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DOES PATENTING INCREASE THE PROBABILITY OF BEING ACQUIRED? EVIDENCE FROM CROSS-BORDER AND DOMESTIC ACQUISITIONS

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ABSTRACT: A firm that owns a patent has a legal right to exclude. Applying for the patent, however, discloses discovery of an invention by the firm. Both the ownership of the right and the disclosure of the discovery expose the firm to an acquisition, because other firms may be interested in buying the right or the invention for a number of reasons. In this paper we put forward the idea of patent-driven mergers and acquisitions (M&As). We test the idea using a large sample of Finnish firms that are mostly small and private. Multinomial logit estimations show that if a Finnish firm owns a number of patents registered via the European Patent Office (EPO), the patents increase the probability that the firm is acquired by a foreign firm. The same does not hold for the probability that the firm is acquired by a Finnish firm. The finding suggests that patenting via the EPO exposes Finnish firms to cross-border M&As. We relate the finding to the existing explanations for the M&A-activity and argue that it speaks for the notion that M&As serve many different economic roles.

KEY WORDS: Merger, acquisition, takeover, patent, M&A, FDI, technology, internationalization

ALI-YRKKÖ, Jyrki**, HYYTINEN,** Ari & **PAJARINEN,** Mika. **LISÄÄKÖ PATENTOINTI YRITYSKAUPAN TODENNÄKÖISYYTTÄ? ANALYYSI ULKO- JA KOTIMAISISTA YRITYSKAUPOISTA.** Helsinki, ETLA, The Research Institute of the Finnish Economy, 2004, 20 s. (Keskusteluaiheita, Discussion Papers; ISSN 0781-6847; no. 891).

TIIVISTELMÄ: Hakemalla patentin yritys saa keksintöönsä yksinoikeuden. Sen vastapainoksi yritys joutuu paljastamaan ja julkistamaan keksintönsä sisällön. Molemmat tekijät – patentin omistaminen ja keksinnön julkistaminen – saattavat aiheuttaa sen, että muut yritykset kiinnostuvat ostamaan patentin omistavan yrityksen. Käyttämällä pääosin pienistä ja keskisuurista yrityksistä koostuvaa suomalaista aineistoa tässä tutkimuksessa selvitetään, missä määrin (potentiaalisen kohdeyrityksen) patentointi vaikuttaa yrityskaupan toteutumiseen. Tulosten mukaan EPO-patenttien (European Patent Office) määrä lisää todennäköisyyttä, että suomalainen yritys päätyy ulkomaisen yrityksen ostamaksi. Patentit eivät kuitenkaan näytä lisäävän todennäköisyyttä, että yritys päätyy suomalaisen yrityksen ostamaksi. Tulokset vahvistavat aiempaa käsitystä, että ulkomaiset yritykset ovat kiinnostuneita suomalaisyritysten teknologisesta osaamisesta.

AVAINSANAT: Fuusio, yrityskauppa, patentti, patentointi, teknologia, todennäköisyys, kansainvälistyminen

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1 Introduction

Mergers and acquisitions (M&As) and takeovers are an important mechanism through which firms, industries and economies restructure and evolve. There are two broad explanations for the M&A-activity.[1] The first suggests that the activity reflects the existence of a market for corporate control (Manne 1965, and Shleifer and Vishny 1988). The second emphasizes industry-specific shocks as a driver of the activity (Gort 1969, Jensen 1993, Mitchell and Mulherin 1996).[2] The shocks may well call both for efficiency-related restructuring and for reallocation of market power. Inspired by recent advances in the economics of patents, we address in this paper a new question: Does patenting by a firm increase the probability that it will be acquired?

We ask the new question, because there are many aspects in the economics of patents suggesting that *a priori*, patenting may increase the probability of being acquired:

- Because owning patents means having a legal right to exclude, other firms may be interested in buying the right for several reasons. They may, for example, buy it because they have been competing head-to-head to develop the technology, but lost the patent race (Kamien 1992). Other firms may also want to buy the right because in the presence of a cumulative innovation process, it blocks the acquiring firm from using its patent(s) (O'Donoghue, Scotchmer and Thisse 1998).
- The positive relation would be implied by the existence of a specific kind of market for corporate control: Companies with inefficient intellectual property (IP) management are potential candidates for acquisitions by other (larger) companies with more efficient IP management. There are, for example, industries in which firms actively acquire and amass large portfolios of patents for the purpose of trading them later (Hall and Ziedonis 2001).
- Patent applications disclose the discovery of inventions and provide information about them to the public (see Gallini 2002 for a discussion of the

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[1] This dichotomization of the existing literature on M&As is, of course, a simplification, for the literature is growing and diverse.

[2] Examples of such shocks are technological and supply shocks as well as deregulation that logically call for reorganization and re-optimization by firms.

role of disclosure).[3] The disclosure of a firm's invention may contribute to the probability that the firm will be acquired, for other firms may wish to enhance their technological capacity by buying the invention (Grandstand and Sjölander 1990).

- Patenting may initially promote entry by small start-ups and thus vertical specialization of an industry (Hall and Ziedonis 2001). A consequence of this tendency is that the small start-ups may later end up transferring the ownership of their technological capacity and IP to larger firms through vertical mergers (Lerner and Merges 1998, Gallini 2002).

The foregoing suggests that patenting by a firm increases the probability that it will be acquired for reasons that are related to the existing explanations for the M&A-activity. Patenting is related to the existing explanations, because it may reflect both industry-specific technological shocks and associated needs for reorganization. It can also enhance the existence of a specific market for corporate control, because a patent 'ties' the intangible assets of a firm to the firm (as opposed to the human capital of the firm's management). The diversity of reasons why patenting can increase the probability of being acquired suggests, interestingly, that should we find evidence for it, the finding would speak for the recently emphasized notion that M&As serve many different economic roles (Andrade, Mitchell and Stafford 2001, and Andrade and Stafford 2002). In this paper we use a sample of more than 800 Finnish firms that are mostly small and private to test directly the idea of patent-driven M&As. We explore, in particular, whether either (a) the ownership of patents or (b) the number of patents increases the likelihood of that a firm is acquired over a three-year period from 1998 to 2000.

We know from the received literature that some firms no doubt become acquisition targets for reasons other than patenting: First, M&As take place because they allow firms from the same industry to exploit economics of scale and/or because they reduce competition within the industry (Arrow 1975). A related explanation is that firms that are in an industry that faces an economic disturbance, such as deregulation, are likely acquisition targets. These motives can explain both horizontal and vertical acquisitions, whereas the management synergy and

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[3] When the firm is granted a patent on an invention, it is granted a temporary monopoly right in exchange for disclosure.

diversification motives speak for conglomerate and cross-industry acquisitions (Gort 1969, Arrow 1975, Palepu 1986). Second, the managerial discipline explanation, based on the idea of the market for corporate control, suggests that the companies with inefficient management are potential candidates for acquisitions by other companies with "more efficient" management. This explanation for M&As suggests that they serve as a corporate control mechanism to dismissal managers who are not acting in the shareholders' best interests.[4] Whether these established explanations for the M&A-activity are empirically important for the unquoted firms of our sample is an open question, because the market for corporate control, for example, is not necessarily as efficient for them as it is for the quoted firms. Should the established explanations nevertheless be empirically important, we control for them (and some other explanations of the M&A-activity) in the empirics.

A novel aspect of this paper is that we distinguish between the targets of cross-border and domestic M&As in the empirics. We do so, because the underlying theoretical reasons why a firm becomes target may differ between cross-border and domestic M&As. On the one hand, combining assets of firms that have different cultures, legal systems and language imposes transaction costs to the acquirer that would not be present were the target from the same country. It has been suggested, for example, that informational asymmetries that arise because of the "liability of foreignness" hamper cross-border M&As (Gioia and Thomsen 2002). The effects of industry-specific shocks are, too, likely to differ between the two types of M&As, because some types of industry-shocks affect the net benefit of domestic M&A-activity disproportionately more than they affect the net benefit of cross-border M&As. The findings of Rossi and Volpin (in press) indicate, furthermore, that cross-border transactions may play a special governance role because they seem to be a means to enhance the degree of investor protection within target firms and thus to control managers who are not acting in the shareholders'

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[4] Two further comments on these explanations are in order: First, it is well-known that the market for corporate control need not always work, because small shareholders may have an incentive free ride by to holding on to their shares in anticipation of a later share price rise (Grossman and Hart 1980). Second, sometimes an "empire-building" motive for M&As is also put forward. The motive explains, however, why a firm buys another firm, not why it may become a target. It is of course also possible that the firms with empire-builders in its management may eventually become targets if they run their firms inefficiently, but the basic tenet of the story is then no longer the same.

best interests under the legislation of the target firm's country (see also La Porta, Lopez-de-Silanes and Vishny, 2000).

The above considerations indicate that the established determinants of M&As differ – at least potentially – between domestic and cross-border deals. The question for us is: Does patenting affect the probability of being acquired by a domestic firm in the same way it affects the probability of being acquired by a foreign firm? Because theory gives us little guidance here, we allow in the empirics for the possibility that it does not. We allow, in particular, for the relative difference in the effect to go either way. This extension is potentially important, for there is anecdotal evidence suggesting that technology has driven quite a few recent acquisitions of Finnish small and medium-sized enterprises by larger foreign firms (see Ali-Yrkkö 2003). The results of Neven and Siotis (1996) also call for such an extension, as they show that "technology sourcing" has been an important motive for Japanese and U.S. companies' foreign direct investments to the EU-region.

Our study has the merit that we are among the first to confront the idea of patent-driven M&As with data using large-sample techniques. Our study is, however, exploratory, because indicators of the ownership of patents and patent counts are known to be imperfect measures of innovation and patent value (see, e.g., Lanjouw, Pakes and Putnam 1998, Hall, Jaffe and Trajtenberg 2001, and Gallini 2002). The reason we have to resort to these imperfect measures is that we face a matching problem when constructing the data set for this paper: Most of the data on M&As and financial statements available to us are from 1998 to 2000. Both the coverage and quality of these data severely deteriorate if we were to include years prior to this period, whereas the coverage and quality of the widely used US patent data (that we would like to use) would be best if we studied years prior to 1996/1997 (Hall, Jaffe and Trajtenberg 2001).[5] What's more, Finnish firms started increasingly to apply for patents from the European Patent Office (EPO) in March 1996 (when Finland joined European Patent Convention), thus gradually eroding from that date onwards the data available to us from the Na-

[5] The NBER Patent Citations Data File ends at December 1999, leading to a rather severe truncation problem for the last years of the sample.

tional Board of Patents and Registers in Finland.[6] The data available to us from the EPO suffer from the same structural break as the Finnish patent data, but in a reverse sense: Only few Finnish firms applied for a patent from the EPO in 1996 and 1997 (or prior to these years). As a result, we use in this study patent data from the EPO and focus on the period from 1998 to 2000, which we can satisfactorily match with the data on M&As and financial statements.[7]

Anticipating, we find that if a Finnish firm owns a number of patents registered via the EPO, the patents increase the probability that the firm is acquired by a foreign firm. The same does not hold for the probability that the firm is acquired by a Finnish firm. The finding suggests that patenting via the EPO exposes Finnish firms to cross-border M&As. The findings also indicate that it is important to distinguish between the targets of cross-border and domestic M&As. Had we not done so, we would not have been able to uncover the differential effects of patenting.

We perform a number of robustness tests to illustrate the robustness of these findings. We consider, for example, the above highlighted possibility that indicators of the ownership of patents and patent counts may be imperfect measures of innovation. We expect, in particular, that owning high quality patents may affect the likelihood of an acquisition more than owning low quality patents. To address this possibility, we use in robustness tests patent data from the National Board of Patents and Registers in Finland. The results obtained using these alternative data are as expected.

The rest of the paper is organized as follows: In the next section we outline a framework for our empirical analysis. In section 3 we discuss the data. In section 4 we present the results of our empirical analysis. Section 5 contains a brief summary.

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[6] Before 1996, it was possible for Finnish firms to apply for a patent via the EPO, but only very few did.

[7] Even these data are not unproblematic: The EPO data currently allow us to only check the ownership of patents and count their number. Even if we had more data, the relatively recent sample period of ours prevents us from properly computing better measures for innovation quality, such as the number of forward citations received (see, Hall, Jaffe and Trajtenberg 2001).

2 Acquisition likelihood model

We employ a multinomial logit model to estimate the probability that a firm will be acquired. The model allows both for a domestic and cross-border acquisition and specifies the probability, P_{ij}, that firm *i* belongs to outcome *j*, where *j* = 0 if the firm is not acquired, *j* = 1 if it is acquired by a domestically owned firm, and *j* = 2 if it is acquired by a foreign-owned firm.

Following the previous analyses (see, Maddala 1983, and Powell 1997), the model is specified as follows:

$$P_{ij} = \frac{\exp(\beta_j' X_i)}{1 + \sum_j \exp(\beta_j' X_i)} \qquad (1)$$

where β_j is a vector of parameters to be estimated and X_i a vector of target-specific explanatory variables. As usual, the normalisation $\beta_0 = 0$ is imposed to identify the parameters of the model.

As we will explain shortly, our sample includes all targets (between the beginning of 1998 and the end of 2000), but only a random selection of non-targets. The sample we use to study the determinants of M&A-activity is thus choice-based and not representative of the true population (Palepu 1986). The bias introduced by this choice-based sampling is however not a serious concern for us, because in the logit model, it is limited to the parameter estimate of the constant term only (Maddala 1983; see also Powell 1997). The model is therefore estimated in standard fashion using maximum likelihood. The procedure also gives consistent estimates of asymptotic standard errors.

3 Data

3.1 Sample

Our Finnish dataset is a combination of three different types of data: M&A-data, financial statements data, and patent data. The M&A-data are originally collected by Talouselämä, a major Finnish financial magazine, which pursue to report all M&As in Finland in which the net sales of the target company exceed EUR 0.5

million. The financial statements data are from the database of Balance Consulting Ltd., a commercial vendor of financial statement data. Finally, our patent data are from the EPO.

The data used in this study consists of a pooled sample of targets and non-targets over the three-year period from 1998 to 2000. The initial group of targets consists of 1116 firms that were acquired during the period. From this initial group of targets, 648 firms are excluded either because for them required financial statements data are not available (645 firms) or because they belong to the financial services sector (3 firms).[8] Following the previous literature (see for example Powell 1997), we constructed a (matching) sample of non-target firms as follows: From the population of non-target firms available to us, we draw a random sample in each year between 1998 and 2000.[9] The number of non-targets selected for each year equals the number of targets (with financial statements) for that year. Of these candidate non-target firms those with required financial statement data and those that do not belong to the financial services sector, are included eventually as non-targets each year. As a result of this sample construction process, the final estimation sample includes 817 observations. Table 1 provides a snapshot of the process.

Table 1. Composition of the Estimation Sample

	Targets						Non-targets			Total
	Number identified	Financial statements	Sample excl. financials	Meet all criteria (financials excl.)	Domestic	Cross-border	Population	Random sample	Meet all criteria (financials excl.)	Meet all criteria (financials excl.)
1998	284	121	120	99	70	29	10384	121	96	195
1999	368	159	159	134	99	35	9737	159	137	271
2000	464	191	189	172	123	49	6444	191	179	351
Total	1116	471	468	405	292	113	26565	471	412	817

[8] We lose these 645 firms because we need complete financial statements data at the end of the fiscal year preceding the acquisition year. Because complete financial statements data are more likely to be available for larger firms, this requirement biases our sample towards larger SMEs. The bias means that we are probably less likely to find that patenting matters, because most of the theoretical arguments indirectly suggest that patenting exposes especially smallish firms to an acquisition.

[9] There are 10384, 9737 and 6444 firms in 1998, 1999 and 2000, respectively, in the "population" of non-targets that is available to us.

3.2 Definition of variables

Measuring acquisitions

The dependent variable used in this study is TARGET, which equals 0, if the firm is not acquired; 1 if it is acquired by a domestically owned firm; and 2 if it is acquired by a foreign-owned firm. While this definition has the merit of simplicity, we report below robustness tests in which we use alternative definitions of the dependent variable.

Measuring patenting

In this exploratory study, we use two simple measures of patenting activity by a firm. First, we check whether the firm owns valid EPO patents. We denote the dummy indicating the ownership of patents PATENT_ED. Second, if PATENT_ED = 1, we check how many EPO patents the firm owns. The count indicating the number of EPO patents owned is denoted PATENT_EC.

As we already noted earlier, the literature on the economics of patents suggests that simply checking the ownership of patents or counting their number is a poor proxy for the value of patents. However, because of the matching problem explained in the introduction, the data currently available to us do not allow us to compute better proxies for the patent quality, such as forward citations. This lack of better patent data is what makes our study exploratory, for owning high quality patents may affect the likelihood of an acquisition more than owning low quality patents. In this study, we can address this concern, but only imperfectly. We address it in robustness tests where we use patent data from the National Board of Patents and Registers in Finland instead of the EPO data.

Control variables

Measuring inefficient management: The inefficient management explanation of the M&A-activity encompasses at least two prominent but related ideas (see Palepu 1986 and Dickerson, Gibson and Tsakalotos, 2002). We take each of them in turn:

- *Management discipline motive*: This motive suggests that M&As serve as a part of corporate control mechanism where inefficient management is replaced with more efficient management team. A number of empirical studies have examined whether the likelihood of becoming a target is decreasing or increasing in the profitability of a firm, which is an often-used proxy for managerial performance. No general conclusion can, however, be drawn on the effects of the profitability (see Palepu, 1986, Dickerson, Gibson and Tsakalotos, 2002). In this study, we use the return on investment, denoted ROI, to proxy managerial performance.
- *Free cash flow:* The free cash flow theory of Jensen (1986) suggests that managers may have an incentive to spend corporate resources lavishly particularly if there is a lot of cash flow in the firm in excess of that required to fund all projects that have positive net present value when discounted at the relevant cost of capital. The empirical evidence for this idea is, however, somewhat mixed. Powell (1997) finds, for example, that free cash flow do not have statistically significant impact on the likelihood of takeover (see also Dickerson, Gibson and Tsakalotos, 2002). In this study, the ratio of cash flow to total assets is used to proxy "free cash flow". We denote the ratio FREECASH.

Measuring industry and company specific factors: Industry-specific factors are another prominent explanation for M&A-activity. In spirit of the previous analyses, our primary control for such effects is a vector of thirty industry dummies (INDUSTRY).[10] Other factors that typically vary systematically by industry are firm size, tangible assets (as a proportion of total assets), and growth opportunities (see also Dickerson, Gibson and Tsakalotos 2002). Because these variables may capture explanations for the M&A-activity on and above their association with specific industries, we briefly consider each of them in turn:

- *Firm size:* Both Palepu (1986) and Powell (1997) argue that transaction costs of takeovers and M&As increase with firm size. Moreover,

[10] We define industries using a Finnish "TOL2" classification of industries. The classification is similar but not identical to the two-digit SIC-industry classification.

difficulties in financing large acquisitions may hamper the M&A-activity if capital markets are imperfect. Both of these ideas suggest that the likelihood of an M&A decreases with the firm size. Empirical studies that have considered the firm size effect are, however, inconclusive, as a number of studies have documented a negative relation (e.g. Palepu 1986, Berger and Ofek 1996), while others have found the opposite relation (see e.g. Dickerson, Gibson and Tsakalotos 2002). To test for the firm size effects we include the logarithm of total assets to control for the effects of the size of a firm. The variable is denoted LSIZE.

- *Ratio of tangible assets to total assets:* An acquiring firm can use the target's assets as collateral for debt financing, if such financing is needed to finance the acquisition. As tangible (fixed) assets may imply greater debt capacity (Stulz and Johnson 1985), the likelihood of an acquisition may increase with the ratio of fixed assets to total assets. We use the ratio to control for this possibility and denote it TANGIBLE.
- *Growth-resource imbalance:* This idea suggests that high-growth, resource-poor firms and low-growth, resource-rich firms are potential targets. For instance, high-growth firms with low resources are potential targets of firms with the opposite imbalance (Palepu 1986). Because this possibility is considered in quite a few previous studies, we control for it by including a dummy called IMBALANCE. To construct the dummy, we first define its constituents: growth is measured as annual sales growth last year, leverage as the ratio of long-term debt to total assets, and liquidity as the ratio of cash and market-able securities to total assets. Each of the variables is defined to be 'high' if its value for a firm is greater than the sample average, and 'low' otherwise (see Palepu 1986). Dummy IMBALANCE equals one for the combinations high growth - low liquidity - high leverage and low growth - high liquidity - low leverage; and is zero otherwise.

Our data are annual. All the right-hand-side variables (X_i:s in equation 1) are therefore measured at the end of the year preceding the year when the M&A (P_{ij}

in equation 1) takes (potentially) place. The final estimating sample consists of 817 firms.

4 Results

4.1 Univariate analysis

Table 2 presents descriptive statistics separately for targets and non-targets. A comparison PATENT_ED and PATENT_EC between targets and non-targets indicates the non-targets are less frequently patent owners and have on average fewer EPO patents than the targets. The tests for the difference in means (two-tailed *t*-test) show that the differences are statistically significant at better than the 10% level. This finding is consistent with the idea that patenting increases the likelihood of being acquired. Finally, the targets are larger (significant at better than the 1% level) and have more tangible assets (significant at better than the 10% level) than the firms that are not acquired. The remaining tests for the difference in means are not statistically significant.

Table 2. Descriptive Statistics for Targets and Non-Targets

	NON-TARGETS		TARGETS		T-test for means	
	Mean	S.D.	Mean	S.D.	*t* stat.	*p*-value
ROI	0.27	0.36	0.29	0.43	-0.507	0.612
LSIZE	0.94	1.56	1.35	1.65	-3.714	0.000
TANGIBLE	0.24	0.23	0.27	0.22	-1.867	0.062
FREECASH	0.10	0.16	0.11	0.14	-1.189	0.235
IMBALANCE	0.29	0.45	0.25	0.44	1.108	0.268
PATENT_ED	0.03	0.18	0.06	0.25	-2.192	0.029
PATENT_EC	0.13	0.99	0.55	4.64	-1.814	0.070

Note: S.D. = standard deviation.

Table 3 compares domestic with cross-border targets. The comparison suggests that the cross-border targets have more often EPO patents and on average more of them than the domestic targets. These differences in means are statistically significant at better than the 5% level. It seems that patenting affects the probability of being acquired by a domestic firm less than it affects the probability of being acquired by a foreign firm. The remaining tests for the difference in means are not statistically significant.

Table 3. Descriptive Statistics for Domestic (TARGET = 1) and Cross-Border (TARGET = 2) Targets

	TARGET = 1		TARGET = 2		T-test for means	
	Mean	S.D.	Mean	S.D.	*t* stat.	*p*-value
ROI	0.28	0.39	0.31	0.52	-0.754	0.451
LSIZE	1.27	1.57	1.57	1.83	-1.630	0.104
TANGIBLE	0.28	0.23	0.25	0.22	1.120	0.263
FREECASH	0.11	0.14	0.10	0.15	0.825	0.410
IMBALANCE	0.25	0.43	0.27	0.44	-0.320	0.749
PATENT_ED	0.05	0.21	0.11	0.31	-2.152	0.032
PATENT_EC	0.11	0.56	1.70	8.67	-3.131	0.002

Note: S.D. = standard deviation.

To test the robustness of these univariate results, we next proceed to multivariate analysis.

4.2 Basic regression results

Table 4 presents estimated multinomial logit models. The regressors are those defined above (section 3.2) and yearly time dummies. The time dummies are included, because the M&A-activity is known to be cyclical (see e.g. Andrade, Mitchell and Stafford 2001). Results for domestic targets are displayed in column (i) and those for foreign targets in column (ii). The numbers displayed are coefficients and the associated standard errors.[11] To save space, we report for the industry and time dummies only the Wald tests for the joint significance.

The table provides us with three main findings. *First*, patenting matters for foreign M&As. The coefficient of PATENT_EC is positive and has a *p*-value of 0.011 in the equation modeling the probability that a firm is acquired *by a foreign firm*. This finding means that having more EPO patents exposes a Finnish firm to a foreign acquisition. A joint test for PATENT_ED and PATENT_EC indicates, moreover, that the two variables are jointly significantly different from zero (*p*-value = 0.006) in the equation for cross-border targets. PATENT_EC remains significant (*p*-value = 0.012) even if PATENT_ED is excluded from the regression. The equation for domestic targets is a bit more difficult to interpret, because

[11] A positive (negative) sign of a parameter indicates that an increase (decrease) of the variable increases (decreases) the probability of an event.

it seems that having more EPO patents *decreases* the probability that a firm is acquired by a domestic firm and because the dummy (PATENT_ED) is statistically insignificant. A joint test for PATENT_ED and PATENT_EC indicates, in addition, that the two variables are jointly *not* significantly different from zero (p-value = 0.113) in the equation for domestic targets. What's more, PATENT_EC is no longer significant at the 10% level if PATENT_ED is excluded from the regression. The net effect of patenting on domestic M&As is therefore uncertain.

Second, size matters. The larger the firm, the more likely that it is acquired. None of the other variables is statistically significant. We thus find relatively little evidence for the inefficient management hypothesis. *Third*, industry matters. The *p*-values of the Wald tests for their joint significance are less than 1% in both column (i) and (ii).

Table 4. Multinomial Logit Estimates for TARGET

	Multinomial logit estimates Dependent variable: TARGET			
	(i) TARGET = 1		(ii) TARGET = 2	
	Coef.	Std. Err.	Coef.	Std. Err.
ROI	-0.211	0.277	0.425	0.558
LSIZE	0.128	0.057 **	0.222	0.082 ***
TANGIBLE	0.742	0.480	0.167	0.670
FREECASH	0.835	0.773	-1.039	1.049
IMBALANCE	-0.046	0.190	0.004	0.257
PATENT_ED	0.801	0.597	0.578	0.652
PATENT_EC	-0.285	0.136 **	0.100	0.039 **
CONSTANT	0.514	1.278	-0.244	1.443
INDUSTRY	Yes		Yes	
YEAR	Yes		Yes	
Observations	817			
Wald Chi^2	152.12			
degr. of freedom (df)	62			
significance	0.000			
Log likelihood	-714.84			
R^2_{pseudo}	0.113			
Joint tests (df)	Chi^2	*p*-value	Chi^2	*p*-value
INDUSTRY (22)	82.79	0.000	50.16	0.001
YEAR (2)	1.76	0.415	1.91	0.385
PATENT (2)	4.37	0.113	10.14	0.006
Other controls (5)	11.29	0.046	8.07	0.153

Last but not least, the estimates of Table 4 show that the targets of domestic acquirers are different from the targets of foreign acquires. In particular, testing

the coefficients of PATENT_ED and PATENT_EC in column (i) against the corresponding coefficients in column (ii) shows that they differ. The statistic of the joint test (not reported in the table) is significant at better than the 1% level. This finding echoes the results of the univariate analysis, as it shows that patenting affects the probability of being acquired by a domestic firm less than it affects the probability of being acquired by a foreign firm.

4.3 Robustness tests

In what follows we investigate alternative explanations and robustness of our empirical findings. To this end we run several new regressions. We do not report them in detail (to save space), but make instead the following observations:

Robustness test 1: Why do we find relatively little evidence for the inefficient management hypothesis? Because the earlier studies have found more evidence for it, we consider the possibility that the definitions of the variables reflecting management inefficiency (and also those of the other control variables) may be biased against the hypothesis. To explore this possibility, we re-run the regressions (of Table 4) five more times using (i) return on assets (ROA) in place of ROI, (ii) the ratio of cash-flow to investments in place of FREECASH, (iii) net sales in place of LSIZE[12], (iv) the ratio of fixed capital + working capital to total assets instead of TANGIBLE, and finally (v) sales growth, leverage and liquidity directly instead of IMBALANCE. The results of these new regressions show that our basic qualitative results remain intact: First, the coefficient of PATENT_EC for the targets of foreign firms remains in each regression positive and statistically significant at better than the 5% level. Second, the effect of patenting on the targets of foreign acquirers remains larger than its effect on the targets of domestic acquirers. Finally, we do not find more evidence for the inefficient management hypothesis.[13]

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[12] We also tried total assets in linear-form (i.e., not with logarithm-transformation). The results did not change.

[13] The only notable difference is the following: When sales growth, leverage and liquidity are used directly instead of IMBALANCE, we find that leverage is inversely related to the probability of acquisition. In this regression, TANGIBLE seems to gain a more significant coefficient than it does in the basic regressions of Table 4 (but only in the equation for domestic targets).

Robustness test 2: To define industries is known to be difficult. Because our study is no exception and because industry-specific shocks may play an important role, mis-measured industry dummies are a cause of concern to us. To address this concern, we re-run the regression of Table 5 using more crude industry dummies ("TOL1-based") instead of the finer ("TOL2-based") dummies. This change reduces the number of dummies from thirty to ten. This change does not, however, affect our basic findings. In particular, the coefficient of PATENT_EC for the targets of foreign firms remains positive and statistically significant at better than the 5% level.

Robustness test 3: Are our results an artifact of the multinomial logit model? To address this concern, we run a binomial logit model in which the dependent variable equals one if the firm is acquired by a foreign firm and zero otherwise. The results of the binomial logit estimations echo our previous findings: the likelihood of being acquired by a foreign firm is higher, the more EPO patents it owns. In this regression the coefficients (*p*-values) of PATENT_ED and PATENT_EC are 0.412 (0.489) and 0.147 (0.002), respectively. We also run a binomial logit model in which the dependent variable equals one if the firm is acquired by a domestic firm and zero otherwise. The results are similar to those of the multinomial logit model.

Robustness test 4: To test to what extent our results depend on the patent data we have used, we resort to patent data from the National Board of Patents and Registers in Finland. We expect to find *weaker* effects using this data for three reasons: First, these data suffer from a kind of adverse selection over our sample period, because it is likely that the higher the quality of an innovation, the more likely that it is patented via the EPO and not via the National Board of Patents and Registers in Finland. Second, most of the reasons why patenting may increase the probability of being acquired are related to that the fact that when a firm is granted a patent on an invention, it is granted a temporary monopoly right in which other firms are interested. We expect weaker effects here, because the monopoly right that a patent acquired via the EPO conveys is more important than that conveyed by a corresponding Finnish patent. Finally, the disclosure effect of Finnish patents (which are in Finnish) is clearly smaller than the corresponding effect of an international patent.

Our estimations based on the alternative patent data show that the coefficient of the patent count variable in the equation for the targets of foreign firms remains positive. It is statistically significant the 10% level. This weaker effect is in line with what was expected. The corresponding coefficient in the equation for the targets of domestic firms is negative, but no longer statistically significant. Thus, we conclude that the change of the source of the patent data does not affect our basic finding. Patenting matters, especially in foreign acquisitions.

Robustness test 5: To what extent are our results specific to the period on which we focus? Addressing this question is difficult for a number of reasons. First, there is essentially no historical EPO patent data that we could use to test whether the results hold prior to our sample period. Second, as we just explained, using patent data from the National Board of Patents and Registers in Finland is not ideal, because the monopoly right and the disclosure in which a Finnish patent results are clearly of limited value to foreign acquirers. Third, financial statements data that are available to us for the years prior to our sample period are biased towards larger firms. Fourth, in early 1998 it became evident that Finland will join the third phase of EMU (which began at the beginning of 1999). In this connection it was decided that the Finnish markka is to be irrecoverably fixed relative to ECU at a certain exchange rate, eliminating exchange risk from cross-border M&As. The risk was clear and present prior to the decision, because Finnish markka was not among the most stable currencies in the early 1990s. Fifth, early 1990s was a period of very deep economic crisis in the Finnish economy and the crisis resolved only gradually during the 1990s. The crisis was so deep (it resulted, for example, in a fundamental restructuring of the banking sector) that it probably affected the data generating process of cross-border M&As, too. Finally, the acquisition of Finnish firms by foreign firms was partially regulated before 1993, when a remaining restriction on such capital movements was removed. For all these reasons, it is difficult to test how period specific our results are.

Despite the caveats, we now consider data on M&As from 1989 to 1997. The data are constructed using the same procedure that we use to construct the data from 1998 to 2000. We are able to build a matched dataset of targets and non-targets that eventually results in an estimating sample of 190 firms. As expected, there are relatively few foreign acquisitions per year in the sample. For this and the above-discussed reasons it is not surprising that the results from a

multinomial logit model estimation are different from our main results reported in Table 4. In particular, patenting variables (based on Finnish patent data) seem to play not role. Our analysis is thus consistent with the previously documented fact that the determinants of M&As change over time.

5 Conclusions

A firm that owns a patent has a legal right to exclude. Applying for the patent, however, discloses discovery of an invention by the firm. Both the ownership of the right and the disclosure of the discovery expose the firm to an acquisition, because other firms may be interested in buying either the right or the invention for a number of reasons.

We put forward in this paper the idea of patent-driven mergers and acquisitions (M&As). We test the idea using a large sample of Finnish firms that are mostly small and private and find that if a Finnish firm owns a number of patents registered in the European Patent Office, the patents increase the probability that the firm is acquired by a foreign firm. The same does not hold for the probability that the firm is acquired by a Finnish firm. The finding suggests that patenting exposes Finnish firms to cross-border M&As. The findings also suggest that the characteristics of targets of cross-border and domestic M&A-deals differ. It is therefore important to distinguish between the two types of targets in an empirical analysis. Had we not done so, we would not have been able to uncover the differential effects of patenting.

As we have argued, recent insights from the economics of patenting suggest that patenting by a firm increases the probability that it will be acquired for reasons that are related to the existing explanations for the M&A-activity. First, patenting is related to the existing explanations, because it may reflect industry-specific technological shocks and associated needs for re-organization. Second, our findings can also be related to the inefficient management hypothesis, because patenting increases the liquidity of a firm's intellectual assets and allows their separation from the management and employees of the firm. To put it in specific terms, this idea suggests that companies with inefficient intellectual property management are potential candidates for acquisitions by other (larger) companies that actively acquire and amass large portfolios of patents (see also Hall and Zie-

donis 2001). Patenting can thus enhance the existence of a specific market for corporate control.

The diversity of theoretical reasons why patenting can increase the probability of being acquired suggests that M&As serve many different economic roles. We leave it for future research to establish which economic roles are more important than others and whether patenting is specifically related to some of them.

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