RESEARCH INSTITUTE OF INDUSTRIAL ECONOMICS

IFN Working Paper No. 772, 2008

Should R&D Champions be Protected from Foreign Takeovers?

Olivier Bertrand, Katariina Nilsson Hakkala, Pehr-Johan Norbäck and Lars Persson

Research Institute of Industrial Economics
P.O. Box 55665
SE-102 15 Stockholm, Sweden
info@ifn.se
www.ifn.se

Should R&D Champions be Protected from Foreign Takeovers?*

Olivier Bertrand[†] Katariina Nilsson Hakkala[‡] Pehr-Johan Norbäck[§]
Lars Persson[¶]

October 15, 2008

Abstract

We analyze how the entry mode of Foreign Direct Investments (FDI) affects affiliate R&D activities. Using unique affiliate level data for Swedish multinational firms, we first present empirical evidence that acquired affiliates have a higher level of R&D intensity than greenfield (start-up) affiliates. This gap persists over time and with the age of the affiliates, as well as for different firm types and industries. To explain this finding, we develop an acquisition-investment-oligopoly model where we show that for a foreign acquisition to take place in equilibrium, the acquiring MNE must invest sufficiently in sequential R&D in the affiliate. Otherwise, rivals will expand their business, thus making the acquisition unprofitable. Two additional predictions of the model – that foreign firms acquire high-quality domestic firms and that the gap in R&D between acquired and greenfield affiliates decreases in acquisition transaction costs – are consistent with the data.

Keywords: FDI, M&A, R&D, Multinational Firms

JEL classification: F23, L10, L20, O30

*We are very grateful to Mattias Ganslandt and Thierry Mayer for their comments and suggestions and to Fredrik Hesseborn and Martin Olsson for their excellent research assistance. We also thank seminar participants at Research Institute of Industrial Economics, Paris School of Economics and the WZB and CEPR conference on Anti-trust and Innovation in Berlin. Katariina Nilsson Hakkala thanks Riksbankens Jubileumsfond and Pehr-Johan Norbäck and Lars Persson thank Tom Hedelius' and Jan Wallander's Research Foundations for financial support.

[†]Graduate School of Management of St Petersburg State University and Toulouse School of Economics.

[‡]Helsinki School of Economics and Government Institute for Economic Research (VATT).

[§]Research Institute of Industrial Economics.

[¶]Research Institute of Industrial Economics and CEPR. Corresponding author. Lars.persson@ifn.se.

1. Introduction

Foreign direct investments (FDI) play a key role in today's global economy.[1] Many countries encourage inflows of greenfield FDI (i.e. start-ups), in particular in R&D industries, with the motivation that they will give rise to positive externalities and future R&D investments. For example, the Government of Alabama paid the equivalent of $150,000 per employee to Mercedes for locating its new plant in the state in 1994[2] and the British Government provided an estimated $30,000 and $50,000 per employee to attract Samsung and Siemens, respectively, to the North East of England in the late 1990s.[3]

At the same time, there is a concern about foreign acquisitions[4] of certain types of domestic firms.[5] Most countries have regulations that can block foreign acquisitions for national security reasons. For instance, in the US, the Exon-Florio Amendment to the Defense Production Act authorizes the US President to block acquisitions of US companies by foreign interests for national security reasons. However, many countries have recently been re-evaluating their regulations of foreign acquisitions and consider extending the protection of firms in strategic industries, including R&D industries.[6] For instance, in 2005, the rumors about a takeover bid of the French dairy producer Danone by the American company PepsiCo provoked an outcry on the French political arena. A few weeks later, the French government officially proposed to shield ten "strategic" industries, including biotechnologies, and secure information systems from foreign acquisitions. Similar processes have recently taken place in several countries including Canada, China, Italy and USA.[7]

[1] There has been an increase in FDI relative to GDP in the last few decades. FDI has not only grown faster than GDP, it has also outpaced the growth of world trade in this period. See Barba Navaretti (2004).

[2] See Head (1998).

[3] See Girma, Greenaway and Wakelin (2001).

[4] At the end of the 1990's, nearly 90 percent of the FDI transactions in developed countries were cross-border mergers and acquisitions (M&As). In the 1998-2001 period, the share was 36% in developing and transition economies and 76% in the world as a whole (computed from UNCTAD, FDI/TNC Database by Barba Navaretti and Venables, 2004).

[5] See references in Mattoo et al. (2004).

[6] See Graham and Marchick (2006).

[7] See "China adopts anti-monopoly law", August 30, 2007, *China Daily*, "Canadians worried about foreign takeovers, want action: poll", September 7, 2007, CBC news, "Bank chief in Italy off EU hook?", *International Herald Tribune*, *Business*, September 17, 2005, "America for Sale, 2 Outcomes When Foreigners Buy Factories", April 7, 2008, *New York Times* and Graham and Marchick (2006).

In this paper, we examine this policy issue by empirically and theoretically investigating how the entry mode of FDI has had an impact on affiliate R&D activities in the host country.

Using unique micro data on R&D investments in foreign affiliates of Swedish multinational enterprises in 34 countries over the period 1970–1998, we first find evidence that:[8]

- Acquired affiliates have a higher level of R&D intensity (and are more likely to perform R&D) than greenfield affiliates. This gap persists over time and with the age of affiliates, as well as for different firm types and industries.

- While cross-border M&As became the dominating entry mode in the 1990's, we find that the gap in favor of the R&D intensity of acquired affiliates was larger in the 1970's than in the 1990's.

We then develop a theoretical model to explain these empirical facts. Our model has the following key ingredients: there are several MNEs which may enter a host country market by either acquiring a domestic firm or setting up a new plant from scratch (i.e. greenfield investment). All firms in the market then invest in new (sequential) R&D assets and compete in an oligopolistic product market. The domestic firm possesses unique R&D assets, which may be of different initial quality. The level of complementarity between the foreign owners' assets and the domestic R&D assets may vary.

We first show that for an acquisition to take place, the asset complementarity between the assets of the acquirer and the target firm must be sufficiently high. The reason is that when the complementarity is high, the acquiring MNE will invest sufficiently in sequential R&D which prevents rivals from making the acquisition unprofitable by expanding their business. Synergies necessary for a profitable acquisition thus provide an explanation as to why acquiring MNEs invest more intensely in affiliate R&D than greenfield entrants.

The theory also shows that there is a tendency to "cherry-picking acquisitions", i.e. foreign acquisitions of domestic assets of high initial quality. These can be explained as follows: the value for an MNE of obtaining the domestic firm consists of the profit of the MNE as an acquirer net the profit of the MNE as a non-acquirer, whereas the reservation price of the domestic firm is the firm's product market profit when keeping its assets. When the initial quality of the R&D assets increases, the MNE's profit as the possessor will increase in parity with the profit for the domestic

[8] Data is collected by the Research Institute of Industrial Economics in Stockholm.

target firm as the possessor. But, since the MNE's profit as a non-acquirer also decreases due to stronger competition with the domestic firm (or an alternative acquirer), the MNE's valuation will increase more than the reservation price of the domestic firm. Sequential R&D investments driven by an efficiency-enhancing cherry-picking foreign acquisition thus provide an additional mechanism to account for the observation that acquiring MNEs invest more intensively in affiliate R&D than greenfield entrants. However, it is also shown that such "cherry-picking" foreign acquisitions will predominantly occur when the acquiring MNE is sufficiently efficient in using high-quality assets, once more due to the merger profitability requirement.

We now turn to explaining why the R&D gap in favor of acquired affiliates has been reduced over time. There has been a substantial decrease in the transaction costs of cross-border M&As since the 1980s due to the deregulation of restrictions on foreign ownership around the world. Then, we show that a reduction in the transaction costs of cross-border M&As does not only increase the incentives to undertake cross-border M&As, but also that cross-border M&As involving a lower level of sequential R&D investments are more likely to occur. The reason is that less efficient MNEs investing less in sequential R&D can then afford to take over domestic firms in foreign countries. Our model thus provides an insight into why the R&D gap in favor of acquired affiliates was larger in the 1970's than in the 1990's while there was a dramatic increase in the number of cross-border M&As: decreased transaction costs may have induced more but less efficient cross-border M&As.

Having developed a theory which is consistent with the empirical facts, we use the theory to evaluate the welfare effects of blocking cross-border M&As. Then, we use a parametric version of our theoretical model, referred to as the Linear-Quadratic-Cournot (LQC) Model. We show that blocking foreign acquisition is welfare improving if and only if the combination of synergies and initial quality is sufficiently low. However, the analysis also presents several arguments against interventionist policies. First, a large part of potentially welfare reducing foreign acquisitions are blocked by market forces, i.e. they are not profitable when allowed. Second, and contrary to the above policy concern, the expected welfare gain of restricting cross-border M&As is not higher for targets endowed with a high initial quality (i.e the so-called "cherries" or national champions). While a market-power driven acquisition of domestic targets of high quality can emerge in equilibrium, the potential welfare benefit of cross-border M&As with high complementarities is also higher when the target firm's assets are of higher quality. The welfare cost of blocking a foreign acquisition of a national champion can therefore be substantial.

Our study is related to the recent literature on international M&As in oligopolistic markets which, in contrast to the traditional FDI literature, emphasizes that greenfield investments and cross-border acquisitions are not perfect substitutes as entry modes of FDI.[9] Nevertheless, this literature typically treats the greenfield investment alternative as cursory. In this context, we extend the model developed by Norbäck and Persson (2008) by explicitly modeling R&D investments and allowing the quality of the R&D assets of the domestic firm to vary. This enables us to analyze when cherry-picking acquisitions may take place and how cross-border M&As could affect future R&D investments in the host country.

Our study is also related to the literature on firm heterogeneity and entry modes in foreign markets,[10] in particular to Nocke and Yeaple (2007, 2008). They study how differences in firm productivity influence the greenfield versus acquisition choice of MNEs according to the nature of assets, i.e. their degree of international mobility. Our model, based on an acquisition-investment-oligopoly framework, examines how the entry mode of FDI depends on international ownership efficiency differences and asset complementarities and how cross-border M&As influence future R&D investments in both acquired and greenfield affiliates. In particular, we show that MNE heterogeneity can stem from cross-border M&As creating MNEs with unique assets. These differences between MNEs can be further excaberated by sequential R&D investment driven by strategic oligopolistic effects.

Focusing on sequential R&D investments, our study finally makes a contribution to the empirical literature which has so far mainly focused on the determinants of entry mode, and not on the effects on sequential investments.[11] To the best of our knowledge, the only exception is Belderbos (2003) in the business literature who in a cross-section of manufacturing affiliates of Japanese firms finds that the R&D intensity of acquired affiliates substantially exceeds that of wholly-owned greenfield affiliates. In this paper, we go further by examining how the entry mode

[9] See, for instance, Blonigen (1997), Bjorvatn (2004), Bertrand and Zitouna (2005), Head and Ries (2006), Mattoo *et al.* (2004), Norbäck and Persson (2008) or Raff *et al.* (2005). There is also a small theoretical literature addressing welfare aspects of cross-border mergers in international oligopoly markets. This literature includes papers by, for example, Falvey (1998), Head and Ries (1997), Horn and Persson (2001), Lommerud, Straume and Sorgard (2004), Neary (2007) and Norbäck and Persson (2007).

[10] See, for instance, Bernard, Eaton, Jensen, and Kortum (2003) and Helpman, Melitz and Yeaple (2004).

[11] Nocke and Yeaple (2008) and Raff et al. (2005) find evidence that firm characteristics affect the choice of entry mode, thus confirming that cross-border acquisition and greenfield entry are not perfect substitutes.

affects both the decision to conduct R&D and the level of R&D expenditures over a long period of time and in a very large number of host countries.

The paper proceeds as follows: Section 2 presents evidence of R&D and entry modes of FDI. Section 3 presents the theoretical model and analysis. In section 4, we show how the theory could be used to explain the presented evidence. In Section 5, our theoretical model is used to undertake a welfare evaluation of a restrictive cross-border M&A policy. Section 6 concludes the paper.

2. Entry mode and R&D: Empirical evidence

To obtain empirical evidence of the relationship between the entry mode of FDI and R&D investments, we use unique data on acquired and greenfield affiliates of Swedish multinational firms from the Research Institute of Industrial Economics (IFN). The data is based on a questionnaire sent to all Swedish MNEs every fourth year, on average, since 1970. Data on R&D expenditures for affiliates is available for five surveys: 1970, 1978, 1990, 1994 and 1998. Our sample represents an unbalanced panel including information on almost all Swedish multinational firms in the manufacturing sector and their producing majority-owned affiliates abroad. A more detailed description of the data can be found in the Appendix.

This database offers two main advantages. First, it makes it possible for us to identify these two main entry modes over a long period of time (from 1970 to 1998) and in a large number of developed and developing countries. Second, detailed information about parent and affiliate firm characteristics makes it possible to control for other factors with an impact on the innovative global strategies of MNEs. In the appendix we give a more detailed description of the data. Table A1 indicates the number of affiliates by entry mode, year, sector and region in the world.

The limitations of the data set are that we do not have any information on the acquired firms prior to the acquisition. On the other hand, our data has the advantage of providing valuable information on the effects of foreign acquisitions due to the availability of an alternative control group of affiliates created by greenfield entry. The theory presented in the next section will show the merits of this comparison.

2.1. Raw differences

Figure 2.1 (i) plots the number of affiliates established by greenfield investments and mergers and acquisitions, respectively. As can be seen, affiliates established through greenfield entry were more common in the 1970's, whereas this was reversed in the 1990's. This is consistent with the empirical trend towards an increasing importance of cross-border M&As. It suggests that the investment liberalization and the integration of international capital markets in the 1990's have had a more pronounced impact on acquisitions than on greenfield investments. Figures 2.1 (ii) and (iii) plot the total share of acquired affiliates by sectors and regions. M&As are very important as an entry mode in developed countries, but their role has grown most significantly in developing countries. The rise in the share of M&As in science-based industries constitutes a large part of the overall increase in M&As since the mid 1990's.[12]

Let us now investigate if there are any systematic differences in R&D activities between acquired affiliates and affiliates created by greenfield investments. As a measure of R&D activity, we use R&D intensity defined as the share of R&D expenditures in total sales. Thus, we normalize R&D expenditures with total sales to control for size effects. Figure2.2 (i) indicates that, on average, acquired affiliates have a higher R&D intensity than greenfield affiliates.

We then state our first observation:

Observation 1: *Acquired affiliates have, on average, a higher level of R&D intensity than affiliates created by greenfield investments.*

Let us now investigate whether the probability of undertaking R&D differs between acquired and greenfield affiliates. Indeed, R&D is not conducted at all in about half the Swedish affiliates. Figure 2.2 (ii) shows that acquired affiliates are more likely to conduct R&D and Figure 2.2 (ii) emphasizes that the difference remains over time. These differences suggest that in cross-border M&As, MNEs obtain R&D capabilities, or R&D assets, which are continuously used after an acquisition.

We can then state our second observation:

[12] We may also note that there has been a decreasing trend in the number of affiliates in the 1990s. This may be explained by the fact that some large Swedish MNEs were acquired or merged with foreign firms during the 1990s and are no longer in the data base. Nevertheless, FDI from Swedish MNEs increased in terms of employees and sales in the 1990s (Ekholm and Hesselman, 2000).

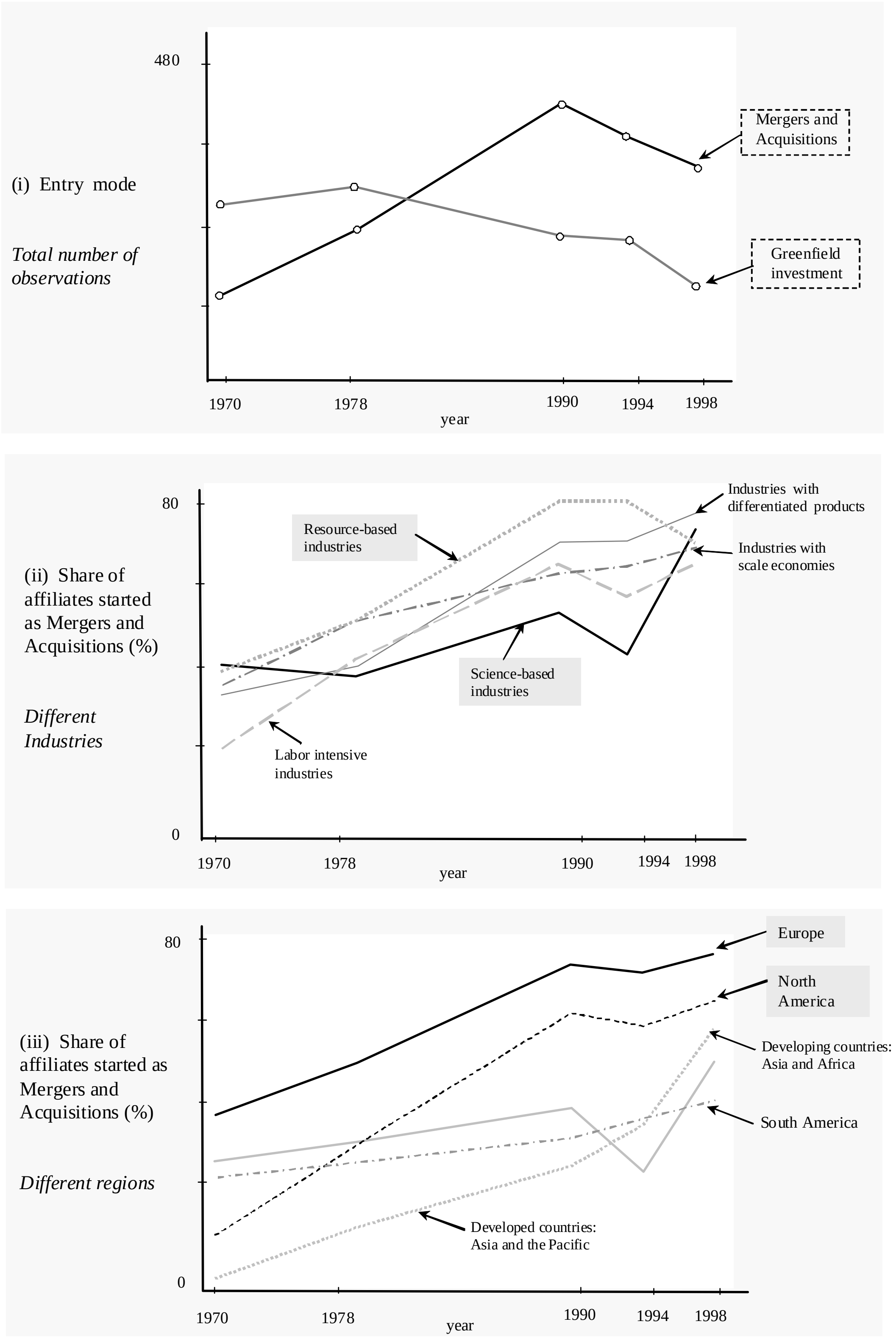

Figure 2.1: Mode of entry over time, industries and regions.

Observation 2: *Acquired affiliates are, on average, more likely to conduct R&D than affiliates created by greenfield investments.*

As illustrated in Figure 2.1, there has been a significant increase in the number of cross-border acquisitions since the 1970's. This may be a consequence of investment liberalization which has reduced the transaction costs of foreign acquisitions. Despite this, it seems that the R&D gap between acquired affiliates and affiliates created by greenfield entry has diminished over time. This pattern can be seen in Figure 2.2 (i) and, in particular, in Figure 2.2 (iii) which compares R&D intensities of the affiliates to non-zero R&D expenditures.

We can then state our third observation:

Observation 3: *While cross-border M&As start to dominate as the entry mode in the 1990's, the gap between R&D intensity in acquired and greenfield affiliates was larger in the 1970's than in the 1990's.*

However, these observations might just suggest that acquired affiliates can benefit from existing R&D capabilities while greenfield affiliates starting from scratch need time to build up their own capacities. In Figure 2.3 (i), we therefore plot average R&D intensity as a function of the number of years an affiliate has been part of the MNE, which we denote as the affiliate age.[13] Figure 2.3 (i) then shows that the gap in favor of acquired affiliates persists over age. In Figures 2.3 (i) and (ii), we also relate the R&D intensity of an affiliate to the R&D intensity in the three-digit industry in their respective host countries. As expected, average R&D intensity in Swedish affiliates is higher than the industry average. While affiliate R&D intensity seems to decline somewhat at a young age, this decline is stronger for affiliates established by greenfield entry.

In sum, observations 1 to 3 suggest that there are differences in the R&D activities of affiliates created by acquisition and greenfield entry. We now examine if these differences persist when explicitly controling for firm, industry and host country characteristics.

2.2. Conditional differences

We will now further examine the sources of the R&D gap in a simple econometric analysis. As previously noted, a majority of affiliates have zero R&D expenditures. To avoid estimates to

[13] We plot three-year averages of age since there may be too few observations and too much variation per each year of age.

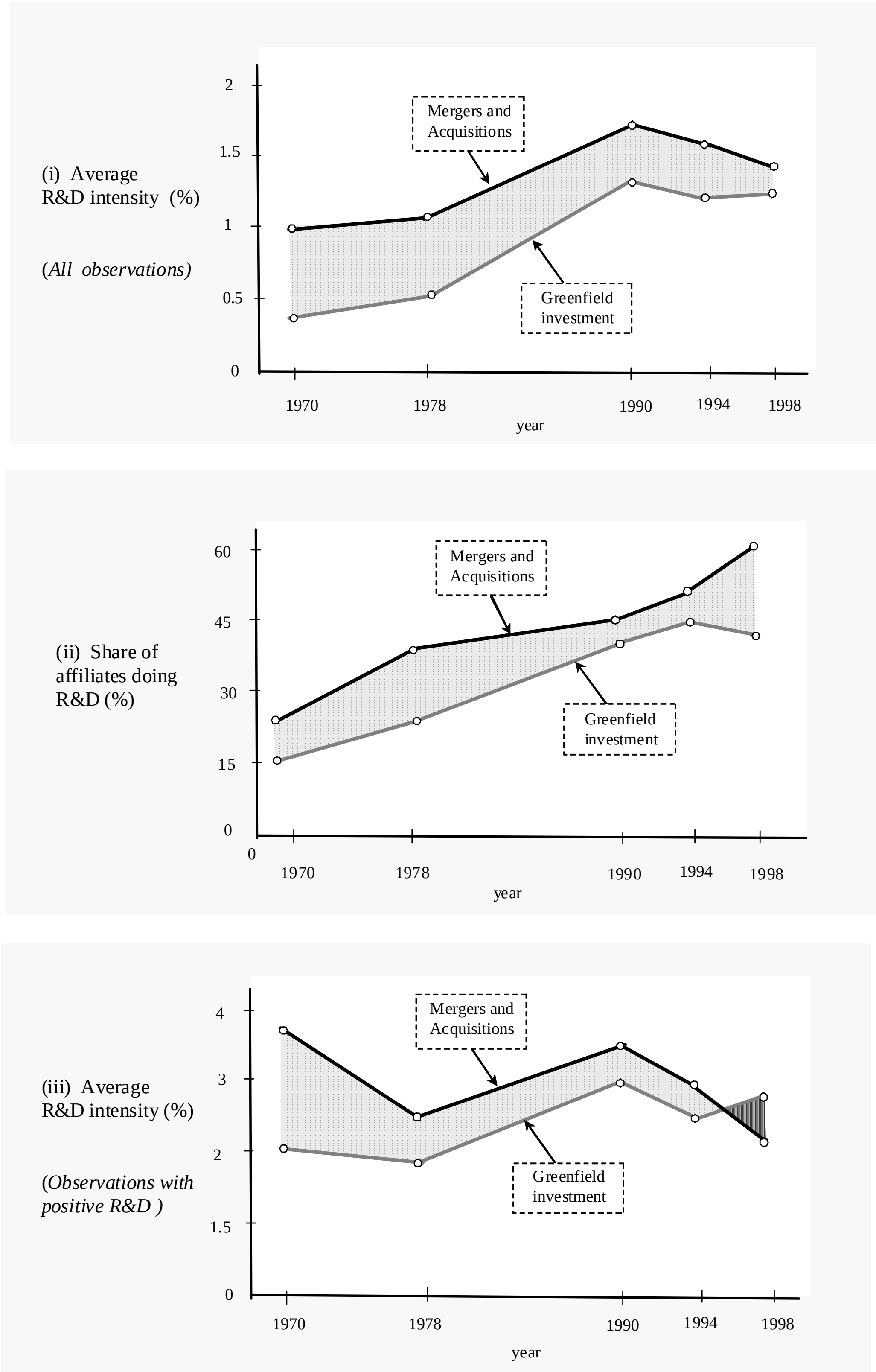

Figure 2.2: Affiliate R&D activities by entry mode over time.

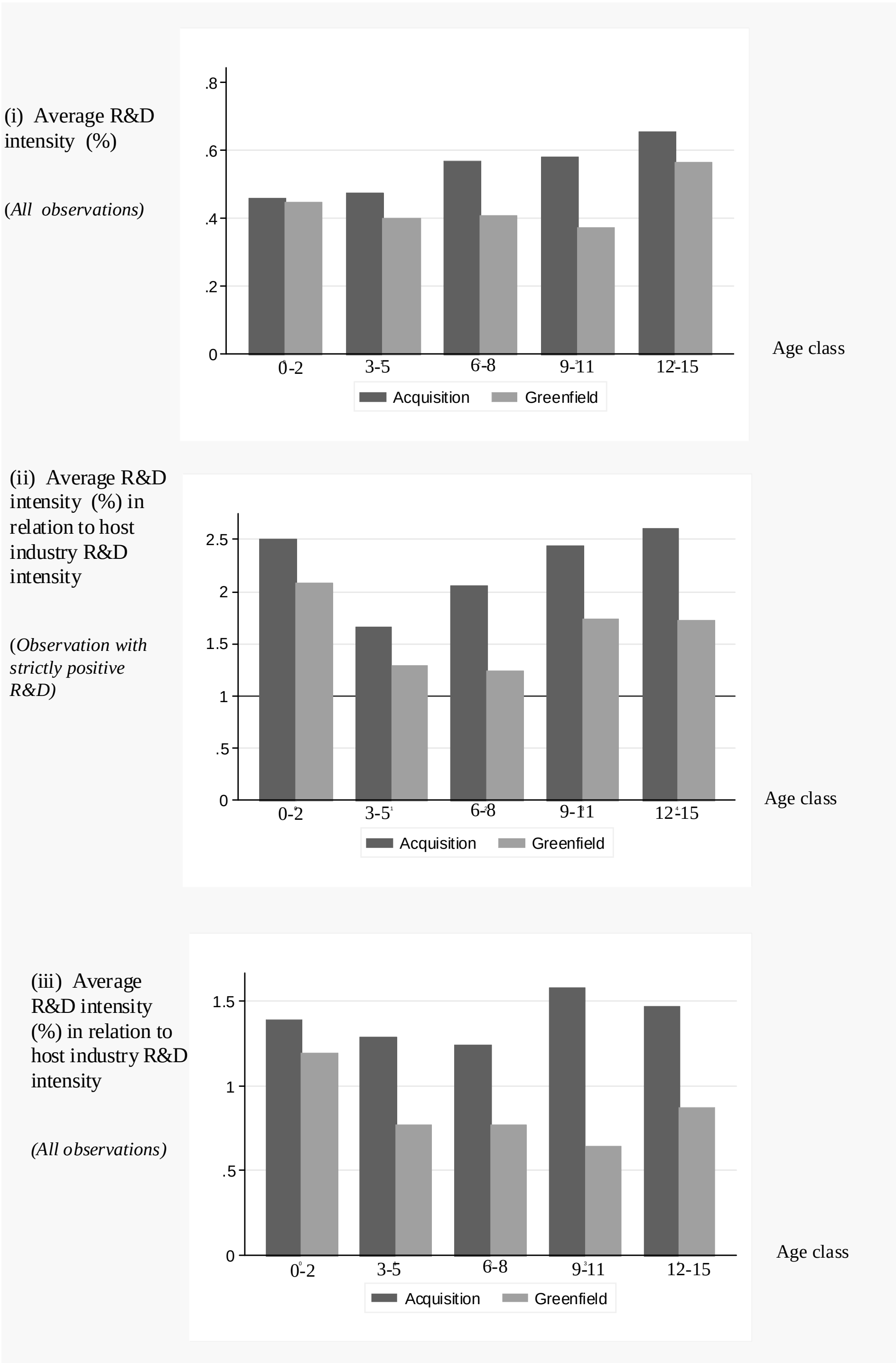

Figure 2.3: Affiliate R&D activities by entry mode over the age of an affiliate.

be both biased and inconsistent, we apply the Heckman (1979) two-stage model to analyze the effect of the entry mode on affiliate R&D activity:[14]

$$DRD_{it} = \alpha_0 + \alpha_1 MA\_GI_i + \alpha_2' Z_{it} + \alpha_3' Z_{jt} + u_{ijt} \tag{2.1}$$

$$\log(RD_{it}) = \beta_0 + \beta_1 MA\_GI_i + \beta_2' X_{it} + \beta_3' X_{jt} + \gamma_{it} + \varepsilon_{ijt}, \tag{2.2}$$

where $DRD_{it} = 1$ if $RD_{it} > 0$, $RD_{it} = 0$ otherwise. MA_GI_i indicates whether an affiliate was acquired ($MA\_GI_i = 1$) or created from a greenfield investment ($MA\_GI_i = 0$). Z_i is a vector of the firm-specific variables and Z_j is a vector of variables affecting the decision to conduct R&D. X_{it} and X_{jt} are the corresponding firm- and host country-specific variables affecting the R&D intensity, u_{ij} and ε_{ijt} are the usual error terms, and $\gamma_{ijt} = \frac{\phi(\alpha' Z)}{\Phi(\alpha' Z)}$ is the error correction variable, where $\phi(.)$ and $\Phi(.)$ are the normal density and cumulative distributions, respectively. The affiliate, parent and country level control variables are variables suggested in the literature and described in detail in the appendix where we also provide summary statistics.

The results from estimating (2.1) and (2.2) are shown in Table 1. Columns (1) and (2) indicate the estimation results for the first and second stages of the Heckman two-stage procedure. The results for the first-stage probit in column (1) show that acquired affiliates are more often associated with R&D activities, independent of affiliate age, size and other characteristics. Furthermore, the positive and significant dummy variable MA_GI in the second stage of the Heckman estimation suggests that acquired firms have a higher R&D intensity than greenfield affiliates, after taking into account unobserved characteristics affecting the selection process.[15]

[Table 1 here]

The economic importance of the estimates is large. The marginal effect of the entry mode dummy MA_GI in equation (2.1) is 0.14. Thus, when comparing two affiliates with otherwise similar characteristics, except the entry mode, an acquired affiliate is 12 percent more likely to perform R&D as compared to an affiliate created by greenfield entry. The corresponding effect of the entry mode dummy in equation (2.2) implies that the R&D intensity is, on average, about 46

[14] We choose not to use a Tobit approach since zero R&D expenditure is likely to be a consequence of binary decision-making rather than censoring, as assumed in a Tobit model. We also estimated Tobit regressions. The results were qualitatively similar and are therefore not reported.

[15] This result is consistent with Belderbos (2003). In his paper, acquired affiliates of Japanese MNEs are shown to have a higher R&D intensity than greenfield affiliates in Tobit estimations. The Tobit method gives qualitatively the same results for our sample.

percent higher in acquired affiliates.[16] These estimated effects are similar to the unconditional differences observed in Figures 2.2 (ii) and (iii).

We then turn to the impact of affiliate age by estimating the effect for affiliates aged less than nine years and those aged between nine and twenty years. Columns (3) to (6) in Table 1 show the results for Heckman estimations. It appears that in both sub-samples, acquired affiliates are more likely to conduct R&D and have a higher level of R&D than greenfield ones which is consistent with Figure 2.2. The coefficient differences indicate that the likelihood of having R&D is larger for the younger acquired affiliates than for the older ones, but the level of R&D is higher among the older acquired affiliates. These regression outcomes suggest that the start-up delay in the R&D activities of greenfield affiliates does not explain the gap in favor of acquired affiliates. Greenfield affiliates do not seem to catch up with the acquired ones over time. Moreover, acquired affiliates do not seem to reduce their R&D over time, at least not to a higher degree than greenfield affiliates, which is consistent with Figure 2.3.

Finally, we split the data into the 1970's and 1990's samples and run separate regressions for these samples. Table 2 shows the entry mode dummy to still be significant and positive, thus suggesting that acquired affiliates are more likely to conduct R&D and have a higher level of R&D during both sub periods. We also find that the coefficient size of the MA_GI dummy is significantly higher in the 1970's than in the 1990's, suggesting that the gap was larger in the 1970's, with the second-stage estimates also being significantly different.

[Table 2 here]

Summing up, examining conditional differences, we find that observations 1 to 3 still hold: *Affiliates created as acquisitions invest more intensively in R&D than affiliates created through greenfield entry, and they are more likely to conduct R&D. Moreover, these differences in R&D behavior have decreased in the 1990's.*

We now present a theory of entry mode of FDI and affiliate R&D which can provide explanations for these observations and can be used for welfare evaluations of blocking cross-border M&As.

[16] The estimate of β_1 in equation (2.2) is $\hat{\beta}_1 = 0.376$. From (2.2), it follows that $\frac{\widehat{RD}^{MA} - \widehat{RD}^{GI}}{\widehat{RD}^{GI}} = e^{\hat{\beta}_1} - 1 = 0.4564$.

3. Theory

Consider a country H, where the market has previously been served by a single domestic firm, denoted d. This local firm possesses domestic R&D assets, denoted k_0. The market will now be exposed to international investments from M symmetric MNEs.[17] The interaction then takes place in three stages. In the first stage, the MNEs might acquire the R&D assets of the domestic firm. In the second stage, all firms may invest in new R&D assets in country H. Finally, in the third stage, firms compete in oligopoly fashion in country H. The following sections describe the product market interaction, the R&D investment game and the acquisition game.

3.1. Period 3: product market interaction

The firm profits will depend on the distribution of the R&D asset ownership, given from the investment game in period 2, and the acquisition game in period 1. To capture this, we will work with the following notation: let the set of firms in the industry be $I = \{d, 1, 2, ..., M\}$, and let the set of (potential) owners of the domestic assets, k_0, be $L = \{d, 1, 2, ..., M\}$. The asset ownership structure $K = (k_d, k_{m_{1,...,}}k_{m_M})$ specifies the asset ownership of each firm. The first entry refers to assets holdings of the domestic firm, the second to assets holdings of the first MNE, the third to assets holdings of the second MNE, etc.

Let $\pi_i(x, \kappa, l) = R_i(x, \kappa, l) - \bar{F}_i - F_i(\kappa_i)$ denote the profit of firm $i \in I$, where $x = (x_d, x_{m_{1,...,}}x_{m_M})$ is the vector of actions taken by firms in the product market interaction in period 3, $\kappa = (\kappa_d, \kappa_{m_{1,...,}}\kappa_{m_M})$ represents the vector of investments in new R&D assets in period 2, and $l \in L$ denotes the ownership of the domestic assets resulting from the acquisition game in period 1. $R_i(x, \kappa, l)$ is the product market profit in period 3, $\bar{F}_i$ is a fixed cost of investment in period 2 and $F_i(\kappa_i)$ is the variable cost of investment in new R&D assets κ_i in period 2.

We are now set to describe optimal firm behavior in the product market. Given the investments in period 2, κ, and the ownership of the domestic assets resulting from period 1, l, firm i chooses an action $x_i \in R^+$ to maximize its product market profit, $R_i(x_i, x_{-i}, \kappa, l)$, where x_{-i} is the set of actions taken by i's rivals. We may consider the action x_i as setting a quantity à la Cournot, or a price à la Bertrand. In either case, we assume the existence of a unique

[17] There could be different reasons for why the market is now open to international investments. The country might be investment liberalizing, the international expansion of MNEs might be a natural step in the life product cycle or stem from increasing local demand and the transaction costs of foreign investments may have been reduced in the globalization process.

Nash-Equilibrium, $\mathbf{x}^*(\boldsymbol{\kappa},l)$, defined as:

$$R_i(x_i^*, x_{-i}^*, \boldsymbol{\kappa},l) \geq R_i(x_i, x_{-i}^*, \boldsymbol{\kappa},l), \quad \forall x_i \in R^+. \tag{3.1}$$

From (3.1), we can define a reduced-form net profit for a firm i, taking as given ownership l of the domestic assets k_0 and the vector of new investments $\boldsymbol{\kappa}$, as $\pi_i(\boldsymbol{\kappa},l) - \bar{F}_i \equiv R_i(x_i^*(\boldsymbol{\kappa},l), x_{-i}^*(\boldsymbol{\kappa},l), \boldsymbol{\kappa},l) - F_i(\kappa_i) - \bar{F}_i$.

3.2. Period 2: Endogenous R&D investments

In period 2, firm i invests in new R&D assets κ_i, given the ownership l of the domestic assets, k_0, determined in the acquisition game in period 1. We make the following standard assumptions: the reduced-form profit $\pi_i(\boldsymbol{\kappa},l)$ decreases in the number of firms in the market and rivals' investments κ_{-i}. It is also supposed to be strictly concave in its own investments κ_i and rise in κ_i for some κ_i.

Formally, firm i makes its choice $\kappa_i \in R^+$ to maximize the reduced-form profit, $\pi_i(\boldsymbol{\kappa},l)$ which we rewrite as $\pi_i(\kappa_i,\kappa_{-i},l)$, where κ_{-i} denotes investments in new R&D assets by i's rivals. We assume there to exist a unique Nash-Equilibrium, $\kappa^*(l)$ defined from:

$$\pi_i\left(\kappa_i^*,\kappa_{-i}^*,l\right) \geq \pi_i\left(\kappa_i,\kappa_{-i}^*,l\right), \quad \forall \kappa_i \in R^+. \tag{3.2}$$

This allows us to define $\pi_i(l) \equiv \pi_i(\kappa^*(l), l) \equiv \pi_h(x^*(\kappa^*(l)), \kappa^*(l), l)$ as a reduced-form profit function for firm i under ownership l of assets k_0, encompassing the firms' optimal actions in period 3, x^*, and optimal R&D investments in new assets in period 2, κ^*.

The assumption that MNEs $1, 2, ..., M$ are symmetric before the acquisition occurs thus implies that we need only distinguish between two kinds of ownership, *domestic* ownership ($l = d$) and *foreign (MNE)* ownership ($l = m$). There are two types of asset ownership structures, $\mathbf{K}(m)$ and $\mathbf{K}(d)$:

$$\mathbf{K}(m) = (0, k_0(\alpha,\gamma) + \kappa_A^*, \underbrace{\kappa_G^*, ..., \kappa_G^*}_{M-1}), \qquad \alpha, \gamma > 0 \tag{3.3}$$

$$\mathbf{K}(d) = (k_0(\alpha,1) + \kappa_d^*, \underbrace{\kappa_G^*, ..., \kappa_G^*}_{M}), \qquad \alpha > 0, \tag{3.4}$$

where we keep track of three types of firms, $h = \{d, A, G\}$, i.e. the domestic firm (d), an acquiring MNE (A), and greenfield entrants (G). The first entry in $K(l)$ shows the asset ownership of the domestic firm, d, the second entry indicates the asset ownership of the potentially acquiring MNE

(MNE 1), and the remaining entries refer to the asset ownership of the symmetric non-acquiring MNEs, i.e. greenfield entrants. Under MNE ownership of the domestic assets, k_0, there is one acquiring MNE and $M-1$ non-acquiring MNEs investing greenfield. Under domestic ownership, there are M MNEs investing greenfield.

The effective quality of the domestic R&D assets k_0 will typically vary and a change from domestic to foreign ownership might induce a different use of them. To capture this, we make use of the following definition:

Definition 1. *(i) Let $\alpha > 0$ denote the initial quality of the R&D assets and let $\gamma > 0$ be a measure of the complementarity between acquired domestic R&D assets and MNEs' firm-specific assets. (ii) The effective quality of the domestic R&D assets is then $k_0(m) = k_0(\alpha, \gamma)$ under foreign ownership and $k_0(d) = k_0(\alpha, 1)$ under domestic ownership. (iii) $k'_{0,\alpha} > 0$, $k'_{0,\gamma} > 0$ and $k''_{0,\gamma\alpha} > 0$.*

MNEs are typically leading firms in their respective industries and possess firm-specific knowledge in terms of technology or organizational and marketing know-how, for instance.[18] Some of this knowledge may be transferred under a change of ownership. This would result in a more productive use of the initial R&D assets, k_0. Then, $\gamma > 1$ and $k_0(m) > k_0(d)$. However, whenever $\gamma < 1$, an MNE is less efficient when using the R&D assets and the effective quality of the domestic R&D assets is lower under foreign ownership, $k_0(m) < k_0(d)$.[19]

To proceed, we then make the following assumption on how reduced-form profits and sequential investments in R&D are affected when the effective quality of the R&D k_0 increases:

Assumption A1 (i) $\frac{d\pi_A(m)}{dk_0} > 0$, $\frac{d\pi_d(d)}{dk_0} > 0$ and $\frac{d\pi_G(l)}{dk_0} < 0$, (ii) $\frac{d\kappa^*_A(m)}{dk_0} > 0$, $\frac{d\kappa^*_D(d)}{dk_0} > 0$ and $\frac{d\kappa^*_G(m)}{dk_0} < 0$.

Assumption A1(i) implies that an increase in the effective quality of R&D assets k_0 will increase the possessor's profit while reducing the profit of its rivals. The increase in the possessor's profit may occur through direct effects, but also indirectly by affecting the optimal actions by rivals in the stage-three product market game (x^*), and through firms' investments in new R&D assets (κ^*). In particular, Assumption A1(ii) implies that an acquiring firm that possesses a

[18] See Barba-Navaretti and Venables (2006), Markusen (2002), Markusen (1995) and Caves (1995).

[19] In addition to distinct corporate cultures, cultural and geographical distance may prevent technology transfer by making communication as well as the assimilation and application of new knowledge more difficult.

higher effective quality of the initial R&D assets will invest more aggressively in new R&D assets. This will then make the rivals less aggressive in their investment behavior, thereby reducing the profits of these competing firms.

Example 1 (The LQC-model). *As an example of a model where Assumption A1 is fulfilled, we extend Neary (2002) into a framework with FDI through greenfield entry and cross-border acquisitions. This Linear-Quadratic Cournot model (LQC-model) is also used to derive more specific results. The oligopoly interaction in period 3 is Cournot competition in homogenous goods. Investments in new R&D assets in period 2 reduce firm marginal costs. The profit for firm i can be written:*

$$\pi_i(\mathbf{q},\boldsymbol{\kappa},l) = R_i(\mathbf{q},\boldsymbol{\kappa},l) - \frac{\mu\kappa_i^2}{2} - \bar{F}_i, \tag{3.5}$$

where $R_i = (P - c_i)q_i$ is the product market profit and where we assume costs to be quadratic in new assets, κ_i, $F_i(\kappa_i) = \frac{\mu\kappa_i^2}{2}$. Firms face the inverse demand $P = a - \frac{1}{s}\sum_{i=1}^{N} q_i$, where $a > 0$ is a demand parameter, s may be interpreted as the size of the market, and N is the total number of firms in the market. Investments in new capital reduce a firm's marginal cost in a linear fashion $c_i = \bar{c}_i - \theta\kappa_i$, where θ is a positive constant parameter measuring how effectively investments in new capital κ_i in stage 2 reduce the marginal cost. For simplicity, we assume that all firms share the same investment technology, θ and μ. Asymmetries between firms are captured by the intercept term, $\bar{c}_i$, which assesses the impact on firm i's absolute efficiency level of the possession of all other assets prior to investment in new R&D assets, κ_i, in stage 2. Making a distinction between firm types, we have:

$$\bar{c}_G = c, \qquad \bar{c}_A = c + \tilde{c}_A - \gamma\alpha, \qquad \bar{c}_d = c + \tilde{c}_d - \alpha, \tag{3.6}$$

where we note that $k_0(m) = \gamma\alpha$ and $k_0(d) = \alpha$ and that $k_0(m)$ and $k_0(d)$ are consistent with Definition 1. Hence, existing assets k_0 and new assets κ_i are assumed to be imperfect substitutes. We capture cost asymmetries between MNEs and the domestic firm by including $\tilde{c}_d \geq 0$ in the domestic firm's intercept term, $\bar{c}_d$. The term $\tilde{c}_A$ captures that different factors may also lead to higher marginal costs when making an acquisition as compared to greenfield investments. From (3.1), we get $\frac{\partial R_i}{\partial q_i} = P - c_i - q_i = 0$ and then optimal quantities $q^*(\kappa, l)$. In stage 2, (3.2) implies that $\frac{d\pi_i}{d\kappa_i} = \frac{\partial R_i}{\partial \kappa_i} + \sum_{j\neq i}^{N} \frac{\partial R_i}{\partial q_j}\frac{dq_j}{d\kappa_i} - F_i' = 0$, where optimal investments are given from $\kappa_i^*(l) = \frac{\theta}{\mu} q_i^*(l)\frac{2N(l)}{N(l)+1}$, where $N(m) = M$ and $N(d) = M + 1$. Solving for stage 2 investments $\kappa^*(l)$ and stage 3 sales $\mathbf{q}^*(l)$, we have the reduced-form profits $\pi_i(l)$. It can be shown that these *profits take the form* $\pi_i(l) = \frac{1}{s}(q_i^*(l))^2\left[1 - \frac{\eta}{2}\left(\frac{2N(l)}{N(l)+1}\right)^2\right] - \bar{F}_i$, *where* $\eta = s\frac{\theta^2}{\mu}$. *The expressions for reduced-form profits are given in the Appendix in Table A.1, where it can be checked that reduced form profits* $\pi_i(l)$ *and R&D choices* $\kappa_i^*(l)$ *fulfill Assumption A1.*

3.3. Period 1: the acquisition game

The acquisition process is depicted as an auction game where M MNEs simultaneously post bids and the domestic firm then either accepts or rejects these bids. Each MNE announces a bid (denoted b_i) for the domestic firm. $b = (b_1, ..., b_i, ..., b_M) \in R^M$ is the vector of these bids. Following the announcement of b, the domestic firm may be sold to one of the MNEs at the bid price, or remain in the ownership of firm d. If more than one bid is accepted, the bidder with the highest bid obtains the domestic assets. If there is more than one MNE with such a bid, these MNEs obtain the assets with equal probability. This winning bid is then referred to as the acquisition price S. The acquisition is solved for Nash equilibria in undominated pure strategies. There is supposed to exist a smallest amount ε such that all inequalities are preserved if ε is added or subtracted.

We now turn to the firms' valuations of the domestic firm's R&D assets, k_0. There are three different valuations which need to be considered. We start with the valuations of MNEs:

- v_{mm} is the *preemptive valuation*, i.e. the value for an MNE of obtaining k_0, when a *rival* MNE would otherwise obtain k_0. The first term shows the profit when possessing k_0. The second term shows the expected profit if a rival MNE obtains k_0, in which case the MNE invests greenfield:
$$v_{mm} = \pi_A(m) - \bar{F}_A - \left[\pi_G(m) - \bar{F}_G\right]. \tag{3.7}$$

- v_{md} is the *takeover valuation,* i.e. the value for an MNE of obtaining k_0, when the *domestic* firm would otherwise keep them. The profit for an MNE of not obtaining assets k_0 is different in this case, due to the change of identity of the firm which would otherwise get the assets:
$$v_{md} = \pi_A(m) - \bar{F}_A - \left[\pi_G(d) - \bar{F}_G\right]. \tag{3.8}$$

- v_d is the *reservation price*, i.e. the value for the domestic firm of keeping k_0. By assumption, $\pi_d(m) = 0$ and thus:
$$v_d = \pi_d(d). \tag{3.9}$$

We have the following Lemma:

Lemma 1. *The equilibrium ownership structure (EOS) and the acquisition price S^* are described in Table 3.1.*

Since MNEs are symmetric, valuations v_{mm}, v_{md} and v_d can be ordered in six different ways and the EOS is solved for each inequality I1-I6 in table 3.1. Three types of ownership structures arise in equilibrium: the one where firm d keeps its assets k_0 is thus $\mathbf{K}(d)$ arising under I5 or I6; the one where k_0 is obtained by one of the MNEs corresponds to $\mathbf{K}(m)$, where the acquisition price is $S^* = v_{mm}$ under inequalities $I1$, $I2$ or $I3$, and $S = v_d$ under inequality $I4$. When $I2$ holds, there exist multiple equilibria. In one equilibrium, firm d keeps the assets and no MNE posts a bid above v_d. There is also an equilibrium where one of the MNEs obtains these assets at a price $v_{mm} - \varepsilon$ and another MNE posts the second highest bid at $v_{mm} - 2\varepsilon$.

Table 3.1: The equilibrium ownership structure (EOS) and acquisition price.

Inequality:	Definition:	EOS:	Acquisition price S*:
I1:	$v_{mm} > v_{md} > v_d$	$\mathbf{K}(m)$	v_{mm}
I2:	$v_{mm} > v_d > v_{md}$	$\mathbf{K}(m)$ or $\mathbf{K}(d)$	v_{mm} under $\mathbf{K}(m)$
I3:	$v_{md} > v_{mm} > v_d$	$\mathbf{K}(m)$	v_{mm}
I4:	$v_{md} > v_d > v_{mm}$	$\mathbf{K}(m)$	v_d
I5:	$v_d > v_{mm} > v_{md}$	$\mathbf{K}(d)$	.
I6:	$v_d > v_{md} > v_{mm}$	$\mathbf{K}(d)$	.

For proof, see Norbäck and Persson (2007).

4. Reconciling theory and empirical evidence

4.1. Why do MNEs invest more in R&D in acquired affiliates?

Let us first explain why MNEs invest more in R&D in acquired affiliates (observations 1 and 2 in Section 2). To this end, we study how the incentives for cross-border acquisitions depend on the asset complementarity γ. From equations (3.7) and (3.9) and Definition 1, it follows that the valuations of MNEs v_{md} and v_{mm} increase monotonously in the complementarity γ, whereas the reservation price v_d is independent of γ. Thus, we can state the following Lemma:

Lemma 2. *There exists a unique γ^T defined from $v_{md}(\gamma^T, \cdot) = v_d$ and a unique γ^P defined from $v_{mm}(\gamma^P, \cdot) = v_d$.*

To explain and illustrate our results, we will make use of the following assumption which, for instance, holds in the LQC model.

Assumption A2 $\gamma^P > \gamma^T > 0$.

Assumption A2 allows us to derive a simple graphical solution where all types of relevant equilibria are present. In Figures 4.1 (i) and 4.1 (ii), we derive the equilibrium ownership structure (EOS) for which the size of the foreign R&D efficiency γ varies. In Figure 4.1 (iii), we explore the effect of endogenous investments as a function of efficiency effects associated with an ownership change in Definition 1. Let us start with Figure 4.1 (i). When complementarities are low $\gamma \in (0, \gamma^T)$, the foreign firm's takeover valuation is lower than the domestic firm's reservation price. This is illustrated in Figure 4.1 (i) where the v_d curve is above the v_{md} curve. In this case, the combined profit of the acquiring foreign firm and the domestic target firm is lower than their stand-alone profits. Thus, without sufficient synergies, the associated increase in concentration is not sufficient to make an acquisition profitable.

From Definition 1, the takeover valuation, $v_{md} = \pi_A(m) - \pi_d(d) - (\bar{F}_A - \bar{F}_G)$, increases in complementarities, γ. Indeed, the profit as an acquirer $\pi_A(m)$ increases in γ since the effective quality of the domestic R&D assets goes up $k'_{0,\gamma}(\alpha, \gamma) > 0$, whereas the domestic firm's valuation v_d and the foreign firm's profit as a non-acquirer $\pi_d(d)$ and $\pi_G(d)$ are independent of γ, $k'_{0,\gamma}(\alpha, 1) = 0$.

$$\frac{d(v_{md} - v_d)}{d\gamma} = \frac{d\pi_A(m)}{dk_0} k'_{0,\gamma}(\alpha, \gamma) > 0. \tag{4.1}$$

A further increase in complementarities γ will thus make a takeover acquisition strictly profitable as $v_{md} > v_d$. The equilibrium sales price is then $S^* = v_d = \pi_d(d)$. This is illustrated at point T in Figure 4.1 (i), where takeover acquisitions occur in the region $\gamma \in [\gamma^T, \gamma^P)$.

Finally, turn to the case of high levels of complementarities $\gamma \in (\gamma^P, \gamma^{\max})$. Using Definition 1, we can note that the preemptive valuation of foreign firms v_{mm} will increase more than the takeover valuation v_{md} since increasing complementarities do not only increase the product market profit as an acquirer but also decrease the product market profit as a non-acquirer. Thus, the preemptive valuation v_{mm} is not only driven by the benefits of obtaining a strong position in the product market as an acquirer, but also by the preemptive motive for avoiding a weak position as a non-acquirer

$$\frac{d(v_{mm} - v_d)}{d\gamma} = \left[\frac{d\pi_A(m)}{dk_0} - \frac{d\pi_G(m)}{dk_0}\right] k'_{0,\gamma}(\alpha, \gamma) > 0. \tag{4.2}$$

It then follows that a further increase in complementarities into the region $\gamma \in (\gamma^P, \gamma^{\max})$ will make a preemptive acquisition strictly profitable as $v_{mm} > v_d$. Fierce bidding competition among foreign firms then drives the equilibrium sales price to $S^* = v_{mm} = \pi_A(m) - \pi_G(m) - (\bar{F}_A - \bar{F}_G)$. This is illustrated by point P in Figure 4.1 (i).

Therefore, we can state the following Proposition:

Proposition 1. *(i) No acquisition will take place if the complementarities between MNEs' firm-specific assets and the domestic assets are low, $\gamma \in (0, \gamma^T)$, (ii) a foreign takeover-acquisition will take place with $S^* = v_d$ if the complementarities are intermediate, $\gamma \in [\gamma^T, \gamma^P)$, and (iii) a foreign preemptive-acquisition will take place with $S^* = v_{mm}$ if the complementarities are high, $\gamma \geq \gamma^P$.*

We can now address the impact of ownership on firms' R&D investment. As will be shown below using the LQC model, while the market power effect may lead to inefficient acquisitions where $\gamma < 1$, the profitability constraint $v_{md} \geq v_d$ will imply that synergies γ cannot be significantly below unity. Therefore, when a takeover acquisition occurs at γ^T, there is a tendency to a discrete increase in R&D investments following a takeover, $\kappa_A^*(m) > \kappa_d^*(d)$. The increase in concentration then enhances the incentives of the foreign owner to make R&D investments. This is illustrated in Figure 4.1 (iii), where non-acquiring MNEs will also increase their investments, $\kappa_G^*(m) > \kappa_G^*(d)$ due to the concentration effect.

Then, from Assumption A1, we know that the investments by the acquirer will increase further when complementarities arise, while non-acquirers will decrease their investments:

$$\frac{d\kappa_A^*(m)}{d\gamma} = \frac{d\kappa_A^*(m)}{dk_0} k'_{0,\gamma}(\alpha, \gamma) > 0, \qquad \frac{d\kappa_G^*(m)}{d\gamma} = \frac{d\kappa_G^*(m)}{dk_0} k'_{0,\gamma}(\alpha, \gamma) < 0. \tag{4.3}$$

Under domestic ownership investments, $\kappa_h^*(d)$ is unaffected by foreign efficiency, or complementarities γ, by Definition 1. As illustrated in Figure 4.1(iii), this implies that when R&D

investments are significantly higher in acquired affiliates than in a domestic firm $\kappa_A^*(m) > \kappa_d^*(d)$, R&D investments in the acquired affiliate will also tend to be significantly higher than in an affiliate created by greenfield entry, $\kappa_A^*(m) > \kappa_G^*(l)$.

Thus, we show that for the acquisition to take place, a foreign owner must be sufficiently efficient in utilizing acquired R&D assets. The value of parameter γ needs to be sufficiently large. In turn, an efficient foreign acquirer will then invest aggressively in sequential R&D to keep rivals from making the acquisition unprofitable by expanding their R&D. This tends to make the expansion in R&D activities larger in acquired affiliates as compared to either affiliates created through greenfield entry or R&D under maintained domestic ownership of the target firm. To summarize:

Proposition 2. *For sufficiently high levels of complementarities γ, R&D investments are higher in the acquired affiliate than in the domestic firm $\kappa_A^*(m) > \kappa_d^*(d)$ and in a greenfield affiliate $\kappa_A^*(m) > \kappa_G^*(l)$.*

4.1.1. "Cherry-picking" and R&D investments

Synergies emerging from foreign acquisitions may explain why MNEs invest more in R&D in acquired affiliates than in affiliates created by greenfield entry (as illustrated by observations 1 and 2 in Section 2). Another alternative explanation, which is a concern among policy makers, is that MNEs just "cherry pick" target firms, i.e. acquire target firms with already existing high quality R&D assets, without generating any significant synergies. However, a priori, it is not obvious that the sellers would like to sell their best firms.

To evaluate this argument, we define cherry-picking as follows:

Definition 2. *Suppose that the EOS is $\mathbf{K}(d)$ at some initial R&D quality of the domestic assets α_0. (i) Cherry-picking arises if, ceteris paribus, increasing the initial quality from α_0 to $\alpha_0 + \varepsilon$, where $\varepsilon > 0$, induces a foreign acquisition and hence foreign ownership, $\mathbf{K}(m)$. (ii) Cherry-picking is "destructive" if the acquisition (induced by higher initial quality) occurs for $\gamma < 1$. (iii) Cherry-picking is "efficiency-enhancing" if the acquisition occurs for $\gamma > 1$.*

We can then derive the following proposition:

Proposition 3. *(i) If and only if complementarities γ are sufficiently large, cherry-picking foreign acquisition takes place .*

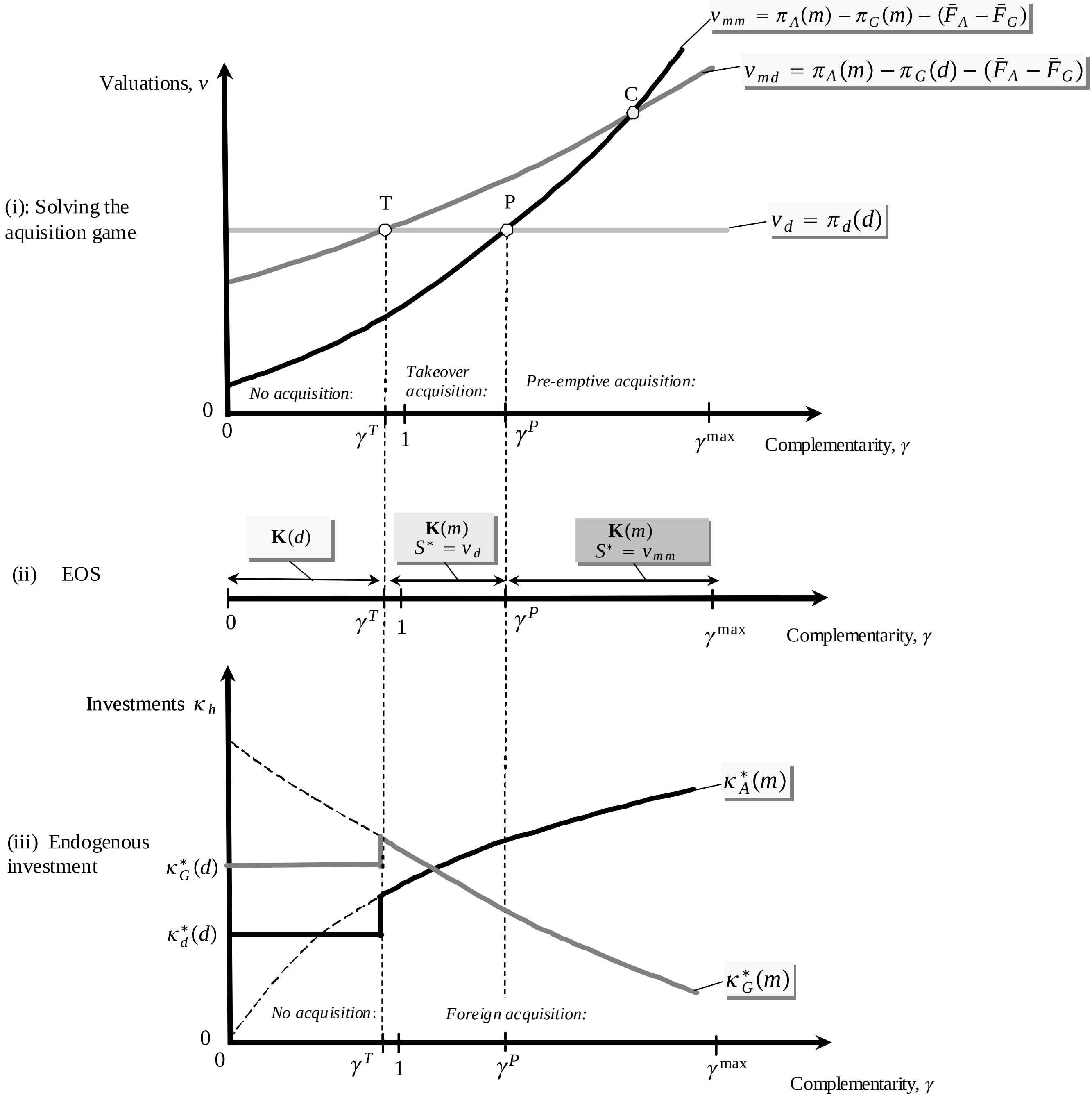

Figure 4.1: Solving for the equilibrium ownership structure (EOS) and equilibrium investments in new R&D assets.

Intuitively, the proposition states that the merger profitability requirement, in general, tends to select efficiency-enhancing foreign acquisitions. This, in turn, will be reflected in the firm's R&D behavior, thus generating the largest sequential R&D investments in acquired affiliates.

To prove Proposition 3, we first define the initial quality $\alpha^T(\gamma)$ as an implicit function of synergies γ from the takeover condition $v_{md} = v_d$. Differentiating in α, size and γ, we have:

$$\frac{d\alpha^T}{d\gamma} = -\frac{\frac{d(v_{md}-v_d)}{d\gamma}}{\frac{d(v_{md}-v_d)}{d\alpha}}, \tag{4.4}$$

where $\frac{d(v_{md}-v_d)}{d\gamma} = \frac{d\pi_A(m)}{dk_0}k'_{0,\gamma}(\alpha,\gamma) > 0$ from (4.1). Hence, the sign of (4.4) hinges on the sign of the term $\frac{d(v_{md}-v_d)}{d\alpha}$ which is the change in the net gain of a takeover acquisition when there is an increase in initial quality. From (3.8), (3.9) and Definition 1, the change in the net gain of a takeover acquisition can be written:

$$\frac{d(v_{md}-v_d)}{d\alpha} = \frac{d\pi_A(m)}{dk_0}k'_{0,\alpha}(\alpha,\gamma) - \frac{d\pi_G(d)}{dk_0}k'_{0,\alpha}(\alpha,1) - \frac{d\pi_d(d)}{dk_0}k'_{0,\alpha}(\alpha,1). \tag{4.5}$$

The sign of (4.5) will depend on the level of complementarities, γ. First, consider the case of synergies, $\gamma > 1$. Since $k'_{0,\alpha}(\alpha,\gamma) > k'_{0,\alpha}(\alpha,1) > 0$ from Definition 1, the profit of the acquiring MNE $\pi_A(m)$ tends to increase at least as much as the profit of the domestic firm $\pi_d(d)$, while the profit of a non-acquiring greenfield entrant $\pi_G(d)$ decreases. Taking the latter negative externality into account, the MNEs' valuation of the domestic assets v_{md} will increase more than the domestic firm's reservation price v_d when the initial quality of the R&D assets α increases, $\frac{d(v_{md}-v_d)}{d\alpha} > 0$. Thus, for $\gamma > 1$, the takeover condition $\alpha^T(\gamma)$ will be downward sloping in the $\gamma - \alpha$ space, as shown in Figure 4.2 which is drawn using the LQC model. Hence, since a higher initial quality of the domestic R&D assets α gives rise to foreign acquisitions for $\gamma > 1$, we note that efficiency-enhancing "cherry picking" arises.

When $\gamma < 1$, $k'_{0,\alpha}(\alpha,\gamma) < k'_{0,\alpha}(\alpha,1)$ holds which makes (4.5) more complicated to evaluate. However, since an acquisition must be profitable ($v_{md} \geq v_d$), we know that synergies γ need to be sufficiently large. In most cases $\frac{d(v_{md}-v_d)}{d\alpha} > 0$ will therefore hold and $\alpha^T(\gamma)$ will be downward sloping also when γ is below unity. Consequently, "destructive" cherry-picking may arise but, as shown by the example from the LQC model in Figure 4.2, the market forces requiring profitable acquisitions will limit the occurrence of such acquisitions.

Figure 4.2 thus illustrates that "efficiency-enhancing" acquisitions tend to arise, that is, foreign acquisitions are not only motivated by the high initial quality of the target assets but

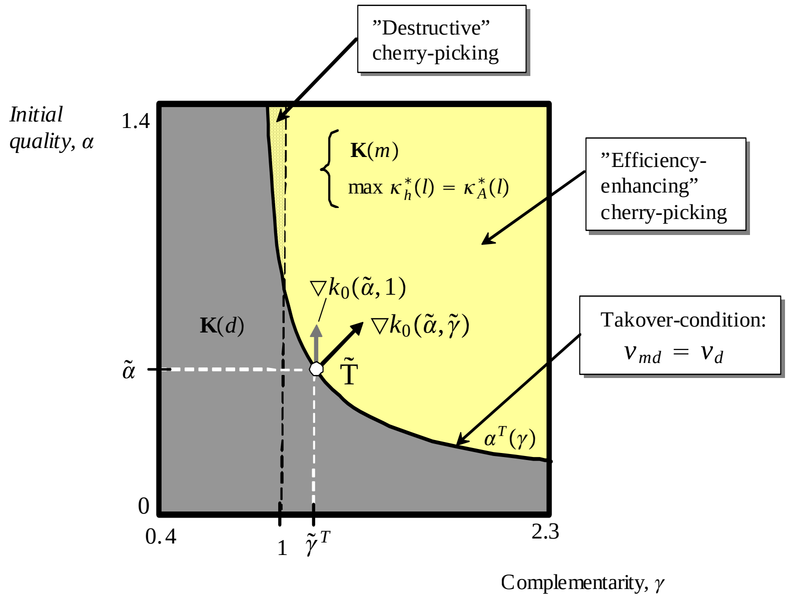

Figure 4.2: Illustrating Cherry-picking acquisitions in the LQC-model. Parameter values set at $M = 5$, $\Lambda = s = 5$, $\eta = 0.15$, $\tilde{c}_A = \tilde{c}_d = 0.3$, $\tilde{c}_G = 0$, $F_G = 2$ and $F_A = F_d = 0$.

also by the efficient use of these assets. Foreign acquisitions then tend to occur in the North-East direction of Figure 4.2, which indicates that the effective size of the domestic R&D assets k_0 will, in equilibrium, be larger under foreign ownership. This is illustrated by the gradients $\triangledown k_0(\alpha, 1) = [k'_{0,\alpha}(\alpha, 1), 0]'$ and $\triangledown k_0(\alpha, \gamma) = [k'_{0,\alpha}(\alpha, \gamma), k'_{0,\gamma}(\alpha, \gamma)]'$. Note that the gradient under foreign ownership $\triangledown k_0(\alpha, \gamma)$ tends to be larger than the gradient under maintained domestic ownership $\triangledown k_0(\alpha, 1)$. From Definition 1, the effective quality k_0 solely increases from the initial quality α under domestic ownership whereas under foreign ownership, the efficient quality increases both due to initial quality α and synergies γ. This also implies that the R&D investments generated from ownership of the R&D assets k_0 will be the largest under foreign ownership: according to Assumption A1, R&D investments by the acquiring MNE $\kappa_A^*(m)$ and the domestic firm $\kappa_d^*(d)$ increase in the quality of the domestic assets k_0, whereas the R&D investments of greenfield entrants $\kappa_G^*(l)$ decrease in k_0. This is also the case in Figure 4.2 which uses the LQC model. Figure 4.3 further shows that the difference in R&D sequential investments between the acquiring MNE and a greenfield entrant, as well as the difference as compared to the domestic firm, is increasing when MNEs make a more efficient use of assets of higher quality. Consequently, we can state the following Corollary:

Corollary 1. *In the LQC model, cherry-picking acquisition tends to be "efficiency-enhancing" and, therefore, R&D investments tend to be larger in acquired affiliates as compared to R&D investments in greenfield affiliates* $\kappa_A^*(m) > \kappa_G^*(l)$*, as well as compared to R&D investments in the domestic firm (had this firm remained under domestic ownership)* $\kappa_A^*(m) > \kappa_d^*(d)$.

Foreign acquisitions driven by the efficient use of high-quality domestic assets can thus account for the empirical evidence developed in Section 2. Acquired affiliates are found to invest more in R&D than affiliates created by greenfield entry. In the empirical analysis, we used R&D intensities (observation 1) and propensities to conduct R&D (observation 2) to highlight this pattern. Using the LQC model, it is straightforward, but tedious, to show that the efficient use of high-quality domestic assets in foreign acquisitions can also explain why R&D intensities $RD_i(l) = \frac{C(\kappa_i^*(l))}{P(l)q_i^*(l)}$ are higher in acquired affiliates, as well as why the propensities to conduct R&D are higher in acquired affiliates.[20]

4.2. Why has the "R&D gap" between acquired and greenfield affiliates decreased?

While policy makers have, in general, welcomed inward greenfield FDI, they have been much more sceptical towards FDI taking the form of cross-border acquisitions. However, the attitude was gradually becoming more positive until the very end of the twentieth century when a return of protectionism could be observed in the policy debate. Large privatization and liberalization programs started in the UK in the late 1970's and spread around the world.[21] In Sweden, firms have faced lower costs of acquiring firms located in other EU countries since the implementation of the single market program and the Swedish EU membership in the 1990's. The development of a well-functioning global capital market has also made cross-border acquisitions less complicated

[20] To examine the extensive margin of R&D, suppose that a share β of the fixed costs F_i of the MNEs could be reduced by choosing not to conduct R&D. Assuming this cost to be sunk for the domestic firm (as previously), it follows from Definition 1 and Assumption A1 that acquired affiliates are more likely to conduct R&D due to the possession of the R&D assets $k_0(\alpha, \gamma)$ when initial quality and synergies are large, while greenfield entry would be less likely to set up an R&D center. Alternatively, if an acquisition of R&D assets simply reduces the fixed costs F_i of conducting R&D when pre-existing assets can be used, acquired affiliates would also be more likely to conduct R&D.

[21] In Sweden, for instance, the restrictions on foreign acquisitions were rigorous in the 1970's, but were basically abolished in the 1990's. See Henrekson and Jakobsson (2003).

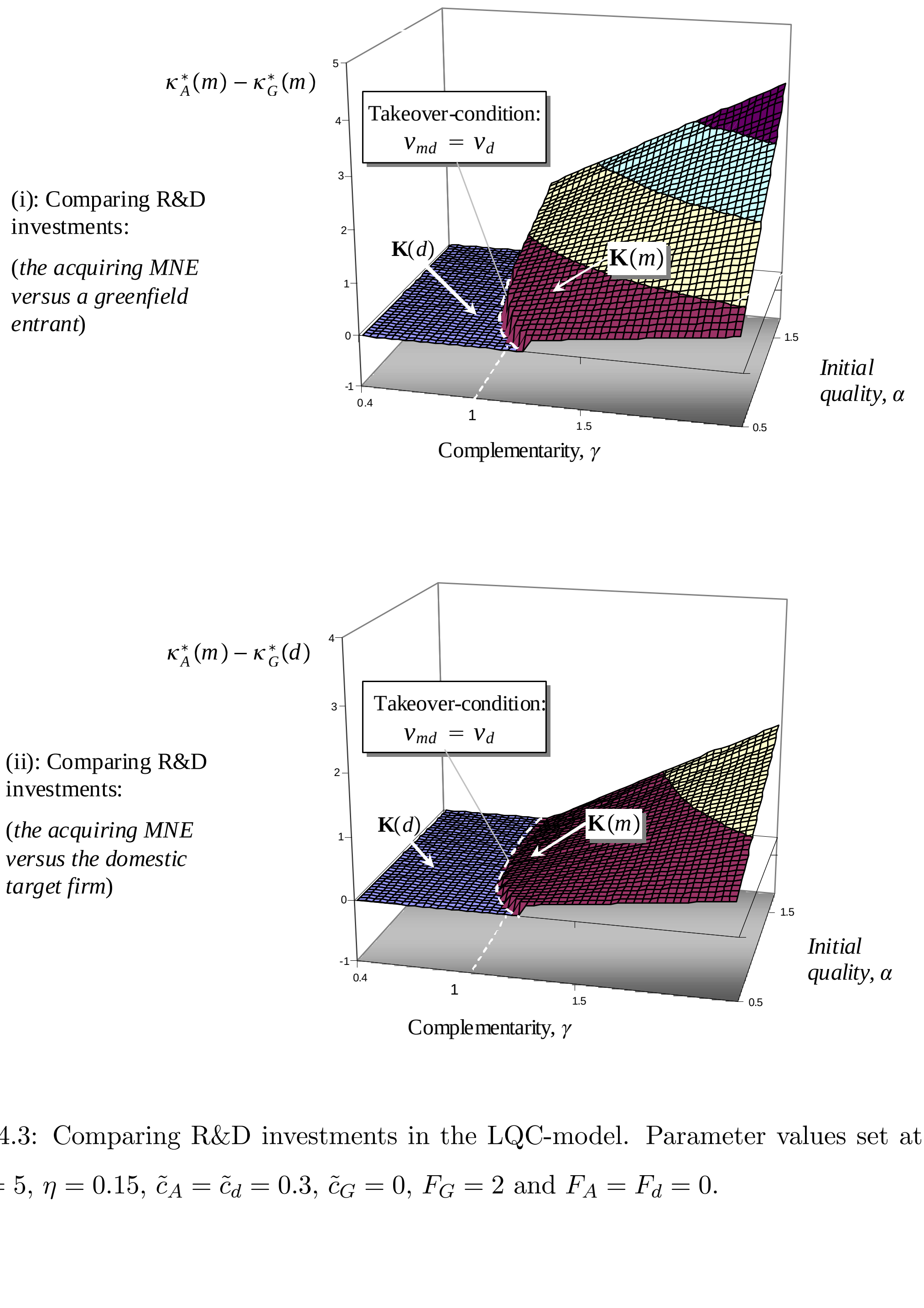

Figure 4.3: Comparing R&D investments in the LQC-model. Parameter values set at $M = 5$, $\Lambda = s = 5$, $\eta = 0.15$, $\tilde{c}_A = \tilde{c}_d = 0.3$, $\tilde{c}_G = 0$, $F_G = 2$ and $F_A = F_d = 0$.

and costly. Consequently, the transaction costs generated by cross-border operations are likely to have decreased between the 1970's and the 1990's. This transaction cost reduction might have been more substantial for international M&As than for greenfield investments, which may explain why M&As as an entry mode has overtaken greenfield FDI in Figure 2.1.

To examine the effects of a reduction in foreign takeover transaction costs, we differentiate the takeover condition $v_{md} = v_d$ in fixed costs of acquisition $\bar{F}_A$ and synergies γ:

$$\left.\frac{d\gamma^{ED}}{d\bar{F}_A}\right|_{v_{md}=v_d} = \left[\frac{d\pi_A(m)}{dk_0}k'_{0,\gamma}\right]^{-1} > 0. \tag{4.6}$$

It follows that reduced transactions costs $\bar{F}_A$ imply that smaller synergies, or complementarities, are needed to make foreign acquisitions profitable. This is shown in Figure 4.4 (i) where γ^T is reduced to $\tilde{\gamma}^T$ from a fall in $\bar{F}_A$ to $\tilde{F}_A$, thus increasing the takeover valuation from v_{md} to $\tilde{v}_{md}$. In Figure 4.4 (ii), we display the effect on equilibrium investments. Note that since marginal acquisitions occur at lower synergies, the difference between investments in acquired affiliates $\kappa_A^*(m)$ and other investments $\kappa_h^*(l)$ decreases. In particular, as displayed in Figure 4.4 (iii), investments in greenfield affiliates may be higher than in acquired affiliates after a liberalization, $\kappa_A^*(m) < \kappa_G^*(m)$ at synergies close to the marginal, $\tilde{\gamma}^T$.[22]

Consequently, we can state the following result:

Proposition 4. *A reduction in foreign takeover transaction costs will (i) increase the incentives for cross-border acquisitions and (ii) imply that cross-border acquisitions associated with lower sequential R&D investment will take place in equilibrium.*

This result is interesting in the light of the deregulation of foreign ownership around the world since the 1980s. Our model may thus explain why we find the R&D gap in favor of acquired affiliates to be larger in the 1970's than in the 1990's; decreased transaction costs may have induced a larger number of but less efficient M&As (observation 3 in Section 2).

5. Welfare effects of blocking foreign takeovers

Let us now turn to an evaluation of the welfare effects of cross-border M&A. The conventional welfare evaluation of M&As and market structures in an international oligopoly is typically made

[22] From (4.6), it also follows that smaller transaction costs will shift the takeover locus $\alpha^T(\gamma)$ in Figure 4.2 inwards. It implies that the efficient size of the domestic R&D assets $k_0(\alpha,\gamma)$ will be smaller under foreign ownership, thus leading to a smaller difference in R&D investment in acquired and greenfield affiliates.

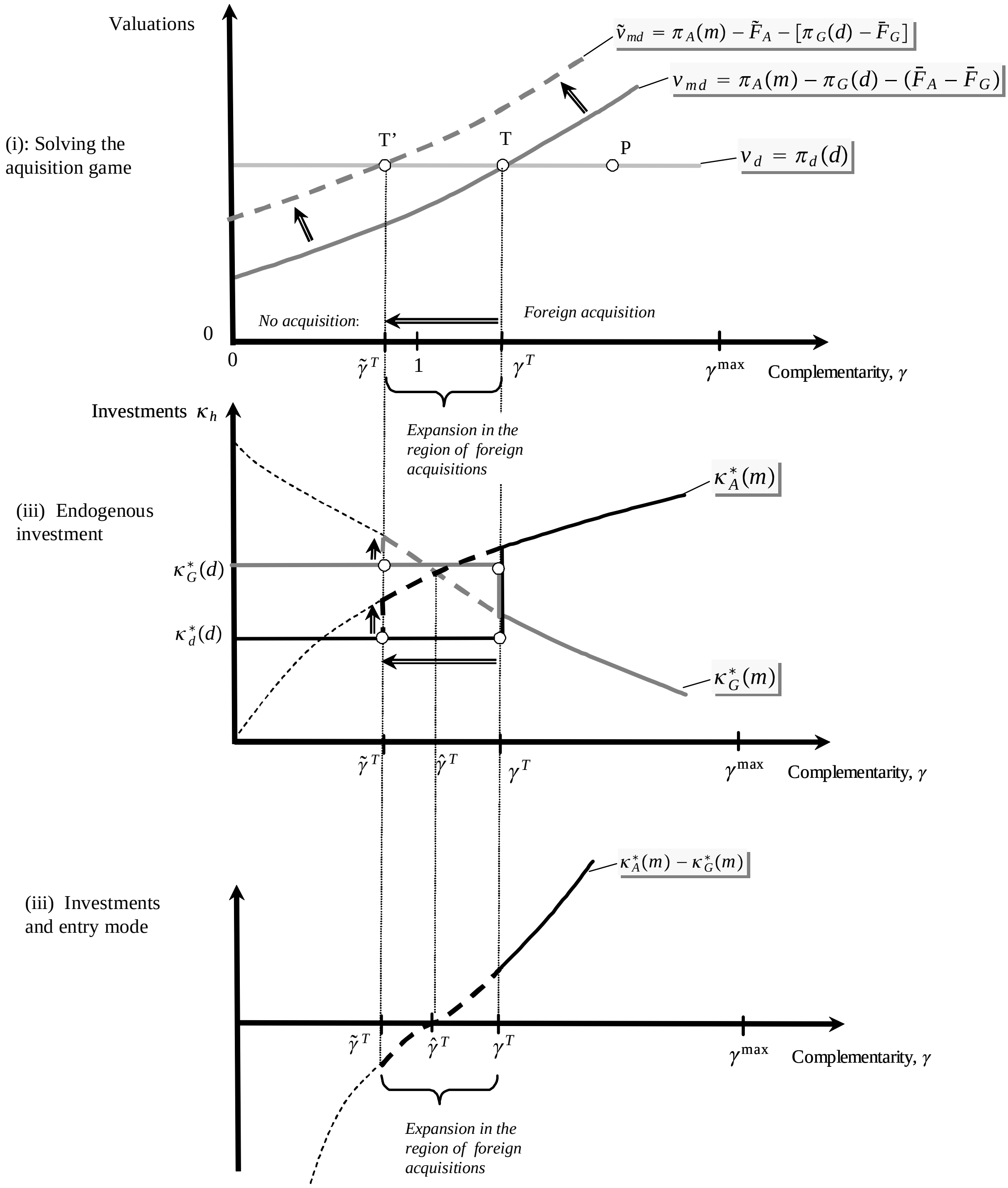

Figure 4.4: Illustrating the effects of a reduction in foreign takeover transaction costs

by comparing the sum of domestic consumer surplus and domestic profits in different market structures.

Then, we compare a Non-discriminatory (ND) policy where both greenfield entry and acquisition entry are allowed to a Discriminatory (D) policy which prohibits cross-border acquisitions. It follows that the ND- and D-policies only differ when an MNE acquires the domestic assets k_0 under the ND-policy. Let $PS(l)$ and $CS(l)$ denote the producer and consumer surplus when the ownership of k_0 is $l = (d, m)$ and let welfare under ownership l be $W(l) = PS(l) + CS(l)$. Defining the difference in welfare $W^{ND-D} = W(m) - W(d)$, and rearranging terms, we obtain:

$$W^{ND-D} = \underbrace{[S^* - v_d]}_{\text{Sales premium}} + [CS(m) - CS(d)], \tag{5.1}$$

if an acquisition occurs under the ND-policy. The first term in (5.1) captures the difference in producer surplus, i.e. the sales premium, and the second term captures the difference in consumer surplus.

The welfare effects of cross-border acquisitions will depend on how efficiently the domestic assets are used, how sequential R&D investments are affected and how market power is changed. Due to the complexity of the effects involved in the model presented above, it is not possible to derive any unambiguous results on the total welfare effect of blocking foreign acquisitions. Thus, to address this issue in more detail, we will use the Linear-Quadratic Cournot model. Let $K(l) = k_0(l) + \sum_{i=1}^{N(l)} \kappa_i^*(l)$ denote the aggregate level of R&D assets under ownership $l = d, m$. Calculations show that:

$$\frac{dK(l)}{dk_0} = 1 + \frac{s\,(N(l)+1)}{(1 + 2N(l) + N(l)^2 - 2N(l)\eta)} > 0, \tag{5.2}$$

where $1+2N(l)+N(l)^2-2N(l)\eta > 0$ is required for a well-behaved equilibrium in the investment game in stage two. Thus, total R&D assets $K(l)$ are increasing in the effective quality of the R&D assets, i.e. the investments in R&D by the possessor of k_0 increase more than the reduction of R&D by rivals when there is an increase in quality. It can then be shown that total output $Q^*(l)$ increases in k_0, consumer prices $P^*(l)$ decrease in k_0 and hence, that the consumer surplus is increasing in effective quality, $\frac{dCS(l)}{dk_0} > 0$.

We can now illustrate the welfare effects of cross-border acquisitions. Figure 5.1(i) gives the Equilibrium Ownership Structure (EOS). When allowed under the ND-policy, foreign acquisitions occur in the North-East direction, with takeover acquisitions being replaced by preemptive

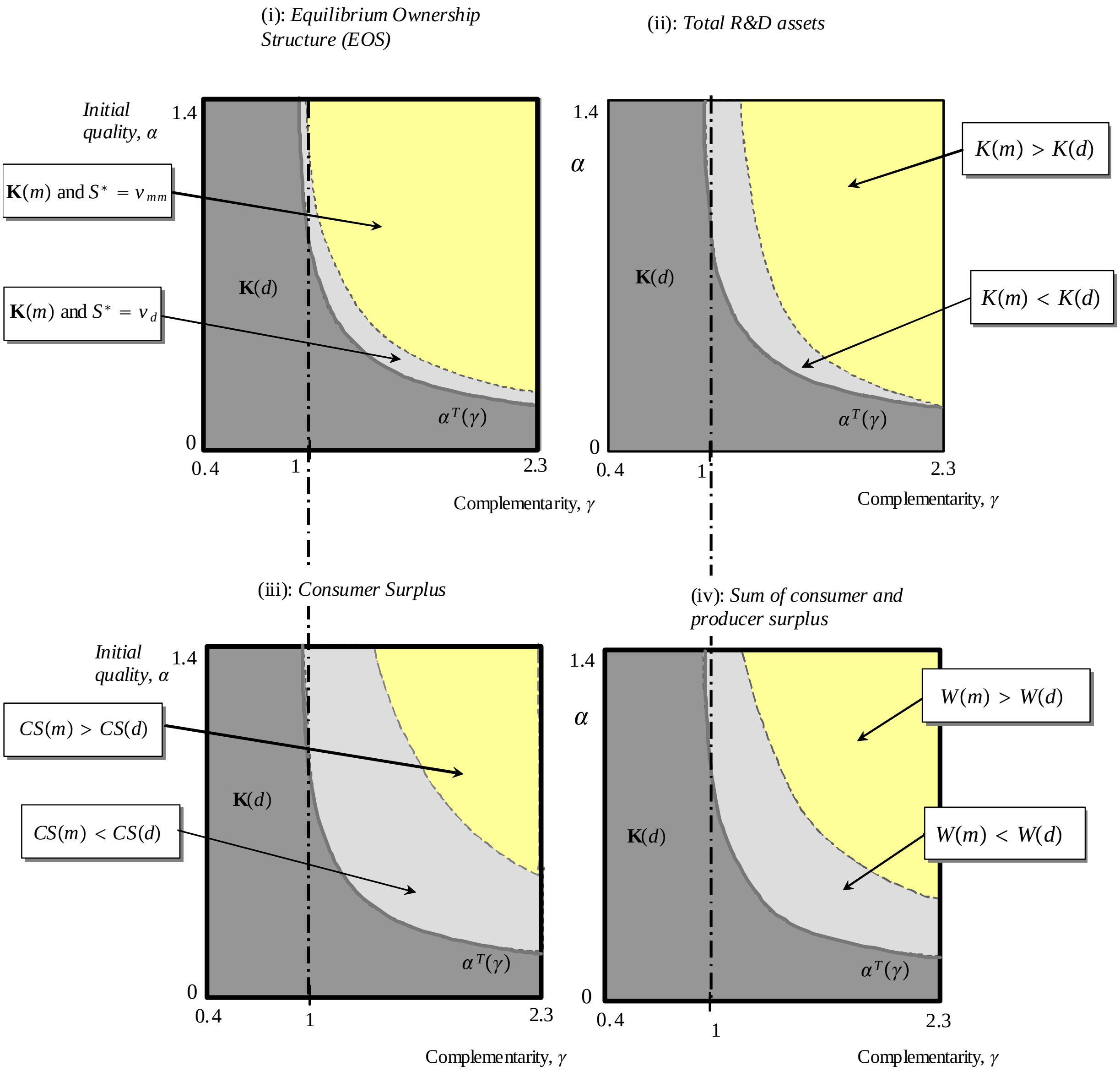

Figure 5.1: Illustrating welfare effects in the LQC model. Parameter values set at $M = 5$, $\Lambda = s = 5$, $\eta = 0.15$, $\tilde{c}_A = \tilde{c}_d = 0.3$, $\tilde{c}_G = 0$, $F_G = 2$ and $F_A = F_d = 0$.

foreign acquisitions when synergies and initial quality increase. Figure 5.1(ii) then shows how total R&D assets $K(l)$ in the host economy are affected by cross-border merger policy. As expected from (5.2), when foreign acquisitions occur for high synergies γ and initial quality α, total R&D assets are higher under the ND-policy, $K(m) > K(d)$. Total R&D assets may be lower under foreign ownership when synergies are limited due to the concentration effect of an acquisition. Nevertheless, from the profitability requirement of an acquisition $v_{md} = v_d$, the area where $K(m) < K(d)$ is limited, thus weakening the arguments in favor of blocking cross-border mergers in order to prevent a reduction of domestic R&D activities.

In Figure 5.1(iii), we show the relationship between equilibrium cross-border acquisitions and consumer surplus. For medium-high levels of complementarities and initial quality levels, cross-border M&As can decrease the consumer surplus due to the concentration effect, whereas at high complementarities and initial qualities, consumers gain from allowing cross-border M&As. Thus, the effects of cross-border acquisitions on consumers display a mirror image of the effects on total R&D assets, $K(l)$.

Finally, considering the total surplus, adding profits and the acquisition price to the consumer surplus, the region where non-discriminatory policy is preferred increases. This is illustrated in Figure 5.1(iv). In a comparison with Figure 5.1(i), the sales premium $v_{mm} - v_d$ is also increasing in the north-east direction since MNEs enter into preemptive bidding over increasingly efficient R&D assets $k_0(\alpha, \gamma)$.

We have derived these four types of pictures for a large set of different parameter values in the LQC model. The general emerging picture is that blocking foreign acquisition can be welfare improving if and only if the combination of synergies γ and initial quality α is sufficiently low. However, this does not imply that an interventionist policy might increase welfare. First, a large share of the potentially welfare-reducing foreign acquisitions are blocked by market forces, i.e. they are not profitable when allowed. Second, while blocking "cherry picking" acquisitions of high-qualitative targets predominantly driven by market power incentives can be warranted, such policies can also backfire. As illustrated by Figure 5.2, the potential welfare benefit of cross-border M&As with high synergies is also higher when the target firm's assets are of higher quality. Thus, the welfare cost of blocking cross-border M&As can be very high when target firm's assets are of higher quality.

To summarize:

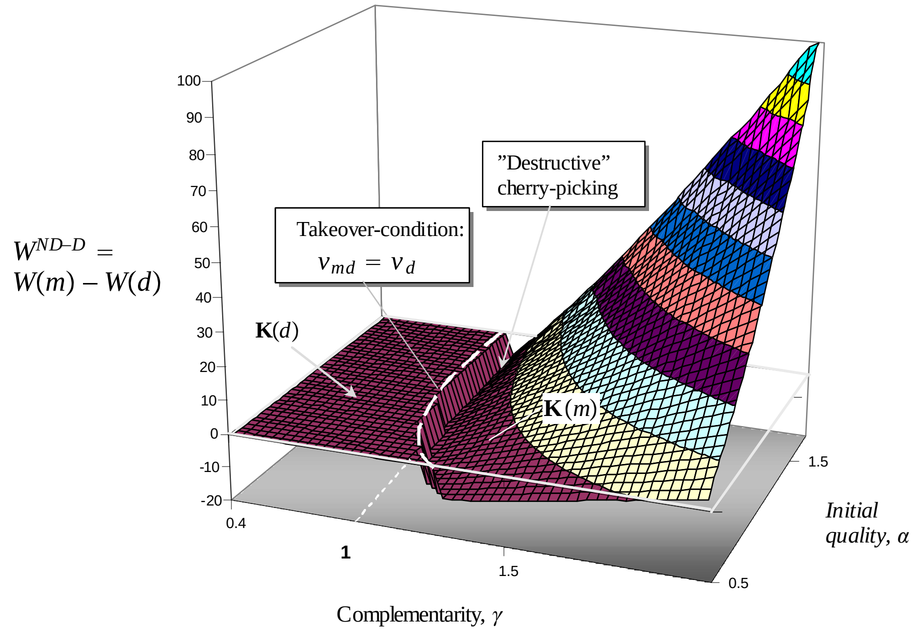

Figure 5.2: Illustrating the high welfare cost of blocking cross-border M&As, W^{ND-D}, when target firm's assets are of high quality, α. Parameter values set at $M = 5$, $\Lambda = s = 5$, $\eta = 0.15$, $\tilde{c}_A = \tilde{c}_d = 0.3$, $\tilde{c}_G = 0$, $F_G = 2$ and $F_A = F_d = 0$.

Proposition 5. *In the Linear-Quadratic Cournot Model: (i) restricting cross-border acquisitions will increase the domestic consumer surplus, the total surplus and total R&D assets in the host country if and only if γ and α are sufficiently low. (ii) a large share of the welfare reducing foreign acquisitions are blocked by market forces, i.e. they are not profitable when allowed. (iii) the expected welfare gain of restricting cross-border acquisitions is not necessarily higher for targets with high-quality R&D assets since the risk of blocking foreign acquisitions generating large efficiency gains is then higher.*

In the case of acquisitions of R&D-intensive firms, the welfare effects of cross-border acquisitions could also depend on their effects on other agents than capital owners and consumers in the considered industry of the host country. For instance, R&D investment may increase the demand for high skilled labor, i.e. jobs associated with high job satisfaction and wage premiums. R&D investment may also create positive technological spillovers in the economy. Adding a term $\beta\left[K(m) - K(d)\right]$ to the welfare expression in (5.1), we then have:

$$W^{ND-D} = [S^{*} - v_d] + CS(m) - CS(d) + \beta\left[K(m) - K(d)\right].$$

It then directly follows from Figure 5.1 that the Non-discriminatory policy would be preferable in an even larger parameter range when evaluating aggregate R&D $K(l)$ in excess and its effect on total surplus in the national economy.[23]

6. Conclusions

In the policy arena, inward foreign direct investments are believed to generate R&D investments and spillovers and should therefore be encouraged. An exception is the foreign acquisition of "R&D national champions", which is feared to have negative effects on future domestic R&D activities. To examine the validity of this argument, we first examine unique micro data on R&D investments in affiliates of Swedish multinational firms in 34 countries during the period 1970-1998. To support a pro-greenfield and anti-international M&As policy, greenfield FDI should be associated with larger sequential R&D investments than acquisition FDI in the data. In contrast, we find that acquired affiliates invest more in R&D than greenfield affiliates. To explain this pattern, we then construct an acquisition-investment-oligopoly model, where MNEs first choose their entry mode and then decide the level of their (sequential) R&D investments.

[23] In the LQC model, it is also straightforward to introduce explicit spillovers between firms.

A key mechanism in the model is that market forces tend to make acquisitions with low synergies unprofitable, since rival firms will then expand their R&D investments, making cross-border M&As fail. While the model shows that welfare reducing market-power driven foreign acquisitions of domestic firms with high-quality assets can arise in equilibrium, the merger profitability requirement implies that foreign acquisitions tend to be efficiency-enhancing. In turn, this implies that acquired affiliates will not only invest more in R&D than affiliates established through greenfield entry, but also that foreign acquisitions will lead to an increase in R&D investment in the target firm after the acquisition. It is also shown that sequential R&D investments following efficiency-enhancing acquisitions can result in significant welfare gains. These findings suggest that competition policy, but not a discriminatory policy towards foreigners, might play an important role in the host country.

How much of the higher R&D intensity of the acquired affiliates is due to synergies in the acquisition and how much is due to a high initial quality of the target firm's R&D assets? It might be argued that this question is best studied by examining the pre- and post-performance of target firms, where our model predicts that R&D intensity would increase after a foreign acquisition and increase substantially if synergies are large. In the IFN data, there is no information on the targets prior to the acquisition, so this hypothesis must be tested in other data sources. However, it is important to stress the problem associated with a comparative pre- versus post-acquisition analysis in oligopolistic markets. As shown in Figure 4.1(iii), the increase in R&D generated by an acquisition would be inflated by the market power effect. This will produce an upward bias on estimates of potential synergies arising in an acquisition in regressions investigating the pre- and post-performance of the target firm. In contrast, our comparison between acquired affiliates and greenfield affiliates does control for this market power effect which suggests that our empirical approach is less likely to suffer from such a bias.

Future work could examine in more detail how ex-ante MNE characteristics affect potential synergies and sequential R&D investments in a strategic acquisition-investment-oligopoly framework. Table A4 in the appendix contains a simple probit regression as an illustration. This regression shows that larger MNEs choose acquisitions as the entry mode, whereas more R&D intensive and more productive MNEs prefer greenfield entry. Given that firms invest more in R&D in acquired affiliates, this may suggest that efficient MNEs will use greenfield affiliates for assembly and marketing, while keeping their R&D activities at home to avoid technology transfer costs.[24] In contrast, less efficient MNEs need to exploit synergies associated with the domestic target firm's assets in order to make the acquisition profitable. Consequently, in the perspective of host country R&D, the largest positive externalities might not come from the investor with the highest productivity, but rather from the investor with the largest gain from acquiring local R&D assets.

References

[1] Barba Navaretti, Giorgio and Anthony Venables (2004), *Multinational Firms in World Economy*, Princeton University Press.

[2] Belderbos, René (2003), "Entry Mode, Organizational Learning, and R&D in Foreign Affiliates: Evidence from Japanese Firms", *Strategic Management Journal*, 24(3), pp. 235-59.

[3] Bernard, Andrew; Eaton, Jonathan; Jensen, Bradford; Kortum, Samuel (2003), "Plants and Productivity in International Trade", *American Economic Review*, 93(4), pp. 1268-1290.

[4] Bertrand, Olivier and Habib Zitouna (2006), "Trade Liberalization and Industrial Restructuring: the Role of Cross-Border Mergers and Acquisitions", *Journal of Economics and Management Strategy*, 15(2), pp. 479-515.

[5] Bjorvatn, Kjetil (2004), "Economic Integration and the Profitability of Cross-Border Mergers and Acquisitions", *European Economic Review*, 48(6), pp. 1211-26.

[6] Blonigen, Bruce (1997), "Firm-Specific Assets and the Link Between Exchange Rates and Foreign Direct Investment", *American Economic Review*, 87(3), pp. 447-65.

[7] Ekholm, Karolina and Marie Hesselman (2000), "The Foreign Operations of Swedish Manufacturing Firms: Evidence from a Survey of Swedish Multinationals 1998", Working Paper No. 540, Research Institute of Industrial Economics.

[8] Falvey, Rod (1998), "Mergers in open economies, " *The World Economy*, 21, pp. 1061-1076.

[9] Ginarte, Juan Carlos and Walter G. Park (1997), "Intellectual Property Rights and Economic Growth", *Contemporary Economic Policy,* 15(3), pp. 51-61.

[24] Norbäck (2001) finds indirect evidence of technology transfer costs affecting the location decision of Swedish multinational firms. Helpman, Melitz and Yeaple (2006) find a similar effect in their sample.

[10] Girma, Sourafel; Greenaway, David; Wakelin, Katharine (2001): "Who benefits from Foreign Direct Investment in the UK?", *Scottish Journal of Political Economy*, 48, pp. 119-133.

[11] Graham, Edward and David Marchick, 2006, US National Security And Foreign Direct Investment, Institute for International Economics,

[12] Head, Keith and John Reis (1997), "International Mergers and Welfare under Decentralized Competition Policy", *Canadian Journal of Economics*, 30(4), pp. 1104-23.

[13] Head, Keith (1998): "Comment on 'Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States", in Baldwin, R., R. Lipsey and J.D. Richardson (eds.), Geography and Ownership as Bases for Economic Accounting, Chicago University Press, pp. 255-258.

[14] Head, Keith and John Ries (2006) "FDI as an Outcome of the Market for Corporate Control: Theory and Evidence", *Journal of International Economics*, forthcoming.

[15] Helpman, Elhanan; Melitz, Marc; Yeaple, Stephen (2004), Export versus FDI with Heterogeneous Firms , *American Economic Review*, 94(1), pp. 300-316.

[16] Henrekson, Magnus and Ulf Jakobsson (2003), "The Transformation of Ownership Policy and Structure in Sweden: Convergence towards the Anglo-Saxon Model?", *New Political Economy*, 8(1), pp.73-102.

[17] Horn, Henrik and Lars Persson (2001), "The Equilibrium Ownership of an International Oligopoly," *Journal of International Economics,* 53 (2), pp. 307-333.

[18] Håkanson, Lars and Robert Nobel (1993), "Foreign Research and Development in Swedish Multinationals", *Research Policy*, 22, 5-6, pp. 373-96.

[19] ITPS (2002) *Structural Study of the Business Sector in Sweden 1999,* Official Statistics of Sweden s2002:002,

ITPS Swedish Institute for Growth Policy studies

[20] Klimenko, Mikhail and Kamal Saggi, "Technical compatibility and the mode of foreign entry with network externalities, *Canadian Journal of Economics*, forthcoming.

[21] Lommerud, K.E., Straume O.R. and Sorgard, L., (2006), "National versus international mergers in unionized oligopoly," *RAND Journal of Economics*, 37, pp. 212-233.

[22] Markusen, John (2002), Multinational Firms and the Theory of International Trade, Cambridge, MA: MIT Press.

[23] Markusen, John (1995), The Boundaries of Multinational Enterprises and the Theory of International Trade, *Journal of Economic Perspective,* 9, pp. 169-189.

[24] Mattoo, Aaditya; Olerreaga, Marcelo; Saggi, Kamal (2004), "Mode of Foreign Entry, Technology Transfer, and FDI Policy", *Journal of Development Economics,* 75(1), pp. 95-111.

[25] Neary, Peter (2002), "Foreign competition and wage inequality," *Review of International Economics*, 10(4), pp. 680-693.

[26] Neary, Peter (2007), "Cross-border mergers as instruments of comparative advantage," *Review of Economic Studies*, 74(4), pp. 1229-1257.

[27] Nocke, Volker and Stephen Yeaple (2008), "An Assignment Theory of Foreign Direct Investment", *Review of Economic Studies*, forthcoming.

[28] Nocke, Volker and Stephen Yeaple (2007), "Cross-border Mergers and Acquisitions versus Greenfield Foreign Direct Investment: The Role of Firm Heterogeneity," *Journal of International Economics,* 72(2), pp. 336-365.

[29] Norbäck, Pehr-Johan (2001) "Multinational Firms, Technology and Location", *Journal of International Economics,* 54(2), pp. 449-69.

[30] Norbäck, Pehr- Johan and Lars Persson (2007) "Investment Liberalization - Why a Restrictive Cross-Border Merger Policy can be Counterproductive", *Journal of International Economics,* 72(2), pp. 366-380.

[31] Norbäck, Pehr-Johan and Lars Persson (2008) "Globalization and Profitability of Cross-border Mergers & Acquisitions", *Economic Theory,* 35(2), pp. 241-266.

[32] Odagiri, Hiroyuki and Hideto Yasuda (1996) "The Determinants of Overseas R&D by Japanese Firms: An Empirical Study at the Industry and Company Levels", *Research Policy*, 25, pp. 1059–1079.

[33] OECD (1987), *Structural Adjustment and Economic Performance*, Paris.

[34] OECD (1992), *Industrial Policy in OECD Countries*, Paris.

[35] Raff, Horst; Ryan, Michael; Stähler, Frank (2005) "Asset Ownership and Foreign-Market Entry", Economics Working Paper no 2006-01,Christian-Albrechts-University of Kiel.

[36] Schenk, Hans (1996), "Bandwagon Mergers, International Competitiveness, and Government Policy", *Empirica*, 23, 3, pp. 255-78.

A. Appendix

A.1. The Linear Quadratic model

Table A.1: Optimal quantities as functions of ownership structure.

	Domestic ownership	Foreign ownership
l:	d	m
$\pi_h(l)$:	$\frac{1}{s}q_h^{*2}(d)\left[1-\frac{\eta}{2}\left(\frac{2N(d)}{N(d)+1}\right)^2\right]$	$\frac{1}{s}q_h^{*2}(m)\left[1-\frac{\eta}{2}\left(\frac{2N(m)}{N(m)+1}\right)^2\right]$
$q_A^*(l)$:		$\frac{s(N(m)+1)[\Lambda(1+N(m)-2N(m)\eta)-N(m)\hat{c}_A(1+N(m)-2\eta)]}{(1+N(m)-2N(m)\eta)(1+2N(m)+N^2(m)-2N(m)\eta)}$
$q_G^*(l)$:	$\frac{s(N(d)+1)[\Lambda(1+N(d)-2N(d)\eta)+\hat{c}_d(N(d)+1)]}{(1+N(d)-2N(d)\eta)(1+2N(d)+N^2(d)-2N(d)\eta)}$,	$\frac{s(N(m)+1)[\Lambda(1+N(m)-2N(m)\eta)+\hat{c}_A(N(m)+1)]}{(1+N(m)-2N(m)\eta)(1+2N(m)+N^2(m)-2N(m)\eta)}$
$q_d^*(l)$:	$\frac{s(N(d)+1)[\Lambda(1+N(d)-2N(d)\eta)-N(d)\hat{c}_d(1+N(d)-2\eta)]}{(1+N(d)-2N(d)\eta)(1+2N(d)+N^2(d)-2N(d)\eta)}$,	
Note:	$\eta \equiv \frac{s\theta^2}{\gamma}$, $\Lambda \equiv a-c$, $\hat{c}_A \equiv \tilde{c}_A - \gamma k_0$,	$\hat{c}_d \equiv \tilde{c}_d - k_0$, $\kappa_i^*(l) = \frac{\theta}{\mu}q_i^*(l)\frac{2N(l)}{N(l)+1}$.

A.2. Data Description

We use unique data from a survey of the foreign activities of Swedish multinational firms. This survey has been carried out by the Research Institute of Industrial Economics (IFN) since the 1970's. The purpose of this survey has been to collect information on the foreign operations of all Swedish firms with: (i) their main activity in the manufacturing sector, (ii) at least 50 employees, and (iii) at least one producing affiliate abroad and their domicile in Sweden. Data on R&D expenditures in affiliates is available from five surveys: 1970, 1978, 1990, 1994 and 1998.[25] The coverage of the survey data ranges between 77 to 95 percent for participating multinationals and 71 to 100 percent for their producing affiliates. Thus, the answering rate is very high both among parent firms and their affiliates. There is a slight decline in 1998 but the answering rate is still high, reaching almost 80 percent.

[25] Data **also exists** for 1965, 1974 and 1986, but these surveys do not include affiliate R&D.

Data allows us to follow the same multinational for several years. In earlier surveys, about 70 percent of the firms remain in at least two consecutive surveys. In later surveys, about half of the firms remain in the sample in two consecutive surveys. This decline may be due to a decrease in the answering rate. Another explanation is that several large Swedish MNEs such as Pharmacia, Astra, Volvo and SAAB were no longer included in the sample as they were acquired by or merged with foreign firms when the regulation against foreign acquisitions of Swedish firms was lifted in the 1990s.

The relative importance of foreign operations of Swedish MNEs has, however, increased during the period studied. In 1970, overseas employment was about 40 percent while in 1998, it had increased to almost 70 percent. Swedish multinationals play a crucial role in Sweden's manufacturing sector. In 1999, Swedish MNEs accounted for about 45 percent of the value added, 62 percent of Swedish exports, 43 percent of Swedish total manufacturing employment and roughly 62 percent of the R&D expenditures (ITPS, 2002).

Table A1 displays the distribution of affiliates in the sample by entry mode, year, region and industry.

A.3. Variables and Descriptive Statistics

In the regressions, we include a set of variables at the affiliate, parent and country level to control for other determinants of affiliate R&D. Most variables are expressed in log form and all variables with a monetary value are converted into US dollars in the constant value of 1995 (see tables A2 and A3 below for variable description and summary statistics). To measure R&D activity in the affiliates, we will use the R&D intensity of an affiliate i in time t, defined as:

$$RD_{it} = \frac{R\&D_{it}}{Sales_{it}} * 100 \tag{A.1}$$

where $R\&D_{it}$ is total outlays for R&D in affiliate i at time t and $Sales_{it}$ is the affiliate's corresponding total sales. Thus, we normalize R&D expenditures with total sales to control for size effects and express the intensity in percentage points. Using the intensity, we also control for omitted variables that have a similar effect on the affiliate's choice of R&D expenditures and sales.[26]

[26] Thus, to avoid endogeneity problems, we will not include affiliate size in the regressions as one of the explanatory variables.

Table A1. Entry mode of FDI.

Year	MA	GI	Total Number	Share in Total
1970	100	228	328	0.15
1978	154	227	381	0.18
1990	306	189	495	0.23
1994	346	202	548	0.25
1998	290	129	419	0.19
Total	1196	975	2171	1.00
Region				
Europe	916	565	1481	0.68
North America	178	181	359	0.17
South America	53	118	171	0.08
Other Developing Countries	26	61	87	0.04
Other Developed Countries	23	50	73	0.03
Total	1196	975	2171	1.00
Industry				
Resource-intensive	173	91	264	0.12
Labor-intensive	211	227	438	0.20
Scale-intensive	369	282	651	0.30
Differentiated Goods	350	260	610	0.28
Science Based	88	112	200	0.09
Total	1191	972	2163	1.00

At the affiliate level, we include the age of an affiliate, defined as the number of years that the affiliate has been part of the MNE (*Age*) and the export intensity of the affiliate (*Export*). Age captures the effect of time on affiliate R&D and Export the affiliate type. High export intensity may indicate that the affiliate is used as a hub for regional or world markets and such affiliates are more likely to function as R&D centers adapting technologies and creating new knowledge (see e.g. Håkansson and Nobel, 1993).

We control for the impact of the R&D intensity of the parent firm (*RD Parent*), the share of foreign R&D in total R&D of the parent firm (*RD Abroad*) and the number of years since the first overseas R&D investment of the parent firm (*Experience*). In general, the relationship between the parent firm's R&D and overseas R&D is not straightforward. On the one hand, a parent firm in a high-technology sector might require a high level of R&D expenditures abroad to adapt high-technology products to the local market and transfer technological knowledge. On the other hand, it may also be costly to protect propriety technologies from being dissipated. If such measures require large resources, the firm may concentrate R&D to the home country (Norbäck, 2001).

The overseas R&D activities may also be a function of corporate experience and growth. As the foreign operations become more important, the role of overseas R&D may change from supportive to creative, thus leading to an increase in affiliate R&D (see e.g. Odagiri and Yasada, 1996). The experience of overseas R&D is believed to promote the efficiency of R&D activities abroad and facilitate the coordination with the network of R&D centers. We add RD Abroad and Experience to capture these effects. Finally, we include the total size of the parent firm (*Size Parent*) and the labor productivity of the parent company (*Prod Parent*) as additional controling variables at the firm level.

Furthermore, we control for host country characteristics including income level (*GDP cap*), market size (*GDP*) and the distance between Sweden and the host country (*Distance*). It is likely that demand for R&D and the supply of assets with potential synergies arising from acquisitions are larger in countries with a higher development level and/or a higher market size. This would, in particular, be important for R&D investments in acquired affiliates.[27] The geographical distance may obstruct technology transfers by making communication as well as supervision of R&D activity abroad more difficult.

In the selection equation of the Heckman estimations (2.1), we add an index of property rights (*IPR*) from Ginarte and Park (1997). Multinational firms should be more reluctant to set up an R&D center when the protection for intellectual property rights is weak. Indeed, the IPR is expected to have a greater impact on the decision of whether to locate an R&D center abroad than on the level of R&D, since it constitutes one major determinant of anticipated total discounted future benefits from R&D activities. IPR may be less relevant for R&D intensity,

[27] M&As could, in fact, be an unrealistic alternative for greenfield investments if the supply of suitable target firms is limited as in developing countries with underdeveloped asset markets. Besides, foreign acquisitions are restricted in many developing countries. On the other hand, in some situations greenfield investment is not an alternative to M&As. For instance, during financial crises or large privatization programs, the supply of target firms overshadows the role of greenfield entry. We partly control for these last two aspects by introducing year, regional and industries dummies.

since improved property rights protection may increase both R&D expenditures and affiliate sales. In the selection equation, we also add affiliate size since a larger affiliate is expected be more likely to perform R&D.

We use dummy variables for year, industry and region.[28] Our industry dummy variables are defined as five broader categories according to a taxonomy in OECD (1987, 1992): resource intensive, labor intensive, scale intensive, differentiated goods and science based goods. We use regional dummy variables defined as five main geographical areas, Europe, North America, South America, Developing Countries in Asia and Africa and Developed Countries in Asia and Pacific.

Table A2. Variable description.

Variable name	Definition	Source
Age	ln(the number of years the affiliate has been part of the corporation)	IFN
Export	affiliate exports to sales	IFN
Size Affiliate	ln(affiliate sales)	IFN
Size Parent	ln(total corporate sales)	IFN
Prod Parent	$\ln(\frac{total\ sales}{total\ number\ of\ employees} * 100)$	IFN
RD Parent	$\ln(\frac{R\&D}{total\ sales} * 100)$	IFN
RD Abroad	$\frac{(total\ parent\ R\&D - parent\ R\&D\ in\ Sweden)}{total\ parent\ R\&D}$	IFN
Experience	ln(the number of years since the first R&D investment abroad)	IFN
Distance	ln(the greater circle distance between capitals)	Penn World Tables
GDP cap	ln(GDP per capita)	WDI, World Bank
GDP	ln(GDP)	WDI, World Bank
IPR	Index of intellectual property rights	Ginarte and Park (1997)
Past number of MAs	The number of M&As in the country over the last three years within the industry	IFN
Exchange rate	$\frac{local\,currency\,per\,USD_t}{local\,currency\,per\,USD_{t-5}}$	Penn World Tables

[28] We also use country and/or parent firm dummies. This does not qualitatively change our conclusions. We do not report these results, but they are available upon request.

Table A3. Summary Statistics.

Variable	Mean	Std. Dev.
Age	14.264	16.325
Export	0.242	0.295
Size Parent[1]	7.187	1.807
Prod Parent[1]	2.205	0.829
RD Parent[1]	0.574	0.979
RD Abroad	0.301	0.282
Experience	16.191	22.814
Distance[1]	7.594	1.095
GDP[1]	27.141	1.432
GDP cap[1]	9.713	0.853
IPR	4.044	3.734
Size Affiliate[1]	109.77	165.51
Number of obs.	2063	

Notes: 1) variables are expressed in log form. All variables with a monetary value are converted into US dollars in the constant value of 1995.

A.4. Entry Mode Choice

In the probit model for entry mode choice (Table A4 below), we use two additional variables in the that have an impact on the trade-off between M&A and greenfield investment: *Exchange rate* and *Past Number MAs*. *Exchange rate* gives the units of local currency per USD at time t related to the units of local currency per USD at $t-5$. A higher value of the variable implies a currency depreciation in the last five years and hence a lower price for acquisition objects. It is expected to increase FDI through M&As as shown by Blonigen (1997). *Past Number MAs,* defined as the number of Swedish M&As within an industry in a country over the last three years, captures both the behavior of MNEs and the supply of local targets. MNEs may first acquire to imitate each other and then to minimize their business risk (Schenk, 1996) or to obtain market power and/or prevent competitors from having an advantage in a country. It should be noted that the variable GDP also proxies the target supply: larger countries are more likely to have a higher M&A activity.

Table A4. Probit regression for the mode of entry: MA or greenfield.

Variable	Probit
Age	-0.121**
	(0.059)
Export	-0.086
	(0.246)
Size Parent	0.170***
	(0.039)
Prod Parent	-0.797***
	(0.235)
RD Parent	-0.179**
	(0.079)
RD Abroad	0.765**
	(0.301)
Experience	-6.04E-05
	(0.004)
Distance	-0.151
	(0.166)
GDP	0.021
	(0.072)
GDP cap	-0.324
	(0.229)
IPR	0.293
	(0.183)
Exchange rate	-9.17E-06***
	(0.000)
Past MA	0.021*
	(0.013)
Labor intensive	-0.218
	(0.221)
Scale intensive	0.033
	(0.196)
Differentiated goods	-0.137
	(0.228)
Science based	-0.581*
	(0.314)
Constant	2.562
	(2.824)
No. obs	631
Pseudo R2/R2	0.22

Note: Standard errors in parenthesis. *** significant at the one,** at the fiveand * at the ten percent level. Time and region dummies are included.

Table 1. Pooled Heckman estimations.

	First stage	Second stage	First-Stage Probit		Second-Stage OLS	
Variable	Probit	OLS	Age≤8	8<Age≤20	Age≤8	8<Age≤20
MA_GI	0.347***	0.376***	0.410***	0.316**	0.333**	0.534***
	(0.077)	(0.091)	(0.127)	(0.136)	(0.163)	(0.165)
Age	-0.006**	-9.6E-05	-0.001	-0.004	-0.006	-0.003
	(0.003)	(0.003)	(0.024)	(0.016)	(0.027)	(0.015)
Export	0.371***	0.966***	0.539***	0.488*	0.761***	1.198***
	(0.124)	(0.141)	(0.180)	(0.231)	(0.215)	(0.238)
Size Parent	-0.247***	-0.113***	-0.245***	-0.151***	-0.107***	-0.042
	(0.026)	(0.022)	(0.038)	(0.048)	(0.029)	(0.038)
Prod Parent	0.171	0.277*	0.345*	-0.048	0.517***	-0.174
	(0.125)	(0.143)	(0.182)	(0.260)	(0.197)	(0.262)
RD Parent	0.414***	0.791***	0.491***	0.379***	0.840***	0.866***
	(0.047)	(0.067)	(0.064)	(0.085)	(0.085)	(0.131)
RD Abroad	1.201***	1.515***	1.583***	0.636**	2.195***	0.960***
	(0.149)	(0.197)	(0.220)	(0.285)	(0.280)	(0.317)
Experience	0.017***	0.003	0.005*	0.012***	-0.007**	0.008**
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)
Distance	-0.235***	-0.452***	-0.465***	0.070	-0.564***	-0.108
	(0.088)	(0.120)	(0.152)	(0.215)	(0.193)	(0.226)
GDP	-0.035	0.176***	-0.047	-0.090	0.143**	0.068
	(0.038)	(0.042)	(0.058)	(0.075)	(0.063)	(0.076)
GDP cap	-0.063	-0.144	-0.112	0.142	-0.199	0.589
	(0.131)	(0.217)	(0.246)	(0.407)	(0.332)	(0.417)
IPR	0.250**	0.131	0.369**	0.135	0.319	-0.153
	(0.101)	0.139	(0.167)	(0.199)	(0.230)	(0.252)
Size Affiliate	0.412***		0.420***	0.372***		
	(0.033)		(0.049)	(0.060)		
Labor intensive	0.030	0.258*	0.114	-0.001	0.096	0.611**
	(0.129)	(0.145)	(0.192)	(0.247)	(0.200)	(0.294)
Scale intensive	-0.109	0.073	-0.090	0.127	0.129	0.757***
	(0.116)	(0.140)	(0.160)	(0.235)	(0.175)	(0.280)
Differentiated goods	0.286**	0.753***	0.509***	0.341	0.799***	1.427***
	(0.22)	(0.143)	(0.172)	(0.237)	(0.192)	(0.294)
Science based	-0.054	1.011***	-0.082	0.293	0.719***	1.710***
	(0.168)	(0.184)	(0.266)	(0.309)	(0.255)	(0.339)
Constant	1.076	-3.295	0.100	-1.663	-1.733	-10.772**
	(1.610)	(2.404)	(2.886)	(4.424)	(3.465)	(4.990)
Lambda		1.478***			1.327***	2.039***
		(0.163)			(0.218)	(0.329)
No. obs	2063	862	970	595	370	272
Pseudo R2/R2	0.30	0.37	0.34	0.26	0.41	0.43

Note: Standard errors in parenthesis. *** significant at the one,** at the five and * at the ten percent level. Time and region dummies are included.

Table 2. Heckman estimations for the 1970's and 1990's.

	1970's		1990's	
Variable	1st stage	2nd stage	1st stage	2nd stage
MA_GI	0.457*** (0.154)	0.728*** (0.210)	0.304*** (0.096)	0.288*** (0.098)
Age	-0.006 (0.004)	-0.003 (0.006)	-0.009** (0.004)	-0.004 (0.004)
Export	0.230 (0.279)	1.496*** (0.341)	0.413*** (0.142)	0.826*** (0.154)
Size Parent	-0.438*** (0.070)	-0.332*** (0.079)	-0.206*** (0.028)	-0.084*** (0.021)
Prod Parent	0.096 (0.225)	-0.781** (0.381)	0.111 (0.163)	0.373*** (0.144)
RD Parent	0.208** (0.082)	0.317* (0.165)	0.472*** (0.057)	0.906*** (0.068)
RD Abroad	2.356*** (0.383)	2.208*** (0.549)	1.025*** (0.167)	1.562*** (0.187)
Experience	0.026*** (0.005)	0.014** (0.006)	0.013*** (0.002)	9.20E-04 (0.002)
Distance	0.258 (0.205)	-0.765** (0.346)	-0.410*** (0.106)	-0.503*** (0.124)
GDP	-0.185 (0.089)	0.178* (0.094)	0.011 (0.044)	0.185*** (0.043)
GDP cap	0.546* (0.290)	-0.839 (0.627)	0.286* (0.161)	0.123 (0.204)
IPR	0.119 (0.217)	-0.044 (0.324)	0.356*** (0.124)	0.308 (0.151)
Size Affiliate	0.489*** (0.079)		0.419*** (0.039)	
Labor int.	0.230 (0.260)	0.882** (0.440)	0.058 (0.158)	0.309** (0.146)
Scale int.	0.016 (0.234)	0.236 (0.387)	0.143 (0.140)	0.021 (0.140)
Differentiat.	0.824*** (0.226)	1.823*** (0.405)	0.215 (0.152)	0.687*** (0.147)
Science	0.516** (0.294)	2.182*** (0.530)	0.186 (0.211)	0.898*** (0.188)
Lambda		0.919*** (0.248)		1.733*** (0.174)
Constant	-3.288 (3.501)	-7.793 (7.519)	2.784 (2.045)	-4.575** (2.240)
No. obs	678	177	1385	685
Pseudo R2/R2	0.37	0.52	0.27	0.40

Note: Robust standard errors in parenthesis. *** significant at the one, ** at the five and * at the ten percent level. Time and region dummies are included.