intensity in a market was characterized as one of the most important factors concerning the choice of entry mode. There are two situations to be distinguished, depending on consumers' surplus. For a sufficiently high consumers' surplus we found that high competition intensity leads to acquisition as the optimal mode of entry, but it is greenfield investment for low levels of competition. The reason for this result is that the acquisition price and the greenfield profit increase with decreasing competition, while the monopoly profit decreases. Less intensive competition results in a reduced incentive to become a monopolist, while the technological advantage becomes more important. More surprisingly, however, we found that the optimal mode of entry depends on the competition intensity in a non-monotonic fashion when consumers' surplus is relatively low. Greenfield investment is the optimal mode of entry when the market is very much or very little competitive, while it is acquisition for intermediate values. This is caused by the fact that for lower consumers' surplus it becomes more important to use the superior technology when the market is very much or very little competitive, while it becomes more important to be a monopolist in the intermediate case.

The presented general analysis sheds some light on the empirical evidence on the choice of foreign entry mode that has been provided recently. In particular, we can give some explanation for the on first sight counterintuitive observations for entry into countries in Central and Eastern Europe. The empirical evidence suggests that these countries are characterized by specific conditions for competition that differ from other markets.

Greenfield investment is the most common mode of entry into CEE as Meyer [1998] derives from his data set. This is a surprising fact since there is a recent trend towards acquisition worldwide. One possible explanation could be that CEE countries lack potential acquisition targets for those industries where greenfield investment took place. We provided other explanations in the present chapter. We showed that greenfield investment is an optimal choice if the local competitor possesses an inferior technology. Since it is a common fact that firms in CEE do not have access to state of the art technology, our model gives a nice explanation for the observed situation. Moreover, our results characterize the exact market conditions under which greenfield investment is the optimal mode of entry.

Entry into fast-growing industries in CEE, surprisingly, takes place via greenfield investment, but not via acquisition. Intuitively, it should be argued that, since the speed of entry is important in industries that are fast-growing, acquisition should be preferred. Acquisition certainly provides a faster entry and access to a market than greenfield investment. Again, it could be argued that the technological backwardness of domestic firms is the reason for the counterintuitive behavior. Meyer [1998] suggests as possible explanations that either the investment itself is the cause for the growth in the industry, or growing industries can accommodate more entrants without frictions between competitors, or the highest growth occurred in until then neglected industries. We showed that greenfield investment is an optimal choice if the competition intensity is low. Since for fast-growing industries it is reasonable to assume a low competition intensity, this provides an alternative explanation for the empirical observation.

A possible extension of the model could be to include the entry decision of more than one MNE, either simultaneously or sequentially. Despite this we feel confident that the assumptions and conclusions of our model are relevant for the entry mode decision and leave other considerations for future research.

Appendix

A) The equilibria in price strategies

In order to compute the profits for the alternative entry modes, the equilibria in price strategies have to be defined for the different situations. When firm 2 enters via acquisition it will afterwards employ its monopoly pricing strategy using technology c_1. That is $p_2^M = s - t$ for $s \geq c_1 + 2t$ or $p_2^M = \frac{s+c_1}{2}$ otherwise. In case of greenfield investment the equilibrium price strategies are:

- For $c_1 \geq s$ firm 1 is not in the market and thus firm 2 chooses $p_2^M = s - t$.
- *Case 1:* $p_1 = c_1$, $p_2 = c_1 - t$.
- *Case 2:* $p_1 = \frac{2c_1+c_2+3t}{3}$, $p_2 = \frac{2c_2+c_1+3t}{3}$.
- *Case 3:* (a) $p_1 = s - \frac{c_2-c_1+3t}{6}$, $p_2 = s - \frac{c_1-c_2+3t}{6}$.
  (b) $p_1^M = \frac{s+c_1}{2}$, $p_2 = \frac{3s-2t-c_1}{2}$.

The first two cases display the common equilibrium price strategies in a model of horizontal product differentiation. In *Case 1* firm 2 can force the incumbent out of the market and then faces all demand. In *Case 2* there exists a consumer with location $\tilde{x}$ who is indifferent between buying from firm 1 or firm 2. In *Case 3* things get a bit more complicated. The reason for this is the assumed situation with constant but asymmetric marginal cost for the two parties and the assumption that firm 2 would in principle like to serve the whole market when using its own technology c_2. On the other hand, there is no restriction on the technological capabilities of firm 1 and therefore *Case 3* emerges as a possible situation. The distinction between *Case 3* (a) and (b) is that in the former firm 1's monopoly supply is greater than $\tilde{x}$ and in the latter it is smaller. The defined equilibria are not unique, since there exists a continuum of equilibria in an ϵ-environment close to them. Its range depends on the exact constellation of parameters. However, the price strategy combinations considered here always constitute an equilibrium for each case. Furthermore, it easily can be shown that the pricing strategies for case (a) cannot be an equilibrium for case (b).

B) Profits for the alternative entry modes

If firm 2 chooses to enter via greenfield investment its profit is determined by the outcome of competition with the domestic firm net of the investment cost k. On the other hand, if the firm enters via acquisition the profit is determined by the monopoly profit when using the inferior technology c_1 net of the acquisition price P_A. As argued before this acquisition price depends on the ability of firm 2 to commit to greenfield entry in case its take-it-or-leave-it offer is turned down. If the firm can commit to greenfield entry the acquisition price is equal to firm 1's post greenfield value - the profit that can be achieved in competition with the MNE. Otherwise if the MNE cannot commit to greenfield entry the acquisition price is equal to firm 1's monopoly profit. The results derived for acquisition entry assume that firm 2 can commit to greenfield entry. Otherwise firm 2 prefers not to enter.

1. Greenfield investment

For $c_1 \geq s$ firm 1 is not in the market. Thus, firm 2's profit becomes

$$\pi_2^G = s - t - c_2 - k.$$

Next, the situation is considered where firm 1 is in the market, that is $s > c_1$. At this point three case have to be distinguished: 1. If the price difference between the two firms exceeds t along the whole interval, one firm has no demand. 2. Otherwise both firms face a demand if s is sufficiently large, such that all consumers want to buy one unit of the good. 3. Both firms possess local monopoly power if s is too small.

Case 1: Within the assumptions of this model there is only one case to be considered, namely firm 2 facing all demand, $p_1 - p_2 > t$.[14] The firms' profits are

$$\begin{aligned} \pi_1^G &= 0, \\ \pi_2^G &= c_1 - c_2 - t - k. \end{aligned}$$

[14]After inserting the equilibrium price strategies for *Case 2* it follows that $p_1 - p_2 > t \Leftrightarrow t < \frac{c_1 - c_2}{3}$.

Case 2: The price difference between the two firms does not exceed t, that is $p_1 - p_2 \leq t$, and s is sufficiently large.[15] Thus, the firms profits are

$$\pi_1^G = \tfrac{(c_2 - c_1 + 3t)^2}{18t},$$

$$\pi_2^G = \tfrac{(c_1 - c_2 + 3t)^2}{18t} - k.$$

The consumers' surplus s is sufficiently large if $s \geq \frac{1}{2}(c_1 + c_2 + 3t)$. Thus, there exists a consumer with location $\tilde{x}$ who is indifferent between buying from firm 1 and buying from firm 2.[16]

Case 3: For $s < \frac{1}{2}(c_1 + c_2 + 3t)$ the consumer with location $\tilde{x}$, who would have been indifferent between the two firms, would not buy if the firms were to choose the competitive prices. Thus, both firms possess local monopoly power. Depending on consumers' surplus two more cases have to be distinguished: (a) The pricing strategies constitute an equilibrium such that the consumer located at $\tilde{x}$ is indifferent between the firms and between buying or not. (b) Firm 1 sets the monopoly price and firm 2 sets a price such that there exists a consumer who is indifferent from which firm to buy and whether or not to buy at all.

(a) For $s > \frac{1}{3}(2c_1 + c_2 + 3t)$ firms' profits are

$$\pi_1^G = (\tfrac{6s - 5c_1 - c_2 - 3t}{6})(\tfrac{c_2 - c_1 + 3t}{6t}),$$

$$\pi_2^G = (\tfrac{6s - c_1 - 5c_2 - 3t}{6})(\tfrac{c_1 - c_2 + 3t}{6t}) - k.$$

(b) For $\frac{1}{3}(2c_1 + c_2 + 3t) \geq s$ firms profits' are

$$\pi_1^G = \tfrac{(s - c_1)^2}{4t},$$

$$\pi_2^G = (\tfrac{3s - c_1 - 2c_2 - 2t}{2})(\tfrac{2t + c_1 - s}{2t}) - k.$$

[15] After inserting the equilibrium prices it follows that $p_1 - p_2 \leq t \Leftrightarrow t \geq \frac{c_1 - c_2}{3}$.

[16] Where $\tilde{x} = \frac{p_2 - p_1 + t}{2t} = \frac{c_2 - c_1 + 3t}{6t}$.

2. Acquisition

For $c_1 \geq s$ acquisition is not feasible since by assumption there exists no target firm. For $s > c_1$ the same three cases as above have to be considered. To calculate firm 2's net profit, its monopoly pricing strategy also has to be taken into account. For $s \geq c_1 + 2t$ the monopolist would like to serve the whole market and otherwise only a part of it.

Case 1: For $t < \frac{c_1 - c_2}{3}$ the acquisition price P_A will be zero.

1. For $s \geq c_1 + 2t$ firm 2's profit is
$$\pi_2^A = s - t - c_1.$$
2. For $s < c_1 + 2t$ the profit is
$$\pi_2^A = \frac{(s - c_1)^2}{4t}.$$

Case 2: For $t \geq \frac{c_1 - c_2}{3}$ and s being sufficiently large, that is $s \geq \frac{1}{2}(c_1 + c_2 + 3t)$, the acquisition price will be $P_A = \frac{(c_2 - c_1 + 3t)^2}{18t}$.

1. For $s \geq c_1 + 2t$ the net profit of firm 2 is
$$\pi_2^A = s - t - c_1 - \frac{(c_2 - c_1 + 3t)^2}{18t}.$$
2. For $s < c_1 + 2t$ the net profit is
$$\pi_2^A = \frac{(s - c_1)^2}{4t} - \frac{(c_2 - c_1 + 3t)^2}{18t}.$$

Case 3: If s is too small the acquisition price becomes in case (a) $P_A = (\frac{6s - 5c_1 - c_2 - 3t}{6})(\frac{c_2 - c_1 + 3t}{6t})$ and in case (b) $P_A = \frac{(s - c_1)^2}{4t}$. Thus, the net profits for firm 2 in these cases are [17]

$$\text{(a)} \quad \pi_2^A = \frac{(3s - 2c_1 - c_2 - 3t)^2}{36t},$$
$$\text{(b)} \quad \pi_2^A = 0.$$

[17] If s is too small it follows that $s < \frac{1}{2}(c_1 + c_2 + 3t) < c_1 + 2t$. Thus, firm 2 will always only serve part of the market using technology c_1.

C) The optimal entry mode

The superiority of one entry mode over the other will be written as an inequality with consumers' surplus s on the left-hand side. In the borderline case when greenfield investment and acquisition yield the same net post-entry payoff, i.e. the constraint is fulfilled with equality, it is simply assumed that acquisition will be chosen.

For $c_1 \geq s$ only greenfield investment is feasible. The entrant will choose this entry mode only if this is viable:

$$\pi_2^G = s - t - c_2 - k > 0.$$

Thus, for

$$s > c_2 + t + k \tag{2.1}$$

firm 2 will choose greenfield investment and otherwise it will not enter the market at all.

If firm 1 is initially in the market, i.e. $s > c_1$, acquisition will be chosen whenever $\pi_2^A \geq \pi_2^G$. Solving for s and re-arranging gives a critical value $\bar{s}$ for each situation:[18]

Case 1: When firm 1 faces no demand in competition with firm 2, i.e. $t < \frac{c_1 - c_2}{3}$, greenfield investment is viable if $k < \bar{k} = c_1 - c_2 - t$.

1. For $s \geq c_1 + 2t$ acquisition is the preferred mode of entry if

$$s \geq \bar{s} = 2c_1 - c_2 - k \tag{2.2}$$

   and otherwise it is greenfield investment.

2. For $s < c_1 + 2t$ acquisition is preferable if

$$s \geq \bar{s} = c_1 + 2\sqrt{t(c_1 - c_2 - t - k)} \tag{2.3}$$

   or greenfield investment in the opposite case.

[18]These values are well defined as long as $k < \bar{k}$ in the respective case.

Case 2: For $t \geq \frac{c_1 - c_2}{3}$ greenfield investment is viable whenever $k < \bar{k} = \frac{(c_1 - c_2 + 3t)^2}{18t}$.

1. For $s \geq c_1 + 2t$ acquisition is the preferred mode of entry if

$$s \geq \bar{s} = \frac{(c_1 - c_2)^2}{9t} + 2t + c_1 - k \tag{2.4}$$

and greenfield otherwise.

2. For $s < c_1 + 2t$ acquisition is preferable if

$$s \geq \bar{s} = c_1 + 2\sqrt{\frac{1}{9}(c_1 - c_2)^2 + t^2 - tk} \tag{2.5}$$

or greenfield investment else.

Case 3: If s is too small, $s < \frac{1}{2}(c_1 + c_2 + 3t)$, greenfield investment is viable in case (a) if $k < \bar{k} = (\frac{6s - c_1 - 5c_2 - 3t}{6})(\frac{c_1 - c_2 + 3t}{6t})$ or in case (b) $k < \bar{k} = (\frac{3s - c_1 - 2c_2 - 2t}{2})(\frac{2t + c_1 - s}{2t})$.

(a) For $s > \frac{1}{3}(2c_1 + c_2 + 3t)$ acquisition is the preferred mode if

$$s \leq \bar{s} = c_1 + 2t - 2\sqrt{\frac{1}{9}(c_1 - c_2)^2 + \frac{1}{2}t(c_1 - c_2 + t) - tk} \tag{2.6}$$

and greenfield otherwise.

(b) For $\frac{1}{3}(2c_1 + c_2 + 3t) \geq s$ acquisition leads to a zero net profit for certain. If greenfield investment is not viable the MNE prefers not to enter at all. Thus, no entry will be the preferred mode if

$$s \leq \bar{s} = \frac{1}{3}(2c_1 + c_2 + 4t - \sqrt{(c_1 - c_2 + 2t)^2 - 12tk}) \tag{2.7}$$

and otherwise greenfield entry is viable and will be chosen.

D) Proofs

Proof of Lemma 2.1:

We have to show that $\frac{d\pi_2^G}{dc_1} > 0$, $\frac{dP_A}{dc_1} \leq 0$, $\frac{d\pi_1^M}{dc_1} < 0$ is fulfilled for all cases.

(i) *Case 1:* $\frac{d\pi_2^G}{dc_1} = 1$, $\frac{dP_A}{dc_1} = 0$.

Case 2: $\frac{d\pi_2^G}{dc_1} = \frac{c_1-c_2+3t}{9t} > 0$, $\frac{dP_A}{dc_1} = \frac{c_1-c_2-3t}{9t} \leq 0$, for $t \geq \frac{c_1-c_2}{3}$.

Case 3: (a) $\frac{d\pi_2^G}{dc_1} = \frac{3s-c_1-2c_2-3t}{18t} > 0$, $\frac{dP_A}{dc_1} = \frac{5c_1-2c_2-6t-3s}{18t} < 0$, for $s > \frac{1}{3}(2c_1 + c_2 + 3t)$.

(b) $\frac{d\pi_2^G}{dc_1} = \frac{2s-c_1-c_2-2t}{2t} > 0$, $\frac{dP_A}{dc_1} = -\frac{s-c_1}{2t} < 0$, for $s \geq \{c_2+2t, c_1\}$.

(ii) For $s \geq c_1 + 2t$ we have $\frac{d\pi_1^M}{dc_1} = -1$ and $\frac{d\pi_1^M}{dc_1} = -\frac{s-c_1}{2t} < 0$ otherwise.

Q.E.D.

Proof of Lemma 2.2:

We have to show that $\frac{d\pi_2^A}{dc_1} \leq 0$ is fulfilled for all cases. Since $\frac{d\pi_2^A}{dc_1} = \frac{d\pi_1^M}{dc_1} - \frac{dP_A}{dc_1}$ it follows from proof of Lemma 2.1 :

Case 1: For $s \geq c_1 + 2t$ it is $\frac{d\pi_2^A}{dc_1} = -1$ and $\frac{d\pi_2^A}{dc_1} = -\frac{s-c_1}{2t} < 0$ otherwise.

Case 2: For $s \geq c_1 + 2t$ it is $\frac{d\pi_2^A}{dc_1} = \frac{c_2-c_1-6t}{9t} < 0$ and $\frac{d\pi_2^A}{dc_1} = \frac{7c_1+2c_2+6t-9s}{18t} < 0$ otherwise.

Case 3: (a) For $s \geq \frac{1}{3}(2c_1 + c_2 + 3t)$ we have $\frac{d\pi_2^A}{dc_1} = \frac{2c_1+c_2+3t-3s}{9t} < 0$.

(b) $\frac{d\pi_2^A}{dc_1} = 0$.

Q.E.D.

Proof of Proposition 2.2:

We have to show that for $k < \bar{k}$ there exists a $\bar{c}_1(s, c_2, t, k)$ such that greenfield investment is the optimal mode of entry for $c_1 > \bar{c}_1$ and acquisition otherwise. Re-arranging equations (2.2) - (2.7) with $\bar{s} = s$ determines the crucial value $\bar{c}_1$:

Case 1: 1. For $s \geq c_1 + 2t$ the crucial value is $\bar{c}_1 = \frac{1}{2}(s + c_2 + k)$.

2. For $s < c_1 + 2t$ the value is $\bar{c}_1 = s + 2t - 2\sqrt{t(s - c_2 - k)}$.

Case 2: 1. For $s \geq c_1+2t$ the value is $\bar{c}_1 = \frac{1}{2}[2c_2-9t+3\sqrt{t^2+4t(s+k-c_2)}]$.

2. For $s < c_1 + 2t$ it is $\bar{c}_1 = \frac{1}{5}[9s - 4c_2 - 6\sqrt{(s-c_2)^2 + 5t(t-k)}]$.

Case 3: (a) $\bar{c}_1 = \frac{1}{5}[9s - 9t - 4c_2 - 3\sqrt{4(s-c_2)^2 + t(2s - t - 2c_2 - 20k)}]$.

(b) $\bar{c}_1 = 2s - 2t - c_2 - \sqrt{(s-c_2)^2 - 4tk}$.

By proof of Lemma 2.1 and Lemma 2.2 we know that $\frac{d\pi_2^G}{dc_1} > 0, \frac{d\pi_2^A}{dc_1} \leq 0$. Thus, it follows that for $c_1 > \bar{c}_1$ greenfield is the optimal entry mode and acquisition otherwise. In *Case 3* (b) $c_1 > \bar{c}_1$ is always fulfilled by assumption $k < \bar{k}$.

Q.E.D.

Proof of Lemma 2.3:

We have to show that $\frac{d\pi_1^M}{ds} > 0, \frac{d\pi_2^A}{ds} \geq 0$ for all cases, $\frac{d\pi_2^G}{ds} > 0, \frac{dP_A}{ds} > 0$ for $s < \frac{1}{2}(c_1+c_2+3t)$, and $\frac{d\pi_2^G}{ds} = \frac{dP_A}{ds} = 0$ otherwise. Note that $\frac{d\pi_2^A}{ds} = \frac{d\pi_1^M}{ds} - \frac{dP_A}{ds}$.

(i) For $s \geq c_1 + 2t$ we have $\frac{d\pi_1^M}{ds} = 1$ or $\frac{d\pi_1^M}{ds} = \frac{s-c_s}{2t} > 0$ otherwise.

(ii) *Case 1:* $\frac{d\pi_2^G}{ds} = \frac{dP_A}{ds} = 0$; $\frac{d\pi_2^A}{ds} = 1$ or $\frac{d\pi_2^A}{ds} = \frac{s-c_s}{2t}$.

Case 2: $\frac{d\pi_2^G}{ds} = \frac{dP_A}{ds} = 0$; $\frac{d\pi_2^A}{ds} = 1$ or $\frac{d\pi_2^A}{ds} = \frac{s-c_s}{2t}$.

Case 3: (a) $\frac{d\pi_2^G}{ds} = \frac{c_1-c_2+3t}{6t}$, $\frac{dP_A}{ds} = \frac{c_2-c_1+3t}{6t} > 0$; $\frac{d\pi_2^A}{ds} = \frac{3s-2c_1-c_2-3t}{6t} > 0$.

(b) $\frac{d\pi_2^G}{ds} = \frac{2c_1+c_2+4t-3s}{2t} > 0$; $\frac{dP_A}{ds} = \frac{s-c_1}{2t} > 0$; $\frac{d\pi_2^A}{ds} = 0$.

Q.E.D.

Proof of Proposition 2.3:

We have to show that a finite value for $\bar{s}(c_1, c_2, t, k)$ always exists when $k < \bar{k}$.

Case 1: 1. For $t \leq \frac{1}{2}(c_1 - c_2 - k)$ the crucial value is $\bar{s} = 2c_1 - c_2 - k$.

2. For $t > \frac{1}{2}(c_1 - c_2 - k)$ the value is $\bar{s} = c_1 + 2\sqrt{t(c_1 - c_2 - t - k)}$.

Case 2: 1. For $t \leq \frac{(c_1-c_2)^2}{9k}$ the value is $\bar{s} = \frac{(c_1-c_2)^2}{9t} + 2t + c_1 - k$.

2. For $t > \frac{(c_1-c_2)^2}{9k}$ the value is $\bar{s} = c_1 + 2\sqrt{\frac{1}{9}(c_1-c_2)^2 + t^2 - tk}$.

Where equations (2.2) - (2.5) determine the values for $\bar{s}(c_1, c_2, t, k)$. We can also determine $\bar{s}(c_1, c_2, t, k)$ in *Case 3*. But increasing s above $s = \frac{1}{2}(c_1+c_2+3t)$ always leads to the situation in *Case 2*, where as shown an $\bar{s}(c_1, c_2, t, k)$

exists whenever $k < \bar{k}$. By proof of Lemma 2.3 we know that $\frac{d\pi_2^G}{ds} = 0$ and $\frac{d\pi_2^A}{ds} > 0$ in *Case 1* and *Case 2*. Thus, it follows that for $s \geq \bar{s}$ acquisition is the optimal entry mode. The intersection of the respective equation for $\bar{s}$ with $s = c_1 + 2t$ or $s = \frac{1}{2}(c_1 + c_2 + 3t)$ determine the case distinctions.

Q.E.D.

Proof of Proposition 2.4:

We have to show that $\bar{t}(c_1, c_2, s, k)$ exists for $s \geq \hat{s}$ and $k \leq \hat{k}$. From proof of Proposition 2.3 we know that for $k < \bar{k}$ there exists an $\bar{s}$ such that acquisition is the optimal mode of entry. In *Case 1* for $s \geq \hat{s} = 2c_1 - c_2 - k$ acquisition is the optimal entry mode. It remains to show that there exists a $\bar{t}$ in *Case 2*. Depending on the exact parameter constellations the crucial $\bar{t}$ is either

$$\bar{t}_1 = max\{\frac{c_1 - c_2}{3}, \frac{1}{4}(s - c_1 + \frac{1}{3}\sqrt{9(s - c_1 - k)^2 - 8(c_1 - c_2)^2})\}$$

or

$$\bar{t}_2 = max\{\frac{c_1 - c_2}{3}, \frac{1}{2}k + \frac{1}{6}\sqrt{9(s - c_1)^2 - 4(c_1 - c_2)^2 + 9k^2}\},$$

with $\bar{t} = \bar{t}_1$ for $\bar{t}_1 \leq \frac{1}{2}(s - c_1)$ and $\bar{t} = \bar{t}_2$ otherwise. Re-arranging (2.4) respectively (2.5) yields the second part in each case.

The crucial $\bar{t}$ exists for $k \leq \hat{k} = \frac{18s(c_1-c_2)-9(c_1^2-c_2^2)+4(c_1-c_2)^2}{18(s-c_2)}$ and $s \geq \hat{s} = max\{2c_1 - c_2 - k, 2c_2 - c_1 + 2k + \frac{1}{3}\sqrt{19(c_1 - c_2)^2 + 36k(c_2 - c_1 + k)}\}$. The intersection of $s = c_2 + 2t$ with (2.6) gives a maximum value for t. Substituting the resulting t into $s = c_2 + 2t$ yields the second part of $\hat{s}$ which ensures that no entry never is an optimal decision in the considered situation. Re-arranging $\bar{t}_2 = \frac{1}{2}k + \frac{1}{6}\sqrt{9(s - c_1)^2 - 4(c_1 - c_2)^2 + 9k^2} \leq \frac{1}{2}(s - c_2)$ results in $\hat{k}$. By construction of the parameter spaces greenfield investment is the optimal mode of entry for $t > \bar{t}$ and acquisition otherwise.

Q.E.D.

Proof of Proposition 2.5:

We have to show that for $s \in (\underline{s}, \tilde{s})$ and $k \in (\frac{1}{3}(c_1 - c_2), \frac{3}{5}(c_1 - c_2)]$ there exist $\underline{t}$ and $\tilde{t}$ with the described properties. Re-arranging (2.3) respectively (2.5) yields

$$\underline{t} = \frac{1}{2}(c_1 - c_2 - k - \sqrt{(c_1 - c_2)^2 - k(2c_1 - 2c_2 - k) - (s - c_1)^2}),$$

$$\tilde{t} = \frac{1}{2}k + \frac{1}{6}\sqrt{9(s - c_1)^2 - 4(c_1 - c_2)^2 + 9k^2}.$$

It is easy to show, that $\underline{t} < \frac{c_1 - c_2}{3} < \tilde{t}$ for $s \in (\underline{s}, \tilde{s})$ and $k \in (\frac{1}{3}(c_1 - c_2), \frac{3}{5}(c_1 - c_2)]$. The value for $\underline{s}$ is equal to equation (2.3) evaluated at $t = \frac{c_1 - c_2}{3}$ and $\tilde{s}$ is equal to $\hat{s}$ in *Case 1* as described in Proposition 2.4. For $(\underline{s}, \tilde{s})$ not to be empty it must be that $k > \frac{c_1 - c_2}{3}$. At the same time no entry should never be an optimal choice in the considered situation. Therefore, k should be small enough such that $\underline{s} \geq 2c_2 - c_1 + 2k + \frac{1}{3}\sqrt{19(c_1 - c_2)^2 + 36k(c_2 - c_1 + k)}$ is fulfilled. This value has already been determined in proof of Proposition 2.4. Re-arranging yields $k \leq (\frac{1}{72}A - 8\frac{4}{9}\frac{1}{A} + \frac{4}{9})(c_1 - c_2)$ with $A = (11348 + 276\sqrt{4641})^{\frac{1}{3}}$. Thus, the upper bound for k is approximately $\tilde{k} \approx \frac{3(c_1 - c_2)}{5}$, with $\tilde{k} < (\frac{1}{72}A - 8\frac{4}{9}\frac{1}{A} + \frac{4}{9})(c_1 - c_2)$.

Q.E.D.

E) Illustration of the results

Figure 2.1: Optimal entry mode for $s = 5$, $c_2 = 1$, $t = 1$.

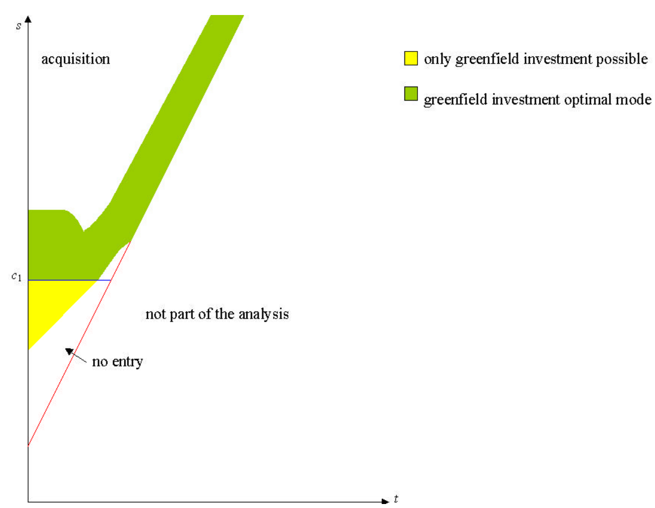

Figure 2.2: Optimal entry mode for $c_1 = 4$, $c_2 = 1$, $k = 1.75$.

Chapter 3

Modes of Foreign Entry under Asymmetric Information about Potential Technology Spillovers

3.1 Introduction

When a multinational enterprise enters a foreign market this can cause external effects on domestic firms. Foreign direct investment may, for example, improve domestic know-how through technology spillovers. If such a technology spillover benefits a company which is a direct competitor to the multinational firm, this externality naturally is not in the interest of the MNE. Strategically there are two key decisions for the multinational enterprise: The mode of foreign entry and the level of control over the local subsidiary. The level of control is associated with the ownership structure.[1] This in turn certainly may be influenced by the prospect of a technology spillover since engagement of a local partner may be the reason for the externality to come up at all.[2] What is the effect of a technology spillover on the choice of

[1]The notion of ownership as entitling the owner with the residual control rights over the asset has been put forward by Grossman and Hart [1986] and Hart and Moore [1990].

[2]In chapter 4, we analyze the effect of a potential spillover on the incentive to transfer technology and how incentives can be controlled through the ownership structure in international joint ventures.

entry mode between setting up a new venture via greenfield investment or acquisition of a local competitor?

This chapter contributes to answering this question by analyzing the effect of technology spillovers on the choice of entry mode. In particular, we ask two questions: What is the effect of technology spillovers on the entry mode choice under different forms of competition, i.e. quantity competition or price competition? How affects asymmetric information about a potential spillover the choice of entry mode? It is very likely that the multinational enterprise and a local competitor have different information concerning such intangible assets like know-how and technology. The MNE, for example, might have private information on whether or not local workers will be employed and get in contact with sensible information. On the other hand, there may be private information for the domestic firm whether its workers or managers are well enough trained to be capable of employing advanced technologies.

Foreign direct investment as a channel of technology transfer has been analyzed theoretically, for example, in Findlay [1978], Das [1987] or Wang and Blomström [1992].[3] One of their arguments is that the technological progress in a developing country depends positively on the technology gap and on the share of FDI in the capital stock. The empirical literature on the transfer of know-how and technology across borders identifies mixed evidence on the impact of FDI on the productivity of domestic firms.[4] Kokko [1994], Borensztein, De Gregorio and Lee [1998] and Xu [2000] found evidence that positive spillovers are more likely generated if the technology gap is not too large and if there exists a minimum threshold of human capital.[5] Both of

[3]For recent surveys on international technology transfer and spillovers see Saggi [2002] or Blomström and Kokko [1998].

[4]International trade can be a source of spillovers, too. Coe and Helpman [1995], Coe Helpman and Hoffmaister [1997], and Lichtenberg and van Pottelsberghe de la Potterie [1998] find evidence that foreign trade partners' R&D influences domestic total factor productivity.

[5]Other studies which found positive effects from the presence of MNEs on the productivity of domestic firms include, for example, the early studies by Caves [1974], Globerman [1979] or Blomström [1986].

these findings are in line with the theoretical results of our model. On the other hand, there also exists evidence for negative spillovers from foreign investment on domestically owned plants, e.g. Haddad and Harrison [1993], Aitken and Harrison [1999] or Djankov and Hoekman [2000].[6] However, none of these studies on technology transfer and spillovers makes a distinction for the choice of entry mode in FDI.

Even though the choice of entry mode is an important decision for the organizational form of foreign direct investment it has received relatively little attention in the economic literature. Empirically a number of potential factors influencing the choice of entry mode have been studied. Kogut and Singh [1988] found that with a greater cultural distance greenfield investment or joint ventures are more likely to be chosen than acquisition. For investment in the US there is evidence that large and diversified companies prefer acquisition as Caves and Mehra [1986] show. This finding gets support in Meyer [1998] for entry into Central and Eastern Europe. Hennart and Park [1993] found that greenfield investment is the preferred mode of entry for R&D intensive Japanese firms for entry into the US. Their results suggest that acquisitions are used by investors with weak competitive advantages, while investors with strong advantages find that greenfield investment is a more efficient entry mode.[7] Both of these findings are supported by the theoretical results of our model. We show that acquisition is the efficient mode of entry when technologies are sufficiently similar, while greenfield investment is the preferred choice when the MNE possesses a very superior technology.

There are only a few theoretical papers dealing with the choice of entry mode in foreign direct investment. Buckley and Casson [1998] and Görg [2000] analyze the effect of market structure and competition intensity on the choice of entry mode. Mattoo, Olarreaga and Saggi [2001] examine how the choice of entry mode affects the extent of technology transfer and the degree

[6] Görg and Strobl [2001] review the empirical literature on multinational companies and productivity spillovers. They argue that the empirical methods used and whether cross-section or panel analysis is employed can have an effect on the empirical results.

[7] Andersson and Svensson [1994] found similar results for Swedish multinational firms.

of competition in the host country.[8] These approaches, however, neither take account of the effect of technology spillovers nor of asymmetric information on the choice of entry mode.

In a recent paper, Das and Sengupta [2001] analyze the effect of asymmetric information about different payoff relevant variables on the formation of international mergers. In particular, they investigate two scenarios, one where a local firm has private information on market size and one where a foreign firm has private information on its own technology. Their main finding is that private information may be a hindrance to the formation of mergers. However, they assume that merger is the preferred mode of entry in case of full information. Hence, asymmetric information may result in fewer, but it cannot result in more mergers.

In contrast to their approach our model allows for both entry modes to be efficient in the first place. Moreover, we analyze the effect of asymmetric information over the same variable in both scenarios of private information. Therefore, we are able to examine the basic effect of a technology spillover on both types of entry mode and the effect of asymmetric information over the externality on the strategic entry choice. We consider a multinational enterprise in possession of a superior technology which can be employed in a greenfield investment. In this case a technology spillover can occur to the single local competitor thereby weakening the competitive advantage of the MNE. Alternatively the MNE could acquire its competitor and thereby avoid the prospect of a spillover. However, in this case only the inferior technology of the acquired company can be adopted.

The acquisition price and the profits for both firms concerning both entry modes are endogenously determined. Theses values which are crucial to the entry mode choice obviously depend on market characteristics, on the potential technology spillover, and on the technology difference between both firms. Interestingly, we find that the effect of a technology spillover on the

[8]See also Bjorvatn [2001] and Norbäck and Persson [2002] for theoretical models of the choice of entry mode.

entry mode choice crucially depends on the nature of competition. With quantity competition a technology spillover is a hindrance to acquisitions. However, with price competition and horizontally differentiated products we obtain exactly the opposite result. The effects of asymmetric information about a potential technology spillover on the entry mode choice are independent of the form of competition. We also find that private information indeed has a negative effect on the overall acquisition activity. In contrast to Das and Sengupta [2001] we show that under certain conditions private information may result in acquisitions which would not have taken place under full information. Finally, we find that the multinational firm ex ante prefers full information rather than private information. This is particularly surprising given the fact that the MNE makes the acquisition offer and should thereby be able to take advantage of its private information. The domestic firm, however, is better off with private information about a potential spillover.

The rest of this chapter is organized as follows. The next section sets up the basic model. In section 3.3, we determine the optimal entry mode under full information. Sections 3.4 and 3.5 analyze the entry mode choice under two scenarios of asymmetric information about a potential technology spillover. In section 3.6, we compare the different informational scenarios from an ex ante perspective. The final section discusses extensions and concludes.

3.2 The Model

Consider a multinational enterprise that enters a foreign market. This market is currently served by a single host country firm (HC). To enter the market the multinational firm 2 can either acquire the domestic firm 1 or set up a new venture via greenfield investment. Apart from the multinational firm there is no other potential entrant. Both firms $i = 1, 2$ produce at constant marginal cost c_i with no fixed cost. The entering MNE employs a superior technology than the domestic firm 1 ($\bar{c}_1 > c_2 \geq 0$). This assumption reflects the fact that a domestic firm located in a country like in Central and Eastern

Europe or a developing country has no access to advanced technologies.

The presence of a multinational firm may have an impact on the technological capabilities of the domestic firm by inducing a technology spillover. A greenfield investment might, for example, result in a turnover of trained workers from the multinational firm to the domestic firm thereby improving the know-how of the domestic firm. There are many other avenues one can think of for the flow of information or know-how. Of course an acquisition could also lead to a technology spillover. However, in our model an acquisition can only cause a spillover into another industry since there exists no other firm. A technology spillover in our model simply results in a reduction of the production cost for the domestic firm 1 to $\underline{c}_1$ such that $\bar{c}_1 > \underline{c}_1 \geq c_2 \geq 0$.[9] The spillover occurs with probability $q \in (0,1)$, but the parties may have private information on whether or not greenfield investment does lead to a technology spillover. We assume that, if a new venture is set up, information is revealed and both parties compete in quantities under full information.[10]

The market demand is represented by a simple linear demand function $p = a - x$, where the total quantity sold is denoted by x. In order for all profits to be non-negative we impose the following restriction on market size:

$$a \geq 2\bar{c}_1 - c_2.$$

When entering by acquisition the entrant has to use the acquired firm's technology $\bar{c}_1$.[11] If instead the entrant sets up a new venture he can implement the superior technology c_2. For simplicity the investment cost for a greenfield investment is assumed to be $k = 0$. Hence, by assumption greenfield investment is always a viable opportunity and market entry by MNE

[9]Thus, the technology spillover can result in a full reduction of the production cost in the sense that $\underline{c}_1 = c_2$ or only a partial reduction $\underline{c}_1 > c_2$.

[10]This is for simplicity. Otherwise we get results for incomplete information competition which simply would make the model more complicated.

[11]We could also assume that the entrant can implement its own technology by adapting the production facility which would involve additional costs. This would give us the same qualitative results.

will always occur.[12] The entry cost in case of acquisition is equal to the acquisition price since no other cost such as an adaptation cost is involved. This acquisition price, P_A, is endogenously determined. The multinational enterprise can make a take-it-or-leave-it offer to acquire firm 1.[13]

The time structure of the entry game is the following:

At stage 1, firm 2 (MNE) can choose between making a take-it-or-leave-it offer to acquire firm 1 (HC), greenfield investment or no market entry.

At stage 2, if firm 2 has made an offer, the incumbent firm 1 can accept or reject the offer.

At stage 3, firm 2 enters via greenfield investment in case firm 1 has turned the offer down.

At stage 4, firms enter competition and profits are realized.

Solving this game by backwards induction yields the sub-game perfect equilibrium of the bargaining game. The exact value of the acquisition offer depends on the informational structure and on the nature of competition.

With respect to stage 4 we will analyze in the following section the effect of a technology spillover on the entry mode choice for quantity competition and besides that for price competition. Therefore, we consider a standard model of horizontal product differentiation. Consumers are uniformly distributed along the unit interval [0,1] with density 1. They receive the surplus s from consumption of the good but incur a linear transportation cost t. HC is located at $x = 0$. MNE can choose between acquisition of HC or a greenfield investment in $x = 1$.

[12] For $k > 0$ greenfield investment may not be viable and therefore no credible option. This in turn can prevent entry, as shown in chapter 2.

[13] This constitutes a lower bound for the acquisition price. Other bargaining frameworks, where HC has bargaining power, too, obviously would lead to a higher acquisition price and thus shift preferences of the MNE in favor of greenfield investment.

3.3 Entry Mode Choice under Full Information

To begin with, consider the full-information case where both parties know whether a technology spillover occurs or not. Since greenfield investment is by assumption always viable the acquisition price P_A in equilibrium is equal to firm 1's post-greenfield entry profit denoted by $\pi_1(\bar{c}_1, c_2)$ if no spillover occurs or $\pi_1(\underline{c}_1, c_2)$ in case of a spillover. Thus, MNE either chooses acquisition at price P_A equal to firm 1's greenfield profit or greenfield investment at $k = 0$ otherwise.

Definition 3.1 $\bar{\pi}_i = \pi_i(\bar{c}_1, c_2)$, $\underline{\pi}_i = \pi_i(\underline{c}_1, c_2)$, $\pi_1^M = \pi_1^M(\bar{c}_1)$.

Without a technology spillover acquisition at price $P_A = \bar{\pi}_1$ takes place whenever

$$\pi_1^M \geq \bar{\pi}_1 + \bar{\pi}_2. \tag{3.1}$$

In case of a technology spillover acquisition at price $P_A = \underline{\pi}_1$ takes place whenever

$$\pi_1^M \geq \underline{\pi}_1 + \underline{\pi}_2. \tag{3.2}$$

How are the profits of both parties and as a result the choice of entry mode affected by a technology spillover? The spillover only occurs when greenfield investment is chosen, but it can be avoided by acquisition of the local competitor. Hence, acquisition has the advantage of becoming a monopolist and avoiding a potential spillover, but it has the disadvantage of a restriction to an inferior technology. With greenfield investment the technological advantage can be exploited, but then there is competition and also the possibility of a technology spillover. As a result of this it is not clear in which direction these effects influence the entry mode choice. It could be argued that acquisition becomes more attractive if a spillover occurs than in a situation without a technology spillover since then there is less need for an acquisition. Thus, more acquisitions should be expected in case of a technology spillover.[14]

[14] In our model, either acquisition is chosen or not, in which case there is greenfield investment. Thus, the number of acquisitions is either 1 or 0. By more acquisitions we

Quantity competition

As a consequence of a spillover on the one hand the acquisition price increases, while on the other the greenfield profit for MNE decreases since obviously $\underline{\pi}_1 > \bar{\pi}_1$ and $\bar{\pi}_2 > \underline{\pi}_2$. A priori it is not clear which of these two effects dominates. For some parameter constellations the effect on the greenfield profit is stronger than the effect on the acquisition price, while for other parameters it is the other way round.[15] Surprisingly, however, we can show that even if the effect on the greenfield profit dominates, there is an unambiguous tendency concerning the impact of a spillover on the entry mode choice: A technology spillover results in fewer acquisitions.

Proposition 3.1 *With quantity competition a technology spillover reduces the parameter space for which acquisition is the optimal entry mode.*

<u>Proof:</u> See Appendix.

Hence, with quantity competition a technology spillover results in fewer acquisitions compared to a situation without spillovers. The intuition for this interesting result is the following. If the effect on the acquisition price dominates, the impact on the entry mode choice is rather natural. Moreover, the effect on the greenfield profit for MNE dominates only if the difference in technologies is relatively large. As a consequence there is no further incentive to acquire since the monopoly profit then is comparably small relative to the greenfield profit for MNE. Therefore, even though the negative effect of a spillover on the greenfield profit sometimes dominates, this effect is never strong enough to change the entry mode choice from greenfield investment (without a spillover) to acquisition (with a spillover). Consequently, condition (3.2) is more restrictive than condition (3.1).

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mean that the condition for which acquisition takes place is less restrictive if a technology spillover occurs.

[15]See Lemma 3.3 in the Appendix.

Price competition

How robust is this result that a spillover, which could be avoided by acquisition, results in fewer acquisitions? Suppose firms were to compete in prices, each producing a horizontally differentiated product. Again, a spillover increases the acquisition price on the one hand, but the greenfield profit for MNE decreases on the other hand, i.e. $\underline{\pi}_1 > \bar{\pi}_1$ and $\bar{\pi}_2 > \underline{\pi}_2$. In contrast to the case of quantity competition the effect of a spillover on the greenfield profit (nearly) always dominates the effect on the acquisition price.[16] Furthermore, this effect is strong enough to change the entry mode choice from greenfield investment (without a spillover) to acquisition (with a spillover).

Proposition 3.2 *With price competition and horizontally differentiated products a technology spillover extends the parameter space for which acquisition is the optimal entry mode.*

Proof: See Appendix.

Hence, with price competition a technology spillover results in more acquisitions compared to a situation without spillovers. Since the effect on the greenfield profit for MNE dominates, the impact on the entry mode choice is fairly obvious. More formally, with price competition and horizontally differentiated products condition (3.1) is more restrictive than condition (3.2). Therefore, it is exactly the opposite result than with quantity competition.

Thus, the overall effect of a technology spillover on the choice of entry mode crucially depends on the nature of competition. The opposing effects of a spillover are caused by the fact that products are either strategic substitutes or strategic complements. A technology spillover has basically two effects: A direct *cost reducing effect* for HC and indirect *competition effects* on both firms. With quantity competition products are strategic substitutes. As a consequence of this the two effects on the profit of HC reinforce each other and dominate the competition effect on MNE. Under price competition and horizontally differentiated products, prices are strategic complements.

[16]See Lemma 3.4 in the Appendix.

Hence, the competition effect of a technology spillover on the profit for MNE dominates.

3.4 Entry Mode Choice when the Host Country Firm has Private Information about Potential Technology Spillovers

Suppose the domestic firm has private information concerning the potential technology spillover. The host country firm is likely to know whether its workers or managers will be capable of learning and applying new technologies or know-how. The multinational firm does not know whether a spillover will occur in case of a greenfield investment but believes that firm 1's production cost will be $\underline{c}_1$ or $\bar{c}_1$ with probabilities q and $1-q$ respectively. If greenfield investment is chosen, information is revealed. Therefore, we then obtain the standard results of the duopoly game.

In case of acquisition there is asymmetric information about the potential spillover. The uninformed multinational firm makes a take-it-or-leave-it offer and becomes a monopolist in this market if the offer is accepted. The domestic firm 1 accepts any offer which gives at least the profit that can be achieved in competition if greenfield investment would take place. If the domestic firm rejects the offer, MNE enters via greenfield investment and firms compete in quantities under full information. We obtain the following result concerning the equilibrium acquisition offer:[17]

Lemma 3.1 *The equilibrium acquisition offer is*

(a) $P_A = \underline{\pi}_1$ *if condition (3.2) is fulfilled and* $q \geq \hat{q}$*,*

(b) $P_A = \bar{\pi}_1$ *if condition (3.2) is fulfilled and* $q < \hat{q}$*,*

or if only condition (3.1) is fulfilled,

[17]Lemma 3.5, in the Appendix, determines the equilibrium acquisition offer if firms compete in prices.

(c) $P_A = 0$ *if neither condition (3.1) nor (3.2) is fulfilled,*

where $\hat{q} = \frac{\underline{\pi}_1 - \bar{\pi}_1}{\pi_1^M - \bar{\pi}_1 - \underline{\pi}_2}$.

Proof: See Appendix.

Intuitively, if acquisition is always efficient under full information, i.e. condition (3.2) is met, and the probability of a spillover is high, i.e. $q \geq \hat{q}$, the uninformed multinational makes a high offer $P_A = \underline{\pi}_1$ which is always accepted. In this case the potential loss of making too high an offer in case there is no potential for a spillover is outweighed by the benefits of becoming a monopolist (and avoiding the spillover) when actually a spillover would have occured. On the other hand, if the probability of a spillover is small, i.e. $q < \hat{q}$, it is in a sense too costly to offer a high acquisition price. Therefore, the multinational makes a low offer $P_A = \bar{\pi}_1$. Moreover, if an acquisition is efficient if no spillover occurs but inefficient in case of a spillover [i.e. condition (3.1) met but (3.2) violated] the multinational always makes a low offer $P_A = \bar{\pi}_1$. A low offer is accepted only in case there is no potential for a spillover and otherwise it is rejected. Finally, if acquisition is never efficient, i.e. the technology difference is too large, the multinational prefers not to make an offer but rather enters competition via greenfield investment.

The overall effect of HC's private information about a potential technology spillover on the entry mode is the following.

Proposition 3.3 *Private information for HC about a potential technology spillover reduces the parameter space for which acquisition is the optimal entry mode.*

Proof: See Appendix.

Private information for HC results in fewer acquisitions compared to full information.[18] This follows immediately from the determination of the equilibrium acquisition offer. MNE makes a high offer only if acquisition is efficient anyway. Hence, a high offer has no effect on the overall acquisition

[18] In the Appendix, we prove that this result is obtained also for the case of price competition and horizontally differentiated products.

activity but on both parties' payoffs. This is also true for the case of no offer, $P_A = 0$, where acquisition is always inefficient even with full information. If the multinational makes a low offer, $P_A = \bar{\pi}_1$, this is accepted only if no spillover occurs. Otherwise a low offer is rejected. This has no effect on the acquisition activity if only condition (3.1) is fulfilled. However, the multinational sometimes enters via greenfield investment even though with full information acquisition would be efficient, i.e. if condition (3.2) is met. We can summarize, private information for HC about a potential technology spillover has a negative effect on the overall acquisition activity.

For a given spillover, after the acquisition offer has been made and entry took place, the question is: which party has an advantage or a disadvantage because of the asymmetric information? It should be expected that the informed party gains from having an informational advantage. But as the following result shows this is not always the case:

Proposition 3.4 *Compared to full information HC gains from private information if condition (3.2) is fulfilled and $q \geq \hat{q}$, if there is no potential for a spillover.*

Proof: See Appendix.

The intuition for this result is pretty straightforward. HC can take advantage from private information only if MNE offers more than the actual post greenfield profit. This happens if the multinational expects a spillover to occur with a high probability and therefore makes a high offer, but there is no potential for a spillover, i.e. a spillover would not have occured. As Lemma 3.1 shows, a high offer is only made if acquisition is efficient in any case, i.e. (3.2) is fulfilled. Therefore, the technological difference and/or the potential technology spillover should not be too large. In all other situations HC receives a payoff which is equal to its post greenfield entry profit.

Considering the situation for the multinational firm we find that the MNE always loses compared to full information if HC gains. Furthermore, the multinational sometimes forgoes an efficient acquisition if a spillover is expected to be not very likely but it actually occurs.

Proposition 3.5 *Compared to full information MNE suffers from private information for HC if condition (3.2) is fulfilled and $q < \hat{q}$ ($q \geq \hat{q}$), if there is (no) potential for a spillover.*

Proof: See Appendix.

Acquisition is efficient in any case and thus condition (3.2) is fulfilled only if the difference in technologies and/or the technology spillover is sufficiently small. Otherwise, if the technology difference or the spillover is too large, the monopoly profit is too small relative to the sum of the acquisition price and the greenfield profit for MNE. Thus, private information for HC about the potential technology spillover may have an effect on payoffs only if the technological difference and therefore the potential spillover is not too large. Compared to the full information case MNE sometimes makes an offer which is too high given that no spillover would have occured. Or MNE sometimes makes an offer which is too low given that a spillover actually occurs. In the former case the domestic firm gains from its private information, while in the latter case it makes no difference to HC.

3.5 Entry Mode Choice when the Multinational Enterprise has Private Information about Potential Technology Spillovers

Now suppose that the multinational enterprise has private information about the potential technology spillover. MNE might, for example, know whether local workers are going to get in contact with sensible information concerning the production technology that might be of value to the domestic competitor. The domestic firm does not know whether a spillover will occur in case of a greenfield investment, but believes that its production cost will be $\underline{c}_1$ or $\bar{c}_1$ with probabilities q and $1 - q$ respectively. Again, if greenfield investment is chosen, information is revealed and both parties compete in quantities under full information.

The informed multinational makes a take-it-or-leave-it offer. By choosing an appropriate offer the MNE may signal whether there is potential for a spillover. In a pooling equilibrium information is not revealed by the offer. In this case the domestic firm accepts any offer which gives at least the expected post greenfield entry profit, i.e. $E[\pi_1] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1$. In a separating equilibrium information is revealed and the domestic firm can distinguish between both types of MNE, i.e with or without potential for a technology spillover. In this case the domestic firm accepts any offer which gives at least the respective post greenfield profit. Again, if the offer is rejected or if no offer is made, MNE enters via greenfield investment and firms compete in quantities under full information. The following result is obtained:

Lemma 3.2 *There exist three possible equilibria for the acquisition offer.*

1. *If $\pi_1^M \geq E[\pi_1] + \bar{\pi}_2$ there exists a* **pooling** *equilibrium where MNE offers $P_A = E[\pi_1]$, and this offer is accepted in equilibrium.*

2. *If $\underline{\pi}_1 + \bar{\pi}_2 > \pi_1^M \geq \underline{\pi}_1 + \underline{\pi}_2$ there exists a* **separating** *equilibrium, where MNE makes a high offer, $P_A = \underline{\pi}_1$, only if there is potential for a spillover. This offer is accepted in equilibrium. Otherwise no offer is made.*

3. *If $\underline{\pi}_1 + \underline{\pi}_2 > \pi_1^M$ there exists a* **pooling** *equilibrium where no offer is made.*

Proof: See Appendix.

The intuition for this result is the following. In pooling equilibrium *1.* information is not revealed since MNE makes the same offer, $P_A = E[\pi_1]$, independently of whether there is potential for a spillover or not. This occurs in equilibrium if it is profitable for both types of MNE to make such an offer.[19] If the multinational gains from such an offer only if there is potential

[19]Typically signaling games have many equilibria. In our case the problem is that several offers can be supported as a pooling equilibrium with different sets of beliefs. To be more precise, any offer $P_A \in (E[\pi_1], \underline{\pi}_1)$ can be supported as a pooling equilibrium. In these

for a spillover, information is revealed in separating equilibrium *2.* Since then HC can distinguish the types of MNE it will only accept an offer $P_A \geq \underline{\pi_1}$ if there is potential for a spillover. Therefore, the equilibrium offer is raised to $P_A = \underline{\pi_1}$ if there is potential for a spillover and otherwise the MNE makes no offer. Finally, in pooling equilibrium *3.* acquisition is not profitable for either type of MNE. Note that the proposed equilibria might exist at the same time. More precisely for certain parameter constellations the pooling equilibrium *1.* and the separating equilibrium *2.* or both pooling equilibria exist simultaneously.[20] The separating equilibrium *2.* and the pooling equilibrium *3.* are mutually exclusive.

How is the acquisition activity affected by private information for MNE about a potential technology spillover? From inspection of the equilibrium acquisition offers it follows that for certain parameter constellations an acquisition which under full information would have been efficient does not take place. This happens whenever the multinational firm makes no offer but (3.1) is fulfilled and a spillover occurs. However, as the following result claims, under certain conditions acquisition is chosen even though with full information the multinational firm would have chosen greenfield investment:

Proposition 3.6 *If condition (3.2) is not fulfilled, private information for MNE about a potential technology spillover extends the parameter space for which acquisition is the optimal entry mode compared to full information in case of pooling equilibrium 1., i.e.* $P_A = E[\pi_1]$.

<u>Proof:</u> See Appendix.

The intuition for this result is straightforward. If (3.2) is not fulfilled the MNE chooses greenfield investment under full information if a spillover occurs simply because acquisition would have been too expensive. With private information MNE offers a cheaper acquisition price, $P_A = E[\pi_1]$, in pooling

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equilibria acquisition is more expensive and therefore the parameter space for which the respective equilibrium exists is more restricted compared to the one considered here. Thus, in a sense $P_A = E[\pi_1]$ constitutes a lower bound for the acquisition price.

[20] See Proof of Lemma 3.2 for a formal description.

equilibrium *1.* and this is always accepted. Thus, acquisition is chosen even if otherwise a spillover would have occured. Note, however, that this result holds only if this equilibrium is selected since for the relevant parameter constellation the pooling equilibria *1.* and *3.* coexist.

To summarize, we find that under certain conditions the acquisition activity is enhanced by private information for MNE. As already mentioned, on the other hand, private information sometimes prevents efficient acquisitions. Despite the opposing effects the overall effect of MNE's private information about a potential technology spillover on the entry mode is unambiguous.

Proposition 3.7 *Private information for MNE about a potential technology spillover reduces the parameter space for which acquisition is the optimal entry mode.*

Proof: See Appendix.

Thus, private information for MNE results in fewer acquisitions compared to full information.[21] The multinational enterprise sometimes makes no acquisition offer at all even though this would be efficient under full information. With full information acquisition is efficient if no spillover occurs and (3.1) is met. In the same situation but with private information for MNE no offer is chosen in case of separating equilibrium *2.* or pooling equilibrium *3.* The positive effect of private information on acquisition activity which was stated in Proposition 3.6 is more than compensated by these two negative effects.[22]

Which of the parties gains and which suffers from private information for MNE about a potential technology spillover for a given spillover? Again, it could be expected that the informed party can take advantage of its information. However, this need not be the case in general. In fact it can be exactly the opposite, with the uninformed HC gaining from asymmetric information.

[21] Again, this result is independent of the form of competition as shown in the Appendix.

[22] Furthermore, the problem of equilibrium selection should be remembered. The result of Proposition 3.7 is straightforward if instead of pooling equilibrium *1.* with $P_A = E[\pi_1]$ pooling equilibrium *3.* with $P_A = 0$ is considered in the respective parameter space.

The reason for this result is that MNE sometimes offers more than the actual post greenfield profit to acquire HC.

Proposition 3.8 *Compared to full information HC (gains) suffers from private information for MNE in pooling equilibrium 1., i.e.* $P_A = E[\pi_1]$*, if there is (no) potential for a spillover.*

Proof: See Appendix.

The acquisition price $P_A = E[\pi_1]$ is too low compared to full information if a spillover occurs but it is too high given that no spillover would have occured. In all other situations HC receives a payoff which is equal to its post greenfield profit with full information independently of whether greenfield investment or acquisition takes place.

For the multinational firm it is exactly the other way round when the equilibrium acquisition offer is equal to $P_A = E[\pi_1]$. Thus, MNE might gain or suffer from having private information. But there are additional disadvantages:

Proposition 3.9 *Compared to full information*

(a) MNE gains (suffers) from private information in pooling equilibrium 1., i.e. $P_A = E[\pi_1]$*, if there is (no) potential for a spillover, or*

(b) MNE suffers from private information if condition (3.1) is fulfilled, if there is no potential for a spillover.

Proof: See Appendix.

The multinational firm takes advantage of its private information only if in pooling equilibrium *1.* a spillover would have occured. Otherwise MNE has a disadvantage in pooling equilibrium *1.* Moreover, in all other cases, if technologies are sufficiently similar, i.e. (3.1) fulfilled, and there is no potential for a spillover, MNE chooses greenfield investment even though acquisition would have been efficient. Hence, the multinational enterprises then suffers from its private information, too. In all other situations the MNE achieves the same payoff as with full information.

Again, private information for MNE about the potential spillover may have an effect on payoffs only if the technological difference is sufficiently small. However, this is a bit different from the situation with private information for HC about the potential spillover. In some sense the circumstances for which private information may have an effect on payoffs are more limited if HC is privately informed than if MNE is privately informed. In the former situation asymmetric information may have an effect only for very similar technologies (i.e. condition (3.2) fulfilled). In the latter it may have an effect also for not too similar technologies (i.e. condition (3.1) fulfilled).

3.6 Comparison of the Different Informational Scenarios from an Ex Ante Perspective

In this section, we compare the different informational scenarios from an ex ante perspective. This enables us to judge which of the described situations should be in the interest of the parties if they were able to choose between being informed or uninformed in the first place, i.e. before any other decisions are determined. A priori one might expect that it is always in the interest of either party to have private information on the potential technology spillover. At least from an ex ante perspective parties should be able to take advantage from being privately informed, even though ex post this must not be the case in general as we have already shown. However, the following result states that this is not the case for the multinational enterprise.

Proposition 3.10 *Ex ante MNE always (weakly) prefers full information over any kind of asymmetric information.*

Proof: See Appendix.

This is particularly surprising given the fact that the MNE proposes the acquisition offer and might thereby further exploit an informational advantage.

What is the reason for this result? Intuitively, we can state that signaling its type is too costly for MNE in some sense from an ex ante perspective. In order to be able to separate the spillover inducing type from the one that has no potential for a spillover, MNE must refrain from announcing a positive acquisition offer if no spillover occurs even though this would be efficient. Moreover, MNE cannot separate in case an acquisition would only be efficient if there is no potential for a spillover since any positive offer can be profitably replicated by the spillover inducing type. To summarize, we can conclude that the multinational enterprise sometimes must forgo efficient acquisitions and is therefore not able to take advantage of its private information. Obviously, private information for HC about the technology spillover cannot be in the interest of MNE.

With respect to the host country firm we obtain the more straightforward result that private information is preferred from an ex ante as well as from an ex post perspective.

Proposition 3.11 *Ex ante HC always (weakly) prefers to have private informations.*

Proof: See Appendix.

Intuitively, the domestic firm can take advantage of private information since there is no signaling cost involved. Some kind of signaling and information revealing takes place by rejection of an offer, which will only happen in case there is potential for a spillover but a low offer is made.

Obviously, there is a difference between the ex ante and the ex post preference towards the informational situation. This is not very surprising since a divergence in ex ante and ex post considerations is a common feature of many economic issues. What is surprising is the fact that the multinational firm would not choose to have private information about the potential technology spillover in the first place. In some sense MNE has the disadvantage of having to make an acquisition offer in both scenarios of asymmetric information.

3.7 Discussion and Conclusions

In the existing literature on FDI there is no well developed theory of the determinants of the choice between greenfield investment and acquisitions. Nevertheless, it is well recognized that this issue is very important both from a host country perspective and from the perspective of a multinational enterprise. As empirical evidence suggests, the strategic entry mode choice is affected by various firm specific and country specific factors. Among others the potential for technology spillovers seems to play an important role. We contribute to the literature by providing a simple theoretical model to analyze the effects of technology spillovers on the choice of entry mode. In particular, we examined the effect of asymmetric information about the potential for a spillover on the entry decision.

First, we showed that under full information the overall effect of a potential technology spillover crucially depends on the nature of competition. With quantity competition a technology spillover results in fewer acquisitions. With price competition and horizontally differentiated products a spillover has exactly the opposite effect. Theses contrary effects are caused by the fact that the choice variables are either strategic substitutes or strategic complements under the two forms of competition.

Previous work emphasized that asymmetric information may be a hindrance to the formation of mergers. In contrast, our approach analyzes its effects on both alternative modes of foreign entry. For the two scenarios of asymmetric information we also find that this has a negative effect on the overall acquisition activity. The reason for this is that the multinational enterprise sometimes must forgo or forgoes otherwise efficient acquisitions. Furthermore, this result is independent of the nature of competition. Even though the overall effect is unambiguous, we find that under certain conditions private information for MNE results in acquisitions which would not have taken place under full information.

Finally, we proved that the domestic firm is always better off when being privately informed. Interestingly, however, the multinational firm would ex ante prefer full information rather than private information about the potential for a spillover. With private information the MNE sometimes must forgo efficient acquisitions and also sometimes chooses inefficient acquisitions.

The results of our theoretical model are consistent with empirical evidence on foreign market entry. R&D intensive firms rather prefer to enter a foreign market via greenfield investment (Caves and Mehra [1986], Meyer [1998]). Moreover, investors with weak competitive advantages use acquisitions, while investors with strong advantages find greenfield investment to be the more efficient entry mode.[23] Our theoretical results confirm that acquisition should be the preferred mode of entry if the technology difference is not too large; otherwise greenfield investment is more efficient. Spillovers may only occur if there exists a certain technology gap. However, there is evidence that spillovers are more likely if the technology gap is not too large (Xu [2000]).[24] In our model, a spillover can occur (if at all) only in case of greenfield investment. Greenfield investment takes place either under certain conditions for an intermediate technology difference or if the multinational firm possesses a very superior technology. For an intermediate technological difference our results exactly indicate that greenfield investment may be chosen even if the probability of a spillover is high. This in turn can lead to a technology spillover. Concerning the case of a very superior technology, we would argue that whether in reality a spillover occurs depends very much on the absorptive capacity of the domestic firm. Of course in our model this has no effect on the entry mode choice since for a large technology gap the MNE always prefers greenfield investment.

An extension of the model could include the analysis of the choice of entry mode when there are more potential targets for acquisition in the market. In this case it is well known that the scope for a profitable merger is

[23]See Hennart and Park [1993] and Andersson and Svensson [1994].

[24]The stock of human capital limits the absorptive capacity of a developing country, as already emphasized in Nelson and Phelps [1966] and empirically tested by Benhabib and Spiegel [1994].

limited.[25] Moreover, it then would be necessary to determine exactly under which circumstances a spillover occurs and whether it benefits all companies in the respective market. These and other considerations are left for future research.

[25]See, for example, Salant, Switzer and Reynolds [1983], Levin [1990], Kamien and Zang [1990] or Gilbert and Newbery [1992] for theoretical discussions.

Appendix

A) The effect of a technology spillover on the greenfield profit and on the acquisition price

Lemma 3.3 *With quantity competition a technology spillover, i.e. a decrease in c_1, always results in a decrease in π_2, while P_A increases.*

Proof:

With asymmetric costs the greenfield profit for the MNE and the acquisition price are

$$\pi_2 = \frac{(a - 2c_2 + c_1)^2}{9}; P_A = \frac{(a - 2c_1 + c_2)^2}{9}.$$

Differentiating π_2 and P_A with respect to c_1 we get

$$\frac{d\pi_2}{dc_1} = \frac{2(a - 2c_2 + c_1)}{9} > 0,$$

$$\frac{dP_A}{dc_1} = -\frac{4(a - 2c_1 + c_2)}{9} < 0,$$

since by assumption $a > 2c_1 - c_2$. Moreover,

$$\left|\frac{d\pi_2}{dc_1}\right| \gtreqless \left|\frac{dP_A}{dc_1}\right| \Leftrightarrow 5c_1 - 4c_2 \gtreqless a.$$

Therefore, the effect of a marginal reduction in c_1, i.e. a technology spillover, on the greenfield profit of MNE dominates only if the difference in technologies is sufficiently large.

Q.E.D.

Lemma 3.4 *With price competition and horizontally differentiated products a technology spillover, i.e. a decrease in c_1, always results in a decrease in π_2, while P_A (weakly) increases.*

Proof:

Consider a standard model of horizontal product differentiation with firms competing in prices. Consumers are assumed to be uniformly distributed along the unit interval [0,1] with density 1. HC is located at $x = 0$ and MNE can choose between acquisition of HC or a greenfield investment with $k = 0$ in location $x = 1$. Consumers receive the surplus s from consumption but they have to incur a transportation cost t which is linear in the distance to the firm from which the good is bought. Depending on market characteristics there are three situations that have to be considered.[26] The profit for the multinational firm and the acquisition price in these three cases are:

Case 1: If $t < \frac{c_1 - c_2}{3}$, MNE can force its competitor out of the market by a greenfield investment:

$$\pi_2 = c_1 - c_2 - t; \; P_A = 0.$$

Case 2: If $t \geq \frac{c_1 - c_2}{3}$ and $s \geq \frac{1}{2}(c_1 + c_2 + 3t)$, there exists a marginal consumer with location $\tilde{x}$ who is indifferent between buying from HC or MNE:

$$\pi_2 = \frac{(c_1 - c_2 + 3t)^2}{18t}; \; P_A = \frac{(c_2 - c_1 + 3t)^2}{18t}.$$

Case 3: Both firms have local monopoly power over their consumers. Here, two more situations have to be considered:

(a) If $t \geq \frac{c_1 - c_2}{3}$ and $\frac{1}{2}(c_1 + c_2 + 3t) > s > \frac{1}{3}(2c_1 + c_2 + 3t)$, prices are chosen such that the marginal consumer at $\tilde{x}$ is indifferent between the firms and between buying or not:

$$\pi_2 = \left(\frac{6s - c_1 - 5c_2 - 3t}{6}\right)\left(\frac{c_1 - c_2 + 3t}{6t}\right);$$

$$P_A = \left(\frac{6s - 5c_1 - c_2 - 3t}{6}\right)\left(\frac{c_2 - c_1 + 3t}{6t}\right).$$

(b) If $t \geq \frac{c_1 - c_2}{3}$ and $\frac{1}{3}(2c_1 + c_2 + 3t) \geq s$, HC chooses its monopoly price and MNE sets a price such that there exists a consumer who is indifferent between the firms and between buying or not:

$$\pi_2 = \left(\frac{3s - c_1 - 2c_2 - 2t}{2}\right)\left(\frac{2t + c_1 - s}{2t}\right); \; P_A = \frac{(s - c_1)^2}{4t}.$$

Differentiating π_2 and P_A with respect to c_1 in the different cases we get:

[26] See chapter 2 for a detailed analysis.

Case 1: $\frac{d\pi_2^G}{dc_1} = 1$, $\frac{dP_A}{dc_1} = 0$.

Case 2: $\frac{d\pi_2^G}{dc_1} = \frac{c_1 - c_2 + 3t}{9t} > 0$, $\frac{dP_A}{dc_1} = \frac{c_1 - c_2 - 3t}{9t} \leq 0$.

Case 3: (a) $\frac{d\pi_2^G}{dc_1} = \frac{3s - c_1 - 2c_2 - 3t}{18t} > 0$, $\frac{dP_A}{dc_1} = \frac{5c_1 - 2c_2 - 6t - 3s}{18t} < 0$.

(b) $\frac{d\pi_2^G}{dc_1} = \frac{2s - c_1 - c_2 - 2t}{2t} > 0$, $\frac{dP_A}{dc_1} = -\frac{s - c_1}{2t} < 0$.

Moreover, it is easy to see that in *Case 1*, *Case 2* and *Case 3* (b) we have

$$\left|\frac{d\pi_2}{dc_1}\right| > \left|\frac{dP_A}{dc_1}\right|,$$

while in *Case 3* (a)

$$\left|\frac{d\pi_2}{dc_1}\right| \geq \left|\frac{dP_A}{dc_1}\right|, \text{ for } \frac{c_1 - c_2}{3} \leq t \leq \frac{4(c_1 - c_2)}{9}, \text{ and}$$

$$\left|\frac{d\pi_2}{dc_1}\right| < \left|\frac{dP_A}{dc_1}\right|, \text{ for } t > \frac{4(c_1 - c_2)}{9}.$$

Therefore, the effect of a marginal reduction in c_1, i.e. a technology spillover, on the greenfield profit of MNE always dominates except under certain conditions for *Case 3* (a).

Q.E.D.

B) **Proofs**

Proof of Proposition 3.1:

We simply have to show that with quantity competition condition (3.2) is more restrictive than condition (3.1). The monopoly profit with technology $\bar{c}_1$ is given by

$$\pi_1^M = \frac{(a - \bar{c}_1)^2}{4}.$$

The greenfield profits for both parties if or if not a spillover occurs, respectively, are given by

$$\underline{\pi}_1 = \frac{(a - 2\underline{c}_1 + c_2)^2}{9}; \ \underline{\pi}_2 = \frac{(a - 2c_2 + \underline{c}_1)^2}{9};$$

$$\bar{\pi}_1 = \frac{(a - 2\bar{c}_1 + c_2)^2}{9}; \ \bar{\pi}_2 = \frac{(a - 2c_2 + \bar{c}_1)^2}{9}.$$

Thus, condition (3.1) becomes

$$\frac{(a-\bar{c}_1)^2}{4} \geq \frac{(a-2\bar{c}_1+c_2)^2}{9} + \frac{(a-2c_2+\bar{c}_1)^2}{9}.$$

$$\Leftrightarrow a \geq 5\bar{c}_1 - 4c_2 \pm \sqrt{(\bar{c}_1-c_2)^2}$$

$$\Rightarrow a \geq 11\bar{c}_1 - 10c_2. \tag{3.1$'$}$$

(The other solution can be neglected since by assumption $a \geq 2\bar{c}_1 - c_2$.)

Condition (3.2) becomes

$$\frac{(a-\bar{c}_1)^2}{4} \geq \frac{(a-2\underline{c}_1+c_2)^2}{9} + \frac{(a-2c_2+\underline{c}_1)^2}{9}$$

$$\Leftrightarrow a \geq 9\bar{c}_1 - 4c_2 - 4\underline{c}_1 \pm 6\sqrt{c_2^2 - 2\bar{c}_1c_2 + 2\bar{c}_1^2 - 2\bar{c}_1\underline{c}_1 + \underline{c}_1^2}.$$

$$\Rightarrow a \geq 9\bar{c}_1 - 4c_2 - 4\underline{c}_1 + 6\sqrt{(\bar{c}_1-c_2)^2 + (\bar{c}_1-\underline{c}_1)^2}. \tag{3.2$'$}$$

(The other solution again can be neglected).
Define $\Delta = \bar{c}_1 - \underline{c}_1 > 0$. Thus, Δ is the potential spillover.
Condition (3.2′) is more restrictive than condition (3.1′) if

$$9\bar{c}_1 - 4c_2 - 4\underline{c}_1 + 6\sqrt{c_2^2 - 2\bar{c}_1c_2 + 2\bar{c}_1^2 - 2\bar{c}_1\underline{c}_1 + \underline{c}_1^2} > 11\bar{c}_1 - 10c_2$$

$$\Leftrightarrow 17\bar{c}_1^2 - 12\bar{c}_1c_2 - 22\bar{c}_1\underline{c}_1 + 5\underline{c}_1^2 + 12\underline{c}_1c_2 > 0$$

$$\Leftrightarrow 12\bar{c}_1 - 12c_2 + 5\Delta > 0.$$

The final inequality holds since $\bar{c}_1 > c_2$ and $\Delta > 0$.

Q.E.D.

Proof of Proposition 3.2:

We have to show that with price competition and horizontally differentiated products condition (3.1) is more restrictive than condition (3.2). The monopoly profit with technology $\bar{c}_1$ is

$$\pi_1^M = \begin{cases} s - t - \bar{c}_1 & \text{, if } s \geq \bar{c}_1 + 2t, \\ \frac{(s-\bar{c}_1)^2}{4t} & \text{, otherwise.} \end{cases}$$

Acquisition is the optimal mode of entry if the respective monopoly profit exceeds the sum of the greenfield profit for MNE and of the acquisition price, which is reflected in conditions (3.1) and (3.2). By Proof of Lemma 3.4 we already know that the effect of a marginal reduction in c_1 on the greenfield profit for MNE dominates the effect on the acquisition price in all cases except under certain conditions for *Case 3* (a). Therefore, it is obvious that in all these other cases a spillover results in acquisition becoming relatively more attractive, or, in other words, condition (3.1) being more restrictive than (3.2).

The greenfield profits for both parties in *Case 3* (a) if no spillover occurs are given by

$$\bar{\pi}_1 = \left(\frac{6s - 5\bar{c}_1 - c_2 - 3t}{6}\right)\left(\frac{c_2 - \bar{c}_1 + 3t}{6t}\right);$$

$$\bar{\pi}_2 = \left(\frac{6s - \bar{c}_1 - 5c_2 - 3t}{6}\right)\left(\frac{\bar{c}_1 - c_2 + 3t}{6t}\right).$$

Thus, condition (3.1) becomes

$$\frac{(s-\bar{c}_1)^2}{4t} \geq \left(\frac{6s-5\bar{c}_1-c_2-3t}{6}\right)\left(\frac{c_2-\bar{c}_1+3t}{6t}\right) + \left(\frac{6s-\bar{c}_1-5c_2-3t}{6}\right)\left(\frac{\bar{c}_1-c_2+3t}{6t}\right)$$

$$\Leftrightarrow s \leq \bar{c}_1 + 2t \pm 2\sqrt{\frac{1}{9}(\bar{c}_1 - c_2)^2 + \frac{1}{2}t(\bar{c}_1 - c_2 + t)}$$

$$\Rightarrow s \leq \bar{c}_1 + 2t - 2\sqrt{\frac{1}{9}(\bar{c}_1 - c_2)^2 + \frac{1}{2}t(\bar{c}_1 - c_2 + t)}. \qquad (3.1'')$$

(The other solution can be neglected since in *Case 3* we have $s < \bar{c}_1 + 2t$.) However, condition $(3.1'')$ can never be fulfilled because in *Case 3* (a) we must have $s > \frac{1}{3}(2\bar{c}_1 + c_2 + 3t)$:

$$\frac{1}{3}(2\bar{c}_1 + c_2 + 3t) > \bar{c}_1 + 2t - 2\sqrt{\frac{1}{9}(\bar{c}_1 - c_2)^2 + \frac{1}{2}t(\bar{c}_1 - c_2 + t)}$$

$$\Leftrightarrow 9t^2 + 12t\bar{c}_1 - 12tc_2 > -3(\bar{c}_1 - c_2)^2.$$

The final inequality holds since $\bar{c}_1 > c_2$.

Thus, in other words, without a spillover greenfield investment is always the optimal entry mode in *Case 3* (a). If, on the other hand, a spillover occurs this will at least not result in fewer acquisitions independently of whether condition (3.2) can be fulfilled in *Case 3* (a). Note finally that in *Case 3* (b) acquisition will never take place anyway.

Q.E.D.

Proof of Lemma 3.1:

In equilibrium MNE will obviously never offer $P_A > \underline{\pi}_1$ since the domestic firm accepts $P_A = \underline{\pi}_1$ anyway. We can also ignore any offer $0 < P_A < \bar{\pi}_1$ which will always be rejected by the domestic firm and it is payoff equivalent to an offer $P_A = 0$. Moreover, any offer $\bar{\pi}_1 < P_A < \underline{\pi}_1$ cannot be an equilibrium offer since this would only be accepted if no spillover occurs which can also be achieved by offering $P_A = \bar{\pi}_1$. Therefore, the multinational firm will offer $P_A = \underline{\pi}_1$ or $P_A = \bar{\pi}_1$ or $P_A = 0$ depending on the efficiency of acquisition and on the probability of a spillover.

If (3.2) is met, acquisition is efficient independently of a spillover. The multinational prefers to offer $P_A = \underline{\pi}_1$ instead of $P_A = \bar{\pi}_1$ if the probability of a spillover q is high enough such that the gain from becoming a monopolist outweighs the loss of a too high offer in case no spillover would have occured:

$$\pi_1^M - \underline{\pi}_1 \geq q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1]$$

$$\Leftrightarrow q \geq \frac{\underline{\pi}_1 - \bar{\pi}_1}{\pi_1^M - \bar{\pi}_1 - \underline{\pi}_2} = \hat{q}.$$

Where $\hat{q} \in (0,1)$ since $\underline{\pi}_1 > \bar{\pi}_1$ and by (3.2).

If only condition (3.1) is fulfilled acquisition at price $P_A = \bar{\pi}_1$ is efficient and will be accepted only if there is no potential for a spillover. Otherwise this offer is rejected. If acquisition is never efficient $P_A = 0$ is chosen.

Q.E.D.

Proof of Lemma 3.2:

There are three types of possible equilibrium acquisition offers P_A which can be supported by different sets of beliefs for different parameter constellations:

1. A pooling equilibrium in which the MNE makes an offer which is always accepted.

2. A separating equilibrium in which MNE makes an offer only if there is potential for a spillover. This offer is accepted. Otherwise MNE makes no offer.

3. A pooling equilibrium in which MNE never makes an offer independently of its type.

Pooling equilibrium *1.*: Consider an acquisition offer with $P_A = E[\pi_1]$, where $E[\pi_1] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1$ and suppose that each type of MNE makes such an offer. According to Bayes' rule the updated belief of HC is then $\tilde{q} = q$, i.e. HC does not learn anything. For the out-of-equilibrium belief Baye's Rule cannot be applied and HC is free to believe anything. However, updating has to be consistent with the equilibrium strategies. The proposed equilibrium acquisition offer can be supported by an out-of-equilibrium belief $\tilde{q} = 1$. Such an equilibrium exists if both types of MNE, i.e. with or without potential for a spillover, gain from such an offer:

$$\pi_1^M - E[\pi_1] \geq \bar{\pi}_2$$

$$\Leftrightarrow \pi_1^M \geq E[\pi_1] + \bar{\pi}_2. \tag{3.3}$$

Separating equilibrium *2.*: The MNE with potential for a spillover makes a high offer $P_A = \underline{\pi}_1$, while the other type makes no offer. Thus, HC can always update its beliefs according to Baye's Rule. Therefore, if $P_A = \underline{\pi}_1$ is observed, the updated belief becomes $\tilde{q} = 1$ and otherwise $\tilde{q} = 0$. The proposed equilibrium exists if condition (3.2) is fulfilled and if it's not worthwhile for the type of MNE without potential for a spillover to imitate, i.e. if

$$\pi_1^M - \underline{\pi}_1 < \bar{\pi}_2$$

$$\Leftrightarrow \bar{\pi}_2 + \underline{\pi}_1 > \pi_1^M. \tag{3.4}$$

Obviously, conditions (3.4) and (3.2) can be simultaneously fulfilled since

$\bar{\pi}_2 > \underline{\pi}_2$.

Finally, pooling equilibrium *3.* with $P_A = 0$ exists if condition (3.2) is not fulfilled. In this case it is not efficient for a MNE with potential for a spillover to acquire. The type of MNE without a potential for a spillover is not able to separate since any positive offer could be profitably replicated by the other type of MNE.

The proposed equilibria can exist at the same time. For certain parameter constellations the pooling equilibrium *1.* and the separating equilibrium *2.* or both pooling equilibria exist simultaneously. More precisely, conditions (3.3) and (3.4) can be fulfilled at the same time and therefore equilibrium *1.* and *2.* exist simultaneously if

$$\pi_1^M - E[\pi_1] \geq \bar{\pi}_2 \geq \pi_1^M - \underline{\pi}_1.$$

Both pooling equilibria may coexist since (3.3) can be fulfilled and at the same time (3.2) can be violated if

$$\pi_1^M - E[\pi_1] \geq \bar{\pi}_2 > \underline{\pi}_2 > \pi_1^M - \underline{\pi}_1.$$

In short, coexistence is only given if (3.3) or (3.4) are fulfilled. Otherwise all proposed equilibria exist independently of each other. Finally, the separating equilibrium *2.* and the pooling equilibrium *3.* are obviously mutually exclusive by (3.2).

Q.E.D.

Proof of Proposition 3.3:

By Lemma 3.1 with private information for HC acquisition is chosen whenever it is also efficient with full information except for the case where (3.2) is fulfilled and $q < \hat{q}$. In this case, if there is potential for a spillover, greenfield investment takes place even though acquisition would have been efficient.

Q.E.D.

Proof of Proposition 3.4:

HC can gain only if MNE offers more than the actual post greenfield profit for HC. This happens if (3.2) is fulfilled and $q \geq \hat{q}$, but there is no potential for a spillover. In this case MNE makes a high offer, $P_A = \underline{\pi}_1$, if HC is privately informed, while MNE would make a low offer, $P_A = \bar{\pi}$, with full information. Condition (3.2) is fulfilled if the technology difference and/or the potential spillover, i.e. $\bar{c}_1 - c_2$ and/or $\Delta = \bar{c}_1 - \underline{c}_1$, are not too large as inspection of condition (3.2′) in proof of Proposition 3.1 displays. In all other situations HC receives the same payoff with private information as with full information.

Q.E.D.

Proof of Proposition 3.5:

MNE suffers from private information if either the domestic firm is acquired too expensive or acquisition inefficiently not takes place. This can happen only if (3.2) is fulfilled. In this case if $q \geq \hat{q}$ MNE offers too much if there is no potential for a spillover or if $q < \hat{q}$ MNE offers too little and thus acquisition not takes place if a spillover actually occurs. In all other situations MNE receives the same payoff with private information as with full information.

Q.E.D.

Proof of Proposition 3.6:

With full information if condition (3.1) is met but (3.2) is not fulfilled and a spillover occurs, MNE chooses greenfield investment since acquisition at price $P_A = \underline{\pi}_1$ is too expensive relative to the monopoly profit. If no spillover occurs MNE acquires the domestic firm at price $P_A = \bar{\pi}_1$. With private information for MNE the acquisition price in pooling equilibrium *1.* becomes $P_A = E[\pi_1]$ and this is always accepted. Therefore, the acquisition price is low enough for acquisition to be profitable even if there is potential for a spillover. Since for certain parameter constellations the pooling equilibrium *1.* exists, if (3.3) is fulfilled and simultaneously (3.2) violated, private information for MNE may thus lead to more acquisitions than full information.

Q.E.D.

Proof of Proposition 3.7:

By Lemma 3.2 with private information for MNE, if condition (3.1) is met, in separating equilibrium *2.* or pooling equilibrium *3.* acquisition inefficiently does not take place if there is no potential for a spillover. Therefore, private information has a negative effect on the acquisition activity. However, by Proposition 3.6 pooling equilibrium *1.* leads under certain conditions to more acquisitions than full information. But overall this positive effect on the acquisition activity is more than offset by the two negative effects.
More formally, pooling equilibrium *1.* results in acquisitions which would not have taken place under full information within the parameter space in which conditions (3.1) and (3.3) are met and condition (3.2) is violated. Separating equilibrium *2.* and pooling equilibrium *3.* may result in greenfield investment, while for full information acquisition would have taken place within the parameter space in which condition (3.3) is not fulfilled but conditions (3.1) and (3.4) are met. Since conditions (3.2) and (3.3) cross for some value of $q \in (0, 1)$ the former parameter space must be smaller than the latter.[27]

Q.E.D.

Proof of Proposition 3.8:

From the view of HC in pooling equilibrium *1.* the acquisition price $P_A = E[\pi_1]$ is too small compared to the acceptable offer under full information if there is potential for a spillover and it is too large otherwise. Therefore, HC suffers from private information for MNE in the former case, while it gains in the latter. In all other situations HC receives a payoff which is equivalent to its post greenfield profit independently of whether acquisition or greenfield investment is chosen.

Q.E.D.

[27]See Figure 3.1 for a graphical illustration. In Figure 3.1 the parameter space for which pooling equilibrium *1.* results in more acquisitions is represented by the triangle between the lines (3.2) and (3.3) and $q = 0$. The other situation is represented by the triangle between the lines (3.1) and (3.3) and $q = 1$. Note that the former space is always smaller than the latter independently of the exact relation between conditions (3.1) - (3.4).

Proof of Proposition 3.9:

MNE gains from having private information only in pooling equilibrium if there is potential for a spillover. In this situation the acquisition price $P_A = E[\pi_1]$ is smaller than it would be with full information. The multinational cannot take advantage of its private information in any other situation. On the other hand, MNE acquires HC at a too high price in pooling equilibrium *1.* if no spillover would have occured. Moreover, MNE also suffers from being privately informed if condition (3.1) is fulfilled and a spillover does not occur. In this case with full information acquisition would have been efficient but greenfield investment is chosen if MNE is privately informed.

Q.E.D.

Proof of Proposition 3.10:

First, we derive the expected payoffs for MNE for the different informational scenarios.

1. Full Information:

$$E[\pi_1] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1.$$

(a) $E[\pi_2] = \pi_1^M - E[\pi_1]$, if conditions (3.1) and (3.2) are fulfilled.

(b) $E[\pi_2] = q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1]$, if only condition (3.1) is fulfilled.

(c) $E[\pi_2] = q\underline{\pi}_2 + (1-q)\bar{\pi}_2$, if none of the conditions is fulfilled.

2. Private Information for HC:

(a) $E[\pi_2 | q \geq \hat{q}] = \pi_1^M - \underline{\pi}_1$ or

$E[\pi_2 | q < \hat{q}] = q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1]$, if conditions (3.1) and (3.2) are met.

(b) $E[\pi_2] = q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1]$, if only condition (3.1) is fulfilled.

(c) $E[\pi_2] = q\underline{\pi}_2 + (1-q)\bar{\pi}_2$, if none of the conditions is fulfilled.

3. Private Information for MNE:

$$E[\pi_1] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1.$$

(a) $E[\pi_2] = \pi_1^M - E[\pi_1]$, if (3.3) is fulfilled.

(b) $E[\pi_2] = q[\pi_1^M - \underline{\pi}_1] + (1-q)\bar{\pi}_2$, if conditions (3.2) and (3.4) are fulfilled.

(c) $E[\pi_2] = q\underline{\pi}_2 + (1-q)\bar{\pi}_2$, if (3.2) is not fulfilled.

Comparison of the different expected profits for MNE shows that the full information expected profit always weakly dominates the expected profit with asymmetric information. More precisely, expected profits when HC has private information are equal to the full information case except in (a) where the expected profit with full information is higher:

1. $\pi_1^M - E[\pi_1] > \pi_1^M - \underline{\pi}_1$, which obviously is fulfilled.

2. $\pi_1^M - E[\pi_1] > q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1] \Leftrightarrow \pi_1^M > \underline{\pi}_1 + \underline{\pi}_2$, fulfilled by (3.2).

Now we compare expected profits with full information and with private information for MNE. Pooling equilibrium *1.* and full information yield the same expected profit if (3.2) is met. Otherwise if (3.2) is not fulfilled the expected profit with full information is higher:

$$q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1] > \pi_1^M - E[\pi_1] \Leftrightarrow \underline{\pi}_1 + \underline{\pi}_2 > \pi_1^M.$$

Separating equilibrium *2.* always yields a lower expected payoff than the full information expected payoff:

$\pi_1^M - E[\pi_1] > q[\pi_1^M - \underline{\pi}_1] + (1-q)\bar{\pi}_2 \Leftrightarrow \pi_1^M > \bar{\pi}_1 + \bar{\pi}_2$, which is fulfilled by (3.2).

Finally, pooling equilibrium *3.* yields the same expected payoff as with full information if (3.1) is violated. Otherwise if (3.1) is fulfilled the full information expected payoff is larger:

$$q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1] > q\underline{\pi}_2 + (1-q)\bar{\pi}_2 \Leftrightarrow \pi_1^M > \bar{\pi}_1 + \bar{\pi}_2.$$

Q.E.D.

<u>Proof of Proposition 3.11:</u>

HC's expected payoff is equal to

$$E[\pi_1] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1$$

except for the case of private information for HC and condition (3.1) fulfilled. In this case if (3.1) is met the expected payoff is

$$E[\pi_1 | q \geq \hat{q}] = \underline{\pi}_1, \text{ or}$$

$$E[\pi_1 | q < \hat{q}] = q\underline{\pi}_1 + (1-q)\bar{\pi}_1.$$

Thus, HC always receives the same expected payoff with the above exception in all cases. Since for $q \geq \hat{q}$ the expected payoff is larger, HC (weakly) prefers private information.

Q.E.D.

Relative relation between conditions (3.1) - (3.4):

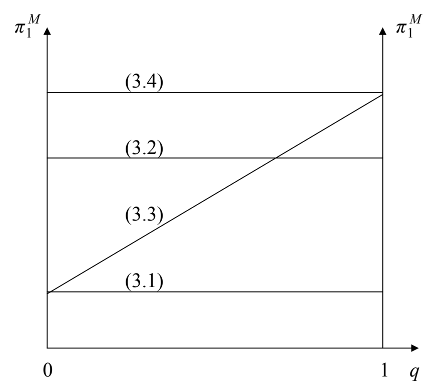

Figure 3.1: Relation of conditions (3.1) - (3.4) under quantity competition.

C) Asymmetric information and price competition

We will now show that the effects of asymmetric information about a potential technology spillover on the entry mode remain qualitatively the same for the case of price competition with horizontally differentiated products. Hence, asymmetric information reduces the parameter space for which acquisition is the optimal entry mode. The main difference is that condition (3.1) is more restrictive than (3.2), as already shown in Proposition 3.2.

The effects of asymmetric information differ with respect to the equilibrium acquisition offer, if the domestic firm has private information about potential technology spillovers:

Lemma 3.5 *The equilibrium acquisition offer is*

(a) $P_A = \underline{\pi}_1$ *if condition (3.1) is fulfilled and* $q \geq \hat{q}$*,*

or if only condition (3.2) is fulfilled and $q \geq \tilde{q}$*,*

(b) $P_A = \bar{\pi}_1$ *if condition (3.1) is fulfilled and* $q < \hat{q}$*,*

(c) $P_A = 0$ *otherwise,*

where $\hat{q} = \frac{\underline{\pi}_1 - \bar{\pi}_1}{\pi_1^M - \bar{\pi}_1 - \underline{\pi}_2}$ *and* $\tilde{q} = \frac{\underline{\pi}_1 + \bar{\pi}_2 - \pi_1^M}{\bar{\pi}_2 - \underline{\pi}_2}$.

Proof:

As argued in proof of Lemma 3.1, MNE will offer $P_A = \underline{\pi}_1$, $P_A = \bar{\pi}_1$ or $P_A = 0$ depending on the efficiency of acquisition and on the probability of a spillover.

If (3.1) is met, acquisition is efficient independently of a spillover. MNE prefers to offer $P_A = \underline{\pi}_1$ instead of $P_A = \bar{\pi}_1$, if the probability of a spillover q is high enough such that the gain from becoming a monopolist outweighs the loss of a too high offer in case there is no potential for a spillover:

$$\pi_1^M - \underline{\pi}_1 \geq q\underline{\pi}_2 + (1-q)[\pi_1^M - \bar{\pi}_1]$$

$$\Leftrightarrow q \geq \frac{\underline{\pi}_1 - \bar{\pi}_1}{\pi_1^M - \bar{\pi}_1 - \underline{\pi}_2} = \hat{q}.$$

Where $\hat{q} \in (0,1)$ since $\underline{\pi}_1 > \bar{\pi}_1$ and by (3.2). Otherwise MNE offers $P_A = \bar{\pi}_1$.

If only condition (3.2) is fulfilled acquisition is efficient only if there is potential for a spillover. MNE prefers to offer $P_A = \underline{\pi}_1$ instead of no offer, $P_A = 0$, if the probability of a spillover q is high enough:

$$\pi_1^M - \underline{\pi}_1 \geq q\underline{\pi}_2 + (1-q)\bar{\pi}_2$$

$$\Leftrightarrow q \geq \frac{\underline{\pi}_1 + \bar{\pi}_2 - \pi_1^M}{\bar{\pi}_2 - \underline{\pi}_2} = \tilde{q}.$$

Where $\tilde{q} \in (0,1)$ since: 1. $\underline{\pi}_1 + \bar{\pi}_2 > \bar{\pi}_1 + \bar{\pi}_2 > \pi_1^M$, because (3.1) is not met.
2. $\bar{\pi}_2 - \underline{\pi}_2 > \underline{\pi}_1 + \bar{\pi}_2 - \pi_1^M \Leftrightarrow \pi_1^M > \underline{\pi}_1 + \underline{\pi}_2$ by (3.2).
Otherwise acquisition is not efficient and hence $P_A = 0$ is chosen.

Q.E.D.

Lemma 3.5 shows that Proposition 3.3 is valid also with price competition. Asymmetric information reduces the parameter space for which acquisition is the optimal entry mode. The reason for this is the following. With private information for MNE greenfield investment is chosen, while acquisition is efficient with full information, if:
1. (3.1) is fulfilled and $q < \hat{q}$.
2. only (3.2) is fulfilled and $q < \tilde{q}$ and a spillover occurs.
On the other hand, if (3.2) is fulfilled and $q \geq \tilde{q}$ but there is no potential for a spillover, MNE chooses acquisition even though under full information greenfield investment would have taken place. However, overall this positive effect on the acquisition activity is more than offset by the two negative effects.

If MNE has private information about potential technology spillovers Lemma 3.2 still applies. Moreover, Proposition 3.7 remains also unchanged. In contrast to quantity competition condition (3.1) is more restrictive than (3.2). As a consequence, there cannot exist parameter constellations where under private information for MNE acquisition takes place even though with full information MNE would have chosen greenfield investment. However, there are cases where MNE makes no acquisition offer even though this would have been efficient under full information, i.e. in separating equilibrium *2*. Thus, private information for MNE reduces the parameter space for which acquisition is the optimal mode of entry. Figure 3.2 gives a graphical illustration of conditions (3.1) - (3.4) under price competition:

<u>Relative relation between conditions (3.1) - (3.4):</u>

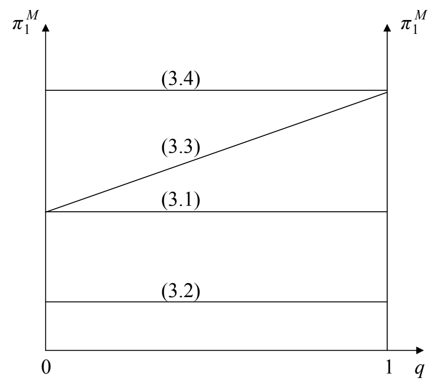

Figure 3.2: Relation of conditions (3.1) - (3.4) under price competition with horizontally differentiated products.

Chapter 4

Technology Transfer and Spillovers in International Joint Ventures

4.1 Introduction

There are two important decisions concerning foreign direct investment by a multinational enterprise. First, the mode of foreign entry has to be determined. The MNE can choose between the acquisition of an existing company or setting up a new venture via greenfield investment. Both entry modes have different consequences for the local market structure and therefore competition in the market. Second, the level of control over the local engagement has to be determined. The MNE can either choose a wholly owned subsidiary or a partially owned, as in joint ventures. When a multinational enterprise possesses a superior technology or a specific knowledge, why should ownership be shared with a foreign partner? What are the determining factors concerning this decision?

The ownership structure is particularly important when the multinational's competitive advantage stems from intangible assets or technological leadership. Sharing of ownership gives rise to the possibility of technology spillovers. This might be due to the fact that it is difficult to write a contract exactly specifying all aspects of the joint venture and the rights to use the intangible assets or technology. The problem of spillovers should be reduced when the MNE owns a substantial part of the foreign firm.[1] Thus, the two levels of ownership, wholly owned versus partially owned, should have different implications for the transfer and diffusion of technology. In order to minimize the potential loss through a spillover a MNE would prefer full ownership of its local subsidiary. But there also exist good reasons why the MNE would voluntarily agree to share ownership. Maybe otherwise the full return of the intangible assets or of the superior technology cannot be achieved because the MNE lacks local experience. Moreover, direct investments are subject to sovereign risks. This issue is particularly important in countries in transition. A government can, for example, choose to indirectly expropriate the assets of a direct investment through excessive taxation. By sharing ownership the MNE might be able to reduce the problem of lack of local experience or the sovereign risk problem.

There exists a large and growing literature on the transfer of knowledge and technology between countries and its impact on the productivity of domestic firms.[2] Two channels for the transfer of know-how can be distinguished: International trade and FDI. International trade can be a source of spillovers through demonstration effects when domestic firms learn the innovative content of imported goods. Coe and Helpman [1995], Coe, Helpman and Hoffmaister [1997], and Lichtenberg and van Pottelsberghe de la Potterie [1998] examine the influence of foreign trade partners' R&D on domestic total factor productivity. The empirical results confirm that foreign R&D influences domestic productivity and that the more open countries are to international trade the more they benefit.[3] FDI as a channel of technol-

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[1] This argument is in line with the property rights approach put forward in the seminal papers by Grossman and Hart [1986] and Hart and Moore [1990]. Ownership entitles the owner with all residual rights of control over all aspects of the asset.

[2] See Saggi [2002] or Blomström and Kokko [1998] for recent surveys on international technology transfer and spillovers.

[3] Keller [1998] doubts the importance of international trade patterns and shows that

ogy transfer has been examined in Kokko [1994], Borensztein, De Gregorio and Lee [1998], Aitken and Harrison [1999] and Xu [2000].[4] The empirical results of theses studies are substantially different.[5] Kokko, Borensztein et al. and Xu show that positive spillovers are more likely if the technology gap between foreign and domestic firms is not too large and if there exists a minimum threshold of human capital.[6] Aitken and Harrison find negative spillovers from foreign investment on domestically owned plants and state that the gains from FDI appear to be entirely captured by joint ventures.[7]

There also exists some work on the interaction of spillovers and the ownership structure in joint ventures. Blomström and Sjöholm [1999] analyze the effects of shared ownership on technology transfer and spillovers. They argue that, as generally believed, local participation with multinationals reveals their proprietary knowledge and in that way facilitates spillovers. This in turn might provide less incentive for the multinational to transfer technology and management skills. Their empirical results show that domestic establishments benefit from spillovers in terms of productivity levels, but the degree of foreign ownership does not affect the extent of it. In contrast, Dimelis and Louri [2002] find evidence that the degree of foreign ownership matters, and productivity spillovers are found to be stronger when foreign firms are in minority positions.[8] Nakamura and Xie [1998] consider a sit-

randomly created trade patterns also give rise to positive international R&D spillovers, which are often larger and explain more of the variation in productivity across countries. Keller [2002] finds that benefits from foreign spillovers decline with geographical distance.

[4]The earliest statistical studies of FDI and intra-industry spillovers are Caves [1974] and Globerman [1979].

[5]Görg and Strobl [2001] review the literature on multinational companies and productivity spillovers. They argue that the empirical methods used and whether cross-section or panel analysis is employed may have an effect on the empirical results.

[6]While a certain technology gap obviously is necessary for spillovers to occur, this finding seems to limit the assumption (e.g. in Findlay [1978] or Wang and Blomström [1992]) that spillovers grow with the size of the technology gap.

[7]Other studies which found evidence for negative spillovers include Haddad and Harrison [1993] or Djankov and Hoekman [2000].

[8]Explanations for the contrasting results of these studies could be the different devel-

uation with bilateral spillovers. They argue that full ownership and joint ventures should differ with respect to the diffusion of technology. The ownership share should reflect the relative importance of the intangible assets which the partners bring into the joint venture. Their empirical results confirm that imports from the foreign mother and the share of exports from total revenue have a significant positive effect, while R&D expenditures of the local partner have a significant negative effect on MNE's share.

The other strand of literature that is related to our approach concerns the effects of sovereign risks on foreign direct investment.[9] Eaton and Gersovitz [1983] discuss a reputation model of FDI with many potential investors. If the host country taxes excessively, potential future investors are deterred and the host country loses access to foreign capital. In a companion paper, Eaton and Gersovitz [1984] show that the threat of nationalization may induce the foreign investor to choose an inefficient technology which makes nationalization less attractive to the host country.[10]

Schnitzer [2002] analyzes the choice between FDI and a combination of debt finance and a licensing agreement in the presence of sovereign risk. One result of this static model is that the sovereign risk problem can be alleviated if the host country and the foreign investor form a joint venture.[11] In particular, it is shown that there are circumstances where a joint venture can be efficiency improving and where the MNE voluntarily agrees to it. This is caused by the fact that by sharing ownership the host country is given an incentive to reduce taxation.[12]

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opment levels of the economies examined and differing econometric methodologies used.

[9] Not relevant for our discussion is the problem of sovereign debt. See Eaton [1993] and Eaton and Fernandez [1995] for recent surveys.

[10] Similar issues have been addressed in the literature on incomplete contracts. The classical notion of the hold-up problem goes back to Williamson [1985].

[11] Schnitzer [1999] shows in a dynamic model of FDI how cooperation may be sustained. In particular, it is shown that sovereign risk may induce over- as well as underinvestment. Moreover, the frequently observed phenomenon of tax holidays is discussed.

[12] Konrad and Lommerud [2001] show that asymmetric information between the MNE and the host country as regards intra-firm trade between the MNE and its foreign affiliate

We ask in particular: How does a potential spillover affect the incentive for a MNE to transfer technology and the policy incentives of the host country? Moreover, we examine how the incentives of both parties can be controlled through the ownership structure in an international joint venture. A spillover directly reduces the profit of the multinational and benefits a domestic (state-owned) firm. We make a distinction between the potential for a spillover and the effective spillover. The potential for a spillover determines the potential benefit to a domestic firm and is taken as exogenously given. The effective spillover contains the benefit that actually occurs and this is endogenously determined. The extent of the effective spillover depends on the technology transfer and on the ownership structure. We argue that the better the transfered technology and the larger the domestic ownership share, the larger will be the effective spillover. With respect to the host country policy we analyze two different scenarios: In scenario 1, the host country chooses the total amount of taxes to be paid and has thus the option to expropriate the entire return stream of the project. In scenario 2, the host country does not impose a tax but has the option to invest in local infrastructure. The difference between the two scenarios is that the tax can only be raised if the project was successful, while the investment in infrastructure is undertaken independently of the project's success. Thus, the investment cannot be interpreted as just a negative tax, i.e. a subsidy. This implies a substantial difference in the strategic choice of the two policies and their impact on technology transfer. In particular, taxation may serve as a perfect substitute for a spillover, while an infrastructure investment in general cannot perfectly compensate for a spillover.

The results of our model show for both scenarios that a potential spillover need not in general have a negative effect on the incentive to transfer technology. In particular, in contrast to generally believed arguments, we can show that there are situations where a spillover has a positive effect on the

is another possibility to alleviate the hold-up problem in FDI. By selling shares of the affiliate to locals the host government is given a further incentive to reduce taxation.

transfer of technology, on both parties' payoffs, and on the efficiency of the project. The extent of the effective spillover increases with the domestic firm's ownership share in the joint venture, while the risk of creeping expropriation decreases or the incentive to invest in local infrastructure increases. These effects indicate that an extreme form of ownership (wholly owned or no equity but licensing) should not always be optimal for the MNE since one of the effects might destroy the incentive to transfer technology. Our results confirm for both scenarios that there are circumstances where a joint venture is mutually beneficial. Moreover, we ask whether or not it should always be in the interest of the host country to form a joint venture. This question is of particular interest to countries in Central and Eastern Europe and other transition countries, where sharing of ownership is often required by host country governments. However, we show that there exist cases where it is in the interest of the host country to restrict the ownership share of the domestic firm or even <u>not</u> to share ownership at all.

The rest of this chapter is organized as follows. The next section sets up the model. Section 4.3 analyzes the effect of spillovers on technology transfer and the incentives for excessive taxation. In section 4.4, we derive the results for spillovers and investment by the host country. Section 4.5 discusses empirical implications of the model, while the final section concludes.

4.2 The Model

When a multinational enterprise engages in foreign direct investment it is often observed that this is done by forming a joint venture with a local firm. In countries in Central and Eastern Europe the joint venture partner often is a state-owned firm. Sometimes the multinational is forced to give away some share of the project without any compensation which is nothing but some special form of expropriation.

Consider the following relationship between a multinational enterprise (MNE) and a state-owned company in a host country (HC). The MNE seeks to exploit an investment opportunity in HC. This investment cannot be carried out by the domestic firm, because HC does not have enough funds available to finance the investment project and cannot obtain a credit on the international capital market. The investment project requires an initial outlay I. Without loss of generality we assume the riskless world interest rate to be zero. If the project is not carried out, both parties get their outside utilities, which are normalized to zero.[13]

MNE and HC can engage in a joint venture where HC receives some share $1 - \alpha$ of the project's net profits. MNE gets the remainder of profits and possesses the control rights of the project. In a first step we assume α to be exogenously given in period $t = 1$. Considering the role of the host country in $t = 2$ we analyze two different scenarios: In scenario 1, the host country has the option to expropriate the entire return stream through taxation. HC chooses the total amount of taxes, T, to be paid. In scenario 2, we assume that the host country does not impose a tax but has the option to undertake an investment, M, on its own in order for the project to be valuable. HC chooses the amount of M, which directly benefits the project. M may be interpreted as an investment in local infrastructure and has to be spent independently of the project's success. The difference between the two scenarios is that the tax T can only be raised if the project has been successful, while the investment M will be spent independently of the project's success. Thus, M cannot be interpreted as just a negative tax, i.e. a subsidy. In $t = 3$ MNE has to engage in additional actions, q, which affect the profitability of the project. For example, MNE may decide on the level of investment in training local workers and managers, in marketing the produced goods, transferring or upgrading technology. In $t = 4$ profits are realized. The time structure is summarized in Figure 4.1.

The project's return is stochastic and may be either R or 0. The probability of success is affected by MNE's decision to transfer technology in $t = 3$.

[13] In principle, there are two possibilities to finance and run the project: *debt finance* and *foreign direct investment*. Since we are interested in determining factors of ownership structure in international joint ventures we will consider the case of FDI. See Schnitzer [2002] for an analysis of the choice between FDI and debt finance.

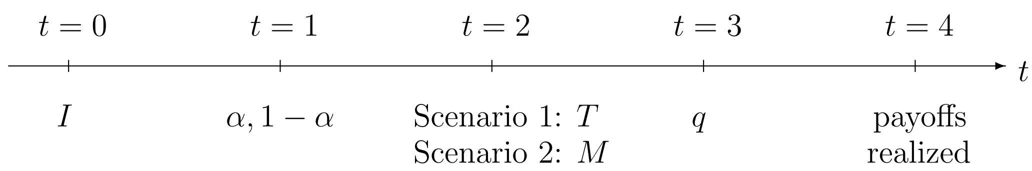

Figure 4.1: Sequence of events.

Without loss of generality we assume that MNE chooses the probability of success, $q \in (0,1)$, directly at cost $K(q)$. $K(q)$ is an increasing, strictly convex function with $K'(0) = 0$ and $\lim_{q \to 1} K(q) = \infty$. The last assumption implies that for q sufficiently close to 1, $K'''(q) > 0$. To guarantee uniqueness of the solutions for the following maximization problems, we assume $K'''(q) > 0$ for all $q \in (0,1)$. We assume that HC does not only share the revenues but also the costs from the subsequent investment into technology transfer. Therefore, it is assumed that a substantial part of these costs will be in local currency and thus HC can share these costs even without access to international capital markets or hard currency.

In scenario 2, where HC chooses an investment, M, the cost of investment, $C(M)$, is borne by HC alone. $C(M)$ is an increasing, strictly convex function with $C'(0) = 0$. We assume that HC is able to finance this infrastructure investment in local currency.

If the project is carried out in form of a joint venture there is potential for a spillover S from MNE to HC, where S is exogenously given. The spillover directly reduces the profit of MNE and benefits HC. We assume that the size of the effective spillover depends on two things: First, it depends on the decision to transfer technology and therefore on the probability of success q. Second, the ownership share $1 - \alpha$ of HC matters. The first assumption emphasizes that the better the transfered technology the larger is the potential gain from a spillover to HC. The second assumption reflects the fact that the size of the effective spillover depends on the ability to get access to the MNE's technology. The possibility to get a closer look at the special features of the technology and know-how certainly depends on the participation of HC. Thus, the effective spillover is equal to $q(1-\alpha)S$. The spillover can be efficient in the sense that the direct reduction of the multinational's payoff is smaller than the benefit for the domestic firm and vice versa for an inefficient spillover. In order to be able to vary the efficiency of the spillover we introduce an efficiency parameter $\beta > 0$. For $\beta = 1$ the effective spillover is symmetric, i.e. the loss for MNE equals the benefit to HC. If $\beta < 1$ the effective spillover is efficient and vice versa for $\beta > 1$.

We can now define the payoffs for both parties in the two scenarios. In scenario 1, where HC chooses the total amount of taxes, T, to be paid, the parties' payoffs are

$$U^T_{MNE} = q\alpha[R - T] - q(1-\alpha)\beta S - \alpha K(q) - I, \tag{4.1}$$

and

$$U^T_{HC} = q\Big[(1-\alpha)[R - T + S] + T\Big] - (1-\alpha)K(q). \tag{4.2}$$

In scenario 2, where HC chooses investment in infrastructure M, payoffs are

$$U^M_{MNE} = q\alpha[R + M] - q(1-\alpha)\beta S - \alpha K(q) - I, \tag{4.3}$$

and

$$U^M_{HC} = q(1-\alpha)[R + M + S] - C(M) - (1-\alpha)K(q). \tag{4.4}$$

4.3 Spillovers and Taxation by the Host Country

Consider MNE's decision on how much to invest into transferring technology in the second stage of the project. MNE maximizes (4.1). Given the assumptions on $K(q)$ the optimal level of investment q is uniquely characterized by the following first order condition:

$$K'(q^T) = R - T - \frac{1-\alpha}{\alpha}\beta S. \tag{4.5}$$

Note that $q^T(T,\alpha)$ is a strictly decreasing function of T for all $T \in (0, R - \frac{1-\alpha}{\alpha}\beta S)$. Note further, that it depends directly on α, MNE's share of profits, because of the existence of a spillover.

When HC decides on the level of taxes to be imposed on the project it takes into account the effect of T on $q^T(T,\alpha)$ and thus on his own share of profits. HC maximizes (4.2). In the Appendix we prove that HC's maximization problem has a unique interior solution $T^T(\alpha) \in (-(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S, R - \frac{1-\alpha}{\alpha}\beta S)$.[14] Hence, the optimal amount of taxes $T^T(\alpha)$ satisfies the following first order condition:

$$\frac{dq^T(T)}{dT}\left[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T^T\right]+\alpha q^T(T)=0. \qquad (4.6)$$

Note that even if $\alpha = 1$, HC will choose $T^T(1) < R$ such that MNE is induced to choose a positive q. Moreover, it could be optimal for HC to choose a negative tax, i.e. a subsidy. The reason for this is that in some circumstances only by subsidization MNE can be induced to choose a positive q. In these situations the profit share and the effective spillover outweigh the cost of the subsidy for HC.

How are the incentives to transfer technology and to raise taxes affected by the potential spillover S? Intuitively, it could be argued that since a spillover directly reduces MNE's payoff its incentive to invest should decrease. At the same time a spillover should provide an incentive for HC to reduce taxation. However, the parties' decisions are interdependent. Hence, a change in S has a direct effect on $T^T(\alpha)$ and $q^T(T,\alpha)$ and an indirect effect through the change in the respective other variable.

We can show that the direct effects of an increase in S on both decisions are negative as expected. And moreover, the overall effect on $T^T(\alpha)$ is always negative. Thus, the indirect effect on the investment $q^T(T,\alpha)$ through the change in $T^T(\alpha)$ is positive. Whether or not this indirect effect dominates the direct effect of a spillover on $q^T(T,\alpha)$ is a priori not clear. We show that the effects of an increase in the potential spillover on the incentive to transfer technology and on both parties' payoffs depend on the efficiency of the spillover. In particular, in case of an efficient spillover MNE is induced to increase its technology transfer which results in a positive effect on the

[14] See Lemma 4.1 in the Appendix.

parties' payoffs. The effects of an increase in the potential spillover on the optimal tax rate, on the optimal investment, on both parties' payoffs, and on total surplus are summarized in the following result:

Proposition 4.1 *Increasing S has the following effects on the optimal tax rate $T^T(\alpha)$, on the optimal investment in technology transfer $q^T(T,\alpha)$, on both parties' payoffs, and on the efficiency of the project:*

(i) $\beta = 1$: $\frac{dT^T}{dS} < 0$, $\frac{dq^T}{dS} = 0$, $\frac{dU^T_{MNE}}{dS} = 0$, $\frac{dU^T_{HC}}{dS} = 0$, $\frac{d(U^T_{MNE}+U^T_{HC})}{dS} = 0$.

(ii) $\beta < 1$: $\frac{dT^T}{dS} < 0$, $\frac{dq^T}{dS} > 0$, $\frac{dU^T_{MNE}}{dS} > 0$, $\frac{dU^T_{HC}}{dS} > 0$, $\frac{d(U^T_{MNE}+U^T_{HC})}{dS} > 0$.

(iii) $\beta > 1$: $\frac{dT^T}{dS} < 0$, $\frac{dq^T}{dS} < 0$, $\frac{dU^T_{MNE}}{dS} < 0$, $\frac{dU^T_{HC}}{dS} < 0$, $\frac{d(U^T_{MNE}+U^T_{HC})}{dS} < 0$.

Proof: See Appendix.

As a special case emerges the situation of a symmetric spillover, $\beta = 1$. In this case the optimal tax rate is exactly adjusted for the spillover such that the optimal investment remains unchanged compared to the case without a spillover, i.e. $q^T(T,\alpha) = q^*(T)$. To be more precise, the taxation will be lowered such that in the aggregate the sum of tax rate and spillover is equal to the taxation when there is no spillover, i.e. $T^T(\alpha) = T^*(\alpha) - \frac{1-\alpha}{\alpha}S$.[15] Hence, for $\beta = 1$ taxation and spillover are perfect substitutes from HC's point of view.

If the spillover is not symmetric, $\beta \neq 1$, it is not a perfect substitute for taxation. Therefore, it has an effect on all variables, on the payoffs of both parties and on efficiency. The indirect effect of an efficient spillover dominates the direct effect on $q^T(\alpha)$ and vice versa for an inefficient spillover. Therefore, the investment $q^T(\alpha)$ increases (decreases) if the spillover is efficient (inefficient). Intuitively we can argue that an efficient spillover, $\beta < 1$, does not harm MNE too much but it fully benefits HC. The opposite is true for an inefficient spillover. As a result of these effects the parties' payoffs and the efficiency of the project also depend on the magnitude of the spillover for $\beta \neq 1$. To be more precise, both parties' payoffs, and therefore the efficiency

[15] $T^*(\alpha)$ and $q^*(T)$ characterize the optimal choices for $S = 0$.

of the project, increase (decrease) in S for $\beta < 1$ ($\beta > 1$). We can summarize that in contrast to widespread opinions a potential spillover need not in general reduce the incentive to transfer technology or the efficiency of a joint venture.

How are the incentives of both parties affected by a change in the ownership structure? Intuitively, it could be expected that decreasing the multinational's ownership share α reduces the incentive to transfer technology. On the other hand, the incentive for HC to choose an excessive taxation is also reduced. Both effects should be more pronounced in the presence of a potential spillover. Which of these effects dominates is a priori not clear. Obviously, since the parties' incentives are affected by a potential spillover the effects of a change in the ownership division should also depend on the spillover. The following proposition summarizes the effects of a decrease in the multinational's share α on optimal taxation, on both parties' payoffs and on the efficiency of the project:

Proposition 4.2 *Suppose $S > 0$. A decrease of MNE's share, α, of net profits reduces the optimal tax rate $T^T(\alpha)$. The effect on MNE's payoff is ambiguous. For large values of α, there exist cases where MNE benefits from giving up some share of the project to HC. The effects on HC's payoff and on the efficiency of the project depend on the efficiency of the spillover:*

(i) $\beta = 1$: HC's payoff and the efficiency of the project are strictly increasing as α decreases. The effects are exactly the same as for $S = 0$.

(ii) $\beta < 1$: HC's payoff and the efficiency of the project are strictly increasing as α decreases.

(iii) $\beta > 1$: There exist cases where HC's payoff and the efficiency of the project increase as α increases. Moreover, there exist cases where HC's payoff and the efficiency of the project are maximized if ownership of the project is not *shared.*

Proof: See Appendix.

$T^T(\alpha)$ is strictly decreasing as α decreases. Intuitively, the lower α is, the higher is the share of profits which goes directly to HC. In order to increase the expected profits of the joint venture HC will restrict the imposed tax.

Proposition 4.2 shows that there are circumstances where a joint venture agreement is mutually beneficial even in the presence of a spillover. For large values of α MNE can sometimes benefit from giving away some share of the profit to HC without being directly compensated for it. By sharing ownership HC is induced to impose lower taxes thereby increasing overall efficiency and MNE's payoff. A joint venture may hence be used to mitigate the problem of creeping expropriation. This result can be obtained independently of the efficiency of a spillover even though it could be argued that an inefficient spillover should reduce the incentive for MNE to share ownership.

We have already shown that a symmetric spillover only has an effect on the optimal tax rate $T^T(\alpha)$. Consequently, it is very intuitive that compared to a situation without spillovers the effects of a change in α differ only with respect to the effect on $T^T(\alpha)$. Because of the spillover a decrease in α reduces the optimal tax rate more than it would without a spillover. The other effects remain unchanged in their magnitude: A decrease in α increases the efficiency of the project and has a strictly positive effect on HC's payoff.

An efficient spillover extends the scope for voluntary joint venture agreements. The reason for this is that the spillover benefits HC more than it reduces MNE's profit. In this case MNE is given a stronger incentive to share ownership since thereby taxation is reduced more, while the loss due to the spillover is comparably small. HC has always an incentive to share ownership and therefore to enjoy a share of the project's net profits and to get access to the effective spillover.

Surprisingly, however, we find that for $\beta > 1$, there are cases where HC benefits and the efficiency of the project increases if α increases. Moreover, it is sometimes not in the interest of HC nor efficient at all to share ownership. What is the reason for this result? Increasing α reduces HC's share of the net profit and induces HC to increase total taxation. Increasing taxation has an indirect negative effect on the technology transfer by MNE and therefore on the probability of a successful project. On the other hand, increasing α has a positive direct effect on investment q since the loss due to the spillover for MNE is reduced. For sufficiently large values of β the latter effect may become very large and outweigh the effect on the profit share. This result gives a rationale why full ownership of the project by MNE can sometimes be in the interest of HC even though only shared ownership gives rise to a spillover. The finding is particularly interesting for countries in transition or Eastern European countries where sometimes multinationals are restricted to shared ownership arrangements. As we show, the negative effects associated with shared ownership, i.e. the reduced incentive for MNE to further invest, can become very strong. And thus, it can be optimal for HC to restrict its own share of the project or even not to share ownership at all, but rather to enjoy a large expected tax revenue.

4.4 Spillovers and Investment by the Host Country

Now we ask how both parties' incentives are affected by a potential spillover if HC does not impose a tax on the project but instead has the option to undertake some investment, M, in order to increase the return of the project. Again, we first consider MNE's decision on how much to invest in the second stage of the project. MNE maximizes (4.3). The optimal level of investment q is characterized by the following first order condition:

$$K'(q^M) = R + M - \frac{1-\alpha}{\alpha}\beta S. \tag{4.7}$$

Note that $q^M(M, \alpha)$ is a strictly increasing function of M for all $M > 0$. Note further, that it depends directly on α because of the existence of a spillover.

When HC decides on the level of investment, M, it takes into account the effect on $q^M(M, \alpha)$ and thus on its own share of profits. HC maximizes (4.4). In the Appendix we prove under which conditions HC's payoff is maximized at $M^M(\alpha) \in (\underline{M}, \infty)$, where $\underline{M} = \max\{0, \frac{1-\alpha}{\alpha}\beta S - R\}$.[16] Hence, the optimal investment $M^M(\alpha)$ satisfies the following first order condition:

$$\frac{dq^M(M)}{dM}\left[(1-\alpha)\frac{\beta - \alpha\beta + \alpha}{\alpha}S\right] + q^M(M)(1-\alpha) - C'(M) = 0. \qquad (4.8)$$

Note that, if $\alpha = 1$, HC will choose $M^M(1) = 0$. Thus, the host country has an incentive to invest in local infrastructure only if ownership of the project is shared.

How are the incentives to transfer technology and to invest in local infrastructure affected by the potential spillover S? Intuitively, it could be argued that a potential spillover reduces the incentive to transfer technology because it directly reduces MNE's payoff. On the other hand, HC is given a stronger incentive to invest in local infrastructure. Since the parties' decisions are interdependent a change in S has a direct effect on $M^M(\alpha)$ and $q^M(M, \alpha)$ and an indirect effect through the change in the other variable. As expected, the potential spillover S has a direct negative effect on the technology transfer $q^M(M, \alpha)$ and a direct positive effect on the investment $M^M(\alpha)$. The overall effect on the investment of HC is positive. Thus, the indirect effect on $q^M(M, \alpha)$ is positive and may therefore compensate for the direct negative effect of S. Which of the effects on the optimal transfer of technology dominates is a priori not clear. The effects of an increase in the potential spillover on both parties' profits and on the efficiency of the project are also ambiguous as the following proposition states:

Proposition 4.3 *Increasing S strictly increases the optimal investment $M^M(\alpha)$. The effects on the optimal investment in technology transfer $q^M(M, \alpha)$, on both parties' payoffs and on the efficiency of the project are ambiguous:*

$$\frac{dM^M}{dS} > 0, \frac{dq^M}{dS} \gtreqless 0, \frac{dU^M_{MNE}}{dS} \gtreqless 0, \frac{dU^M_{HC}}{dS} \gtreqless 0, \frac{d(U^M_{MNE} + U^M_{HC})}{dS} \gtreqless 0.$$

Proof: See Appendix.

[16] See Lemma 4.2 in the Appendix.

In general, a spillover has, independently of its efficiency β, an effect on all variables and therefore on both parties' payoffs and on the efficiency of the project. Again, as in scenario 1 with taxation by HC, the presence of a potential spillover need not in general reduce the incentive to transfer technology.

Contrary to the result in the first scenario, a spillover can affect both parties' payoffs and efficiency even if it is symmetric, $\beta = 1$. The reason for this result is that $M^M(\alpha)$ reacts differently than $T^M(\alpha)$ in case of a symmetric spillover. The investment does not in general perfectly compensate for the spillover and adjust the choice of $q^M(M, \alpha)$. This is caused by the fact that HC has to bear the investment cost $C(M)$ alone and independently of the project's success or failure, while the benefit of this investment can only be enjoyed in case of success.

More surprisingly, however, a spillover can have a negative effect on both parties' payoffs and on the efficiency of the project if the spillover is efficient, $\beta < 1$, or a positive effect if it is inefficient, $\beta > 1$. This is also in contrast to the results in scenario 1, where an efficient spillover always has a positive effect on payoffs and vice versa for an inefficient spillover. In scenario 2, whether the spillover has a positive or negative effect depends on its impact on the incentive to invest for HC. Whenever a potential spillover leads to a strong incentive to invest in infrastructure the multinational is given a stronger investment incentive as well. This results in a positive effect on payoffs. Obviously, the host country's incentive to invest depends on the nature of the investment costs for local infrastructure. We can conclude that the cheaper the cost to invest in local infrastructure, or the more efficient the spillover, the more likely a potential spillover has a positive impact on both parties' payoffs.

How are the incentives of both parties affected by a change in the ownership structure? Intuitively, it could be expected that decreasing the multinational's ownership share α reduces its incentive to transfer technology. On the other hand, the incentive for HC to invest in local infrastructure should increase, which in turn has a positive effect on the incentive for MNE.

Whether or not one of the effects dominates is ambiguous. Since the parties' incentives are affected by a potential spillover the effects of a change in the ownership structure should also depend on the spillover. The following proposition summarizes the effects of a decrease in the multinational's share α on both parties' payoffs and on the efficiency of the project with or without the existence of a potential spillover:

Proposition 4.4 *A decrease of MNE's share, α, of net profits increases the optimal investment $M^M(\alpha)$. The effect on MNE's payoff is ambiguous. For large values of α, there exist cases where MNE benefits from giving up some share of the project to HC. The effects on HC's payoff and on the efficiency of the project depend on the existence of a spillover:*

(i) $S = 0$*: HC's payoff and the efficiency of the project increase as α decreases.*

(ii) $S > 0$*: There exist cases where HC's payoff and the efficiency of the project increase as α increases.*

Proof: See Appendix.

$M^M(\alpha)$ is strictly increasing as α decreases. Intuitively, the lower α the higher the share of profits which goes directly to HC and also the higher the share of the return on the investment $M^M(\alpha)$. In order to increase the expected profits of the joint venture HC will extend its investment.

Proposition 4.4 shows that in the absence of a potential spillover, $S = 0$, a joint venture can be efficiency improving and beneficial for the multinational enterprise. Thus, also in this scenario with an investment by HC instead of taxation there are circumstances where MNE voluntarily gives away a share of the project without direct monetary compensation.[17] HC has always an incentive to share ownership since it only then enjoys a share of the

[17]Asiedu and Esfahani [2001] find evidence that any host country characteristic that increases productivity of local assets in the project tends to lower the foreign equity share. This might be in the interest of the foreign investor because it provides an incentive for the host country to improve its infrastructure and thereby enhance productivity.

project's return and is given an incentive to invest in local infrastructure. Consequently, the overall efficiency also increases with a decreasing ownership share of MNE.

For $S > 0$ there are again cases where a joint venture agreement is mutually beneficial and hence the multinational would voluntarily agree to it. HC has an incentive to share ownership and is thereby given the incentive to invest. Surprisingly, however, the results divert from those in scenario 1 in different aspects. We find that it is sometimes in the interest of HC and efficient to restrict its ownership share to a small fraction. And moreover, this result is independent of the efficiency of the spillover. In other words, even if the spillover is very efficient, $\beta < 1$, there are cases where HC is not interested in holding too large a share of the project. What is the reason for this counterintuitive result? Whether or not HC would like to hold a share of the project depends on the exact nature of the investment cost which HC has to bear independently of success or failure of the project. If investment in infrastructure is too expensive relative to the return on investment, HC has only little incentive to invest. This in turn results in only a small positive effect on the incentive to transfer technology by MNE. Moreover, there exist cases where for a given ownership division both parties have no incentive to invest. Therefore, in this scenario our theoretical analysis gives a rationale against a general restriction of ownership to a specified minimum share of the domestic partner. However, if HC's share of the project, $1-\alpha$, can be chosen sufficiently small, both parties have an incentive to invest and the efficiency of the project can be maximized. The reason for this is that the smaller HC's share $1 - \alpha$ is, the smaller is the spillover and hence the smaller is the investment M needed to compensate for the spillover. Thus, in principle, HC always has an interest to hold at least a small share of the project.

4.5 Empirical Implications

With respect to the influence of a potential spillover, the model produces results which can be straightforwardly interpreted as regards to their empirical implications. In scenario 1, we have shown theoretically that a potential spillover has a very clearcut and intuitive influence on the parties' strategic decisions. Regarding the influence of the host country's taxation policy on the incentive for MNE to transfer technology and the influence of a potential spillover on the taxation policy itself we can formulate the following hypotheses:

Hypothesis 4.1 *The larger the political risk of the host country, the smaller the incentive to transfer technology.*

Hypothesis 4.2 *The larger the potential for a spillover, the smaller the risk of excessive taxation.*

As the model's results show, the influence of the spillover on the investment incentive for MNE depends on the efficiency of the spillover:

Hypothesis 4.3 *The potential for a spillover should have (a) a positive effect on the incentive to transfer technology if the effective spillover is efficient or (b) a negative effect if the effective spillover is inefficient.*

In scenario 2 we have shown that the results for the impact on the incentive to invest are less straightforward. Regarding the influence of the investment in local infrastructure by the host country on the incentive to transfer technology and the effect of a potential spillover on the investment incentive we can state the following hypotheses:

Hypothesis 4.4 *The larger the investment in local infrastructure by the host country, the larger the incentive to transfer technology.*

Hypothesis 4.5 *The larger the potential for a spillover, the larger the incentive to invest in infrastructure.*

Concerning the influence of a potential spillover we cannot formulate an unambiguous hypothesis but rather emphasize a tendency with respect to the efficiency of the effective spillover.

Hypothesis 4.6 *The potential for a spillover should tend to have (a) a positive effect on the incentive to transfer technology if the effective spillover is efficient or (b) a negative effect if the effective spillover is inefficient.*

4.6 Discussion and Conclusions

As previous studies have suggested and often argued, foreign direct investment is a source for the diffusion of knowledge and technology. It is well recognized that sharing ownership with a local partner can reveal a multinational's proprietary knowledge and in that way give rise to technology spillovers. The extent of such technology spillovers certainly depends on the nature of the transfered technology and on the ownership structure in the joint venture. We contribute to the literature by providing a simple model of an international joint venture between a multinational enterprise and a host country firm. In particular, we analyzed the effects of the potential for a spillover on the transfer of technology and on the host country's policy. Concerning the host country policy we considered two different scenarios: Taxation or investment in infrastructure.

In contrast to existing arguments we showed that the potential for a spillover does not necessarily have a negative effect on the incentive to transfer technology. There rather exist cases in both scenarios where a potential spillover has a positive effect on the transfer of technology and on the efficiency of the project. In the first scenario this depends crucially on the efficiency of the spillover. Surprisingly, however, we found that in the second scenario an efficient spillover can also have a negative effect on both parties' profits and vice versa for an inefficient spillover. However, besides these differing results we can still argue that a more efficient spillover generally has a positive effect on the incentive to transfer technology and thus on the efficiency of the project and the other way round for an inefficient spillover.

Moreover, we examined how the incentives of both parties can be controlled through the determination of the ownership structure in an international joint venture. We showed that there are circumstances where a joint venture is mutually beneficial and thus the MNE voluntarily agrees to it. Interestingly, however, we found that it can be efficient for the host country to restrict its ownership share in the joint venture. Furthermore, there are circumstances where it is not in the interest of the host country nor efficient at all to share ownership. Hence, even though a spillover occurs in our model only if the host country holds a share of the project, a joint venture is sometimes not the optimal arrangement for the host country. This result is particularly interesting to countries in Central and Eastern Europe and transition countries, where sharing of ownership is often required by host country governments. The reasoning for these requirements is that in this way the diffusion of knowledge is facilitated and economic growth is spurred. But we show that exactly the opposite can be true, namely that the negative effects on the incentive to transfer technology dominate or the cost of investment in infrastructure is too expensive relative to its return. In these cases the host country should actually prefer not to foster a joint venture.

The present analysis throws some light on the question of whether or not the extent of local participation with multinationals has an impact on the extent of spillovers. As our model suggests, the extent of the effective spillover depends not only on the ownership structure but also on the incentive to transfer technology and on the host country's policy. Theses factors, on the other hand, depend on country specific as well as industry specific determinants. Whether or not a larger ownership share of the host country firm in turn leads to stronger spillovers is a priori not clear and can differ across countries and industries. This observation may help to explain why the empirical evidence on this issue is mixed. While Blomström and Sjöholm [1999] found no effect, Dimelis and Louri [2002] found evidence that the degree of domestic ownership matters with respect to the magnitude of spillovers.

Possible extensions of the model could include more sophisticated specifications of the bargaining game or the examination of the influence of other market characteristics such as competition in the product market. It was not the aim of this model to determine the optimal ownership structure in an international joint venture. Despite these arguments we feel confident that our model helps to explain determining factors for the distribution of ownership in international joint ventures. A sounder theoretical approach to this issue and empirical tests of the proposed hypotheses are left for future research.

Appendix

Lemma 4.1 *For any $\alpha \in (0,1)$, HC's maximization problem has a unique interior solution* $T^T(\alpha) \in \left(-(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S, R-\frac{1-\alpha}{\alpha}\beta S\right)$.

<u>Proof:</u>

We first show that HC's profit function is strictly concave in T. By the implicit function theorem, $\frac{dq^T(T)}{dT} = -\frac{1}{K''(q^T)} < 0$. Differentiating U^T_{HC} with respect to T we get

$$\begin{aligned}
\frac{dU^T_{HC}}{dT} &= \frac{dq^T(T)}{dT}\left[(1-\alpha)[\underbrace{R-T-K'(q^T)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.5)}}+S]+T\right]+\alpha q^T(T) \\
&= -\frac{1}{K''(q^T)}\left[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T\right]+\alpha q^T(T).
\end{aligned}$$

$$\frac{d^2U^T_{HC}}{dT^2} = -\frac{1}{K''}\left[\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T]+1+\alpha\right] < 0.$$

Hence, the optimal $T^T(\alpha)$ must be unique. Furthermore, it is never optimal to choose $T \geq R-\frac{1-\alpha}{\alpha}\beta S$, because this would imply $q^T(T,\alpha)=0$ and $U^T_{HC} = 0$, while a strictly positive payoff can be obtained by choosing $T < R-\frac{1-\alpha}{\alpha}\beta S$. Finally, it cannot be optimal to choose $T = \underline{T} \equiv -(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S$. To see this note that at $T=\underline{T}$ we have $q^T(T,\alpha)>0$.Thus,

$$\frac{dU^T_{HC}}{dT}|_{T=\underline{T}} = \alpha q^T(T,\alpha) > 0.$$

Hence, if $\alpha > 0$, a strictly higher payoff can be obtained by choosing $T > \underline{T}$.

Q.E.D.

Proof of Proposition 4.1:

By the implicit function theorem we can show that

$$\frac{dq^T}{dS} = -\frac{1}{K''}\left[\frac{1-\alpha}{\alpha}\beta + \frac{dT^T}{dS}\right].$$

Using again the implicit function theorem and taking account of the direct effect of an increase in S on q, i.e. $-\frac{1}{K''}\frac{1-\alpha}{\alpha}\beta$, we find that

$$\begin{aligned}
\frac{dT^T}{dS} &= -\frac{\frac{K'''}{[K'']^2}\frac{dq^T}{dS}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + T^T] + \frac{dq^T}{dT}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha} + \alpha\frac{dq^T}{dS}}{\frac{K'''}{[K'']^2}\frac{dq^T}{dT}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + T^T] + \frac{dq^T}{dT} + \alpha\frac{dq^T}{dT}} \\
&= -\left(\frac{1-\alpha}{\alpha}\beta\right)\underbrace{\frac{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + T^T] + 1 + \frac{\alpha}{\beta}}{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + T^T] + 1 + \alpha}}_{=A>0} \\
&= -\left(\frac{1-\alpha}{\alpha}\beta\right)A < 0, \qquad \text{with } A \gtreqless 1 \text{ if } \beta \lesseqgtr 1.
\end{aligned}$$

Thus, it follows

$$\frac{dq^T}{dS} = \frac{1}{K''}\frac{1-\alpha}{\alpha}\beta[A-1].$$

Differentiating U^T_{MNE} and U^T_{HC} with respect to S and re-arranging we get:

$$\begin{aligned}
\frac{dU^T_{MNE}}{dS} &= -\,q^T\alpha\frac{dT^T}{dS} - q^T(1-\alpha)\beta \\
&\quad + \underbrace{\frac{dq^T}{dS}\alpha\underbrace{\left[R - T^T - K'(q)\right]}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.5)}} - \frac{dq^T}{dS}(1-\alpha)\beta S}_{=0} \\
&= q^T(1-\alpha)\beta[A-1].
\end{aligned}$$

$$\frac{dU^T_{HC}}{dS} = \frac{dq^T}{dS}\left[(1-\alpha)[\underbrace{R - T^T - K'(q)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.5)}} + S] + T^T\right] + q^T\left[(1-\alpha) + \alpha\frac{dT^T}{dS}\right]$$

$$= \frac{dq^T}{dS}\left[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + T^T\right] + q^T(1-\alpha)[1-\beta A].$$

Summarizing the effects:

(i) $\beta = 1 \Rightarrow A = 1 \Rightarrow \frac{dT^T}{dS} < 0, \frac{dq^T}{dS}, \frac{dU^T_{MNE}}{dS}, \frac{dU^T_{HC}}{dS} = 0, \Rightarrow \frac{d(U^T_{MNE}+U^T_{HC})}{dS} = 0$

(ii) $\beta < 1 \Rightarrow A > 1 \Rightarrow \frac{dT^T}{dS} < 0, \frac{dq^T}{dS}, \frac{dU^T_{MNE}}{dS}, \frac{dU^T_{HC}}{dS} > 0, \Rightarrow \frac{d(U^T_{MNE}+U^T_{HC})}{dS} > 0$

(iii) $\beta > 1 \Rightarrow A < 1 \Rightarrow \frac{dT^T}{dS} < 0, \frac{dq^T}{dS}, \frac{dU^T_{MNE}}{dS}, \frac{dU^T_{HC}}{dS} < 0, \Rightarrow \frac{d(U^T_{MNE}+U^T_{HC})}{dS} < 0$

For $\beta = 1$ we have $\frac{dq^T}{dS} = 0$. Thus, it follows from (4.5) that for $\beta = 1$ we must have $T^T(\alpha) = T^* - \frac{1-\alpha}{\alpha}S$, where T^* characterizes the optimal choice of T for $S = 0$.

Q.E.D.

Proof of Proposition 4.2:

By the implicit function theorem, it is straightforward to show that

$$\frac{dq^T}{d\alpha} = -\frac{1}{K''}\left[\frac{dT^T}{d\alpha} - \frac{1}{\alpha^2}\beta S\right].$$

Using again the implicit function theorem and taking account of the direct effect of an increase in α on $q^T(T,\alpha)$, i.e. $\frac{1}{K''}\frac{1}{\alpha^2}\beta S$, we can show that

$$\begin{aligned}\frac{dT^T}{d\alpha} &= \frac{1}{\alpha^2}\beta S \underbrace{\frac{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T^T]+1-\alpha^2+\frac{\alpha^2}{\beta}+\alpha}{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T^T]+1+\alpha}}_{=B>0} \\ &\quad + \underbrace{\frac{q^S(T)}{\frac{K'''}{[K'']^3}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T^T]+(1+\alpha)\frac{1}{K''}}}_{=D>0} \\ &= \frac{1}{\alpha^2}\beta SB + D > 0,\ \text{with} B \gtreqless 1 \text{ for } \beta \lesseqgtr 1.\end{aligned}$$

Differentiating U^T_{HC} with respect to α and re-arranging we get:

$$\begin{aligned}\frac{dU^T_{HC}}{d\alpha} &= \frac{dq^T}{d\alpha}\left[(1-\alpha)[\underbrace{R-T^T-K'(q^T)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.5)}}+S]+T^T\right]+\alpha q^T\frac{dT^T}{d\alpha} \\ &\quad + K(q^T) - q^T[R-T^T+S] \\ &= -\frac{1}{K''}\left[\frac{dT^T}{d\alpha}-\frac{1}{\alpha^2}\beta S\right]\left[\underbrace{(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+T^T}_{=K''\alpha q^T \text{ by (4.6)}}\right]+\alpha q^T\frac{dT^T}{d\alpha}\end{aligned}$$

$$
\begin{aligned}
&+ K(q^T) - q^T[R - T^T + S] \\
= \;& \underbrace{K(q^T) - q^T\left[R - T^T + S\right]}_{<0} + \underbrace{q^T \frac{1}{\alpha}\beta S}_{>0}.
\end{aligned}
\tag{4.9}
$$

A marginal increase of α reduces HC's share of total surplus, $q^T[R - T^T] - K(q^T)$, and reduces the received spillover, $q^T S$. On the other hand, a marginal increase of α induces HC to increase total taxation by $\frac{dT^T}{d\alpha}$ and it induces MNE to change investment by $\frac{dq^T}{d\alpha}$. Both effects sum up to $q^T \frac{1}{\alpha}\beta S$, which is basically the direct effect of an increase in α on the investment q^T. This effect may dominate and thus HC may prefer to increase α, if β is sufficiently large. Note that (4.9) can be positive only if $\beta > 1$. To see this, note further that MNE will choose $q^T > 0$ only if $U^T_{MNE} > 0$, i.e.

$$
q^T\alpha[R - T^T] - q^T(1-\alpha)\beta S - \alpha K(q^T) - I > 0.
$$

Condition (4.9) is positive if, after re-arranging, we have

$$
q^T\alpha\left[R - T^T\right] - q^T\beta S + \alpha q^T S - \alpha K(q^T) < 0.
$$

Both conditions can be fulfilled simultaneously only if $\beta > 1$.
Differentiating U^T_{MNE} with respect to α and re-arranging we get:

$$
\begin{aligned}
\frac{dU^T_{MNE}}{d\alpha} &= q^T[R - T^T + \beta S] - K(q^T) - q^T\alpha\frac{dT^T}{d\alpha} \\
&\quad \underbrace{+ \frac{dq^T}{d\alpha}\alpha \underbrace{\left[R - T^T - K'(q^T)\right]}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by } (4.5)} - \frac{dq^T}{d\alpha}(1-\alpha)\beta S}_{=0} \\
&= \underbrace{q^T[R - T^T + \beta S] - K(q^T)}_{>0} - \underbrace{\alpha q^T\frac{dT^T}{d\alpha}}_{>0}.
\end{aligned}
\tag{4.10}
$$

Thus, the impact of α on MNE's payoff may be ambiguous. A marginal increase of α increases MNE's share of the total net payoff, $q^T[R - T^T] - K(q^T)$, and reduces the loss due to the spillover, $q^T\beta S$. On the other hand, a marginal increase of α induces HC to increase total taxes by $\frac{dT^T}{d\alpha}$, of which MNE has to pay the share α in case of a successful project, which happens with probability q^T. If α is close enough to 0, the second effect vanishes and MNE always prefers to increase α. However, if α is sufficiently large, the second effect may dominate. The effect of a change of α on total surplus is given by

$$\begin{aligned} \frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha} &= q^T\frac{1}{\alpha}\beta S - q^T\alpha\frac{dT^T}{d\alpha} + q^T(\beta-1)S \\ &= \underbrace{q^T\frac{1}{\alpha}\beta S[1-B]}_{\gtreqless 0 \text{ for } \beta\gtreqless 1} - \underbrace{\alpha q^T D}_{>0} + \underbrace{q^T(\beta-1)S}_{\gtreqless 0 \text{ for } \beta\gtreqless 1}. \quad (4.11) \end{aligned}$$

By proof of Proposition 4.1 we know that for $\beta = 1$, $T^T(\alpha) = T^* - \frac{1-\alpha}{\alpha}S$ and thus $q^T(\alpha) = q^*(\alpha)$, where $q^*(\alpha)$ and $T^*(\alpha)$ characterize the optimal choices for $S = 0$. Hence, equations (4.9), (4.10), and (4.11), and therefore the effects of a decrease in α are the same for $\beta = 1$ and for $S = 0$.

Summarizing the effects:

(i) $\beta = 1 \Rightarrow \frac{dT^T}{d\alpha} > 0, \frac{dq^T}{d\alpha} < 0, \frac{dU^T_{MNE}}{d\alpha} \gtreqless 0, \frac{dU^T_{HC}}{d\alpha} < 0, \frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha} < 0.$

(ii) $\beta < 1 \Rightarrow \frac{dT^T}{d\alpha} > 0, \frac{dq^T}{d\alpha} < 0, \frac{dU^T_{MNE}}{d\alpha} \gtreqless 0, \frac{dU^T_{HC}}{d\alpha} < 0, \frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha} < 0.$

(iii) $\beta > 1 \Rightarrow \frac{dT^T}{d\alpha} > 0, \frac{dq^T}{d\alpha} \gtreqless 0, \frac{dU^T_{MNE}}{d\alpha} \gtreqless 0, \frac{dU^T_{HC}}{d\alpha} \gtreqless 0, \frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha} \gtreqless 0.$

We prove by example that there indeed exist cases with the properties described in the proposition. Consider the following cost function:

$$K(q) = \frac{1}{1-q} - q.$$

For $\alpha = 0.98$, $R = 40$, and $S = 3$ the following results are obtained for different values of β:

	$\frac{dU^T_{MNE}}{d\alpha}$	$\frac{dU^T_{HC}}{d\alpha}$	$\frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha}$	q^S	T^S	U^T_{MNE}	U^T_{HC}
$\beta = 0.3$	**-0.25**	-4.11	-4.36	0.65866	32.40	2.669	21.434
$\beta = 1$	**-0.07**	-2.72	-2.79	0.65855	32.36	2.665	21.406
$\beta = 1.2$	**-0.02**	-2.32	-2.34	0.65852	32.35	2.664	21.398
$\beta = 3$	0.43	**1.23**	**1.67**	0.65823	32.25	2.655	21.327

Thus, for large values of α, there exist cases where MNE's payoff increases as α decreases. This result can be obtained independently of the efficiency of a spillover β. For $\beta > 1$ there exist cases where HC's payoff and the efficiency of the project increase as α increases. This is the case for $\beta = 3$ in the example. However, for $\alpha = 1$ and $R = 40$ we get:

	$\frac{dU^T_{MNE}}{d\alpha}$	$\frac{dU^T_{HC}}{d\alpha}$	$\frac{d(U^T_{MNE}+U^T_{HC})}{d\alpha}$	q^S	T^S	U^T_{MNE}	U^T_{HC}
$\alpha = 1$	-	-	-	0.65838	32.51	24.921	21.352

Hence, in some cases HC benefits and the efficiency of the project is maximized if ownership is not shared.

Q.E.D.

Lemma 4.2 *For any $\alpha \in (0,1)$, HC's payoff is maximized at $M^M(\alpha)$, with*

(a) $M^M(\alpha) \in (0,\infty)$, if $R > \frac{1-\alpha}{\alpha}\beta S$ and $\frac{d^2U^M_{HC}}{dM^2}|_{M=M^M} < 0$, or

(b) $M^M(\alpha) \in (\frac{1-\alpha}{\alpha}\beta S - R, \infty)$, if $R \leq \frac{1-\alpha}{\alpha}\beta S$, $\frac{d^2U^M_{HC}}{dM^2}|_{M=M^M} < 0$, and $U^M_{HC}(M^M) > 0$, or

(c) $M^M = 0$, if $R \leq \frac{1-\alpha}{\alpha}\beta S$ otherwise.

Proof:

By the implicit function theorem, $\frac{dq^M(M)}{dM} = \frac{1}{K''(q^M)} > 0$. Differentiating U^M_{HC} with respect to M we get

$$\begin{aligned}\frac{dU^M_{HC}}{dM} &= \frac{dq^M}{dM}(1-\alpha)\left[\underbrace{R + M - K'(q^M)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.7)}} + S\right] + q^M(1-\alpha) - C'(M)\\ &= \frac{1}{K''(q^M)}(1-\alpha)\frac{\beta - \alpha\beta + \alpha}{\alpha}S + q^M(M)(1-\alpha) - C'(M).\end{aligned}$$

$$\frac{d^2U^M_{HC}}{dM^2} = -\frac{1}{K''}\left[\frac{K'''}{[K'']^2}(1-\alpha)\frac{\beta - \alpha\beta + \alpha}{\alpha}S - (1-\alpha)\right] - C''(M).$$

Hence, HC's payoff is maximized at $M^M(\alpha)$, if $\frac{d^2U^M_{HC}}{dM^2}|_{M=M^M} < 0$ and if moreover $U^M_{HC}(M^M) > 0$. Given the assumptions on $C(M)$ there must exist an upper bound for M^M.

If $\alpha < 1$ and $R > \frac{1-\alpha}{\alpha}\beta S$, it is never optimal to choose $M = 0$. To see this note that in this case $q^M > 0$ and thus

$$\left.\frac{dU_{HC}^M}{dM}\right|_{M=0} = \frac{1}{K''(q^M)}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + q^M(M)(1-\alpha) > 0.$$

Hence, if $\alpha \in (0,1)$, a strictly higher payoff can be obtained by choosing $M > 0$.

If $\alpha < 1$ and $R \leq \frac{1-\alpha}{\alpha}\beta S$, it follows from (4.7) that $q = 0$ for all $M \leq \frac{1-\alpha}{\alpha}\beta S - R$. Hence, HC chooses $M^M \in (\frac{1-\alpha}{\alpha}\beta S - R, \infty)$ if $U_{HC}^M(M^M) > 0$ and $M^M = 0$ otherwise.

Q.E.D.

Proof of Proposition 4.3:

By the implicit function theorem we can show that

$$\frac{dq^M}{dS} = -\frac{1}{K''}\left[\frac{1-\alpha}{\alpha}\beta - \frac{dM^M}{dS}\right].$$

Using again the implicit function theorem and taking account of the direct effect of an increase in S on $q^M(M,\alpha)$, i.e. $-\frac{1}{K''}\frac{1-\alpha}{\alpha}\beta S$, we find that

$$\begin{aligned}\frac{dM^M}{dS} &= -\frac{-\frac{K'''}{[K'']^2}\frac{dq^M}{dS}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + \frac{dq^M}{dM}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha} + \frac{dq^M}{dS}(1-\alpha)}{-\frac{K'''}{[K'']^2}\frac{dq^M}{dM}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + \frac{dq^M}{dM}(1-\alpha) - C''} \\ &= \frac{1-\alpha}{\alpha}\beta\underbrace{\frac{\frac{K'''}{[K'']^2}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S + \frac{\alpha}{\beta}}{\frac{K'''}{[K'']^2}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S - (1-\alpha) + K''C''}}_{=E>0} > 0.\end{aligned}$$

The last inequality follows from the fact that the denominator has to be positive by Lemma 4.2 if HC's payoff is maximized at $M^M(\alpha)$. And it follows

$$\frac{dq^M}{dS} = \frac{1}{K''}\frac{1-\alpha}{\alpha}\beta[E-1] \gtrless 0.$$

Differentiating U_{MNE}^M and U_{HC}^M with respect to S and re-arranging we get:

$$\begin{aligned}\frac{dU_{MNE}^M}{dS} &= \underbrace{\frac{dq^M}{dS}\alpha\underbrace{[R+M-K'(q^M)]}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.7)}} - \frac{dq^M}{dS}(1-\alpha)\beta S}_{=0} \\ &\quad + q^M\alpha\frac{dM^M}{dS} - q^M(1-\alpha)\beta \\ &= q^M(1-\alpha)\beta[E-1] \gtrless 0.\end{aligned}$$

$$\begin{aligned}
\frac{dU_{HC}^M}{dS} &= \frac{dq^M}{dS}(1-\alpha)\left[\underbrace{R+M-K'(q^M)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.7)}}+S\right]+q^M(1-\alpha)\frac{dM^M}{dS} \\
&\quad + q^M(1-\alpha)-C'(M)\frac{dM^M}{dS} \\
&= -\frac{1}{K''}\left[\frac{1-\alpha}{\alpha}\beta-\frac{dM^M}{dS}\right](1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S+q^M(1-\alpha)\frac{dM^M}{dS} \\
&\quad + q^M(1-\alpha)-C'(M)\frac{dM^M}{dS} \\
&= -\frac{1}{K''}\frac{(1-\alpha)^2}{\alpha}\left(\frac{\beta-\alpha\beta+\alpha}{\alpha}\right)\beta S+q^M(1-\alpha) \gtreqless 0.
\end{aligned}$$

The effect of a change in S on total surplus is given by

$$\begin{aligned}
\frac{d(U_{MNE}^M+U_{HC}^M)}{dS} &= q^M(1-\alpha)\beta[E-1]-\frac{1}{K''}\frac{(1-\alpha)^2}{\alpha}\frac{\beta-\alpha\beta+\alpha}{\alpha}\beta S \\
&\quad + q^M(1-\alpha) \gtreqless 0.
\end{aligned}$$

Q.E.D.

Proof of Proposition 4.4:

By the implicit function theorem we can show that

$$\frac{dq^M}{d\alpha}=\frac{1}{K''}\left[\frac{dM^M}{d\alpha}+\frac{1}{\alpha^2}\beta S\right].$$

Using again the implicit function theorem and taking account of the direct effect of an increase in α on $q^M(M,\alpha)$, i.e. $\frac{1}{K''}\frac{1}{\alpha^2}\beta S$, we can show that

$$\begin{aligned}
\frac{dM^M}{d\alpha} &= -\frac{1}{\alpha^2}\beta S\frac{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S]+\alpha-\alpha^2+\frac{\alpha^2}{\beta}}{\frac{K'''}{[K'']^2}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S]-(1-\alpha)+K''C''} \\
&\quad -\frac{q^M(M)}{\frac{K'''}{[K'']^3}[(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha}S]-(1-\alpha)\frac{1}{K''}+C''} \qquad < 0.
\end{aligned}$$

The last inequality follows from the fact that the denominator has to be positive by Lemma 4.2 if HC's payoff is maximized at $M^M(\alpha)$. Differentiating U_{HC}^M and U_{MNE}^M with respect to α and re-arranging we get:

$$\frac{dU_{HC}^M}{d\alpha} = \frac{dq^M}{d\alpha}(1-\alpha)\left[\underbrace{R+M-K'(q^M)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by (4.7)}}+S\right]+q^M(1-\alpha)\frac{dM^M}{d\alpha}$$

$$
\begin{aligned}
& - C'(M)\frac{dM^M}{d\alpha} + K(q^M) - q^M[R + M^M + S] \\
= & \frac{1}{K''}\left[\frac{dM^M}{d\alpha} + \frac{1}{\alpha^2}\beta S\right](1-\alpha)\frac{\beta - \alpha\beta + \alpha}{\alpha}S \\
& + \frac{dM^M}{d\alpha}\left[q^M(1-\alpha) - C'(M)\right] + K(q^M) - q^M[R + M^M + S] \\
= & \underbrace{K(q^M) - q^M[R + M^M + S]}_{<0} + \underbrace{\frac{1}{K''}(1-\alpha)\frac{\beta - \alpha\beta + \alpha}{\alpha^3}\beta S^2}_{>0} \qquad (4.12)
\end{aligned}
$$

Thus, the impact of α on HC's payoff is, independently of the efficiency of the spillover β, ambiguous. A marginal increase of α reduces HC's share of total surplus, $K(q^M) - q^M[R + M^M]$ and reduces the received spillover $q^M S$. On the other hand, a marginal increase of α induces HC to reduce its investment in infrastructure by $\frac{dM^M}{d\alpha}$ and it induces MNE to change investment by $\frac{dq^M}{d\alpha}$. Both effects sum up to the second expression in (4.12). This effect may dominate depending on the exact nature of investment costs.

$$
\begin{aligned}
\frac{dU^M_{MNE}}{d\alpha} = & \; q^M[R + M^M + \beta S] - K(q^M) + \alpha q^M\frac{dM^M}{d\alpha} \\
& \underbrace{+ \frac{dq^M}{d\alpha}\alpha[\underbrace{R + M - K'(q^M)}_{=\frac{1-\alpha}{\alpha}\beta S \text{ by } (4.7)}] - \frac{dq^M}{d\alpha}(1-\alpha)\beta S}_{=0} \\
= & \underbrace{q^M[R + M^M + \beta S] - K(q^M)}_{>0} + \underbrace{\alpha q^M\frac{dM^M}{d\alpha}}_{<0}.
\end{aligned}
$$

The impact of α on MNE's payoff may also be ambiguous. A marginal increase of α increases MNE's share of total net payoff, $q^M[R+M^M]-K(q^M)$ and reduces the loss due to the spillover by $q^M\beta S$. On the other hand, a marginal increase of α induces HC to reduce its investment in infrastructure by $\frac{dM^M}{d\alpha}$, of which MNE enjoys the share α in case of a successful project, which happens with probability q^M. If α is close to 0, the second effect vanishes and MNE always prefers to increase α. However, if α is sufficiently large, the second effect may dominate. The effect of a change in α on total surplus is given by

$$\frac{d(U_{MNE}^M + U_{HC}^M)}{d\alpha} = \underbrace{q^M(\beta-1)S}_{\gtreqless 0 \text{ for } \beta \gtreqless 1} + \underbrace{\frac{1}{K''}(1-\alpha)\frac{\beta-\alpha\beta+\alpha}{\alpha^3}\beta S^2}_{>0} + \underbrace{\alpha q^M \frac{dM^M}{d\alpha}}_{<0}.$$

Summarizing the effects:

(i) $S = 0 \Rightarrow \frac{dM^M}{d\alpha} < 0, \frac{dq^M}{d\alpha} < 0, \frac{dU_{MNE}^M}{d\alpha} \gtreqless 0, \frac{dU_{HC}^M}{d\alpha} < 0, \frac{d(U_{MNE}^M + U_{HC}^M)}{d\alpha} < 0.$

(ii) $S > 0 \Rightarrow \frac{dM^M}{d\alpha} < 0, \frac{dq^M}{d\alpha} \gtreqless 0, \frac{dU_{MNE}^M}{d\alpha} \gtreqless 0, \frac{dU_{HC}^M}{d\alpha} \gtreqless 0, \frac{d(U_{MNE}^M + U_{HC}^M)}{d\alpha} \gtreqless 0.$

We prove by example that there indeed exist cases with the properties described in the proposition. Consider the following cost functions:

$$K(q) = \frac{1}{3}q^3 \text{ and } C(M) = M^2.$$

For $\alpha = 0.98$, $R = 0.1$, and $S = 20$ the following results are obtained for different values of β:

	$\frac{dU_{MNE}^M}{d\alpha}$	$\frac{dU_{HC}^M}{d\alpha}$	$\frac{d(U_{MNE}^M + U_{HC}^M)}{d\alpha}$	q^M	M^M	U_{MNE}^M	U_{HC}^M
$\beta = 0.4$	**-0.92**	-4.62	-5.54	0.423	0.242	0.05	0.11
$\beta = 0.8$	0.03	**4.32**	**4.35**	0.315	0.326	0.02	0.02
$\beta = 0.9$	-	-	-	**0**	**0**	0	0

Thus, for large values of α, there exist cases where MNE's payoff increases as α decreases. Moreover, there exist cases where HC's payoff and the efficiency of the project increase as α increases. As the example highlights this can be the case even for an efficient spillover. For $\beta = 0.9$ sharing of ownership with $\alpha = 0.98$ results in no investment by both parties. However, for $\alpha = 0.99$, $R = 0.1$, and $S = 20$ we get:

	$\frac{dU_{MNE}^M}{d\alpha}$	$\frac{dU_{HC}^M}{d\alpha}$	$\frac{d(U_{MNE}^M + U_{HC}^M)}{d\alpha}$	q^M	M^M	U_{MNE}^M	U_{HC}^M
$\beta = 0.9$	0.19	0.18	0.37	0.298	0.171	0.02	0.03

Q.E.D.

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