Discussion Paper No. 07-078

# Inventors' Response to Firm Acquisitions

Katrin Hussinger

Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
Economic Research

Discussion Paper No. 07-078

# Inventors' Response to Firm Acquisitions

Katrin Hussinger

## Non-technical Summary

In times of increasing technological competition the access to technological knowledge is one of the major objectives for mergers and acquisitions (M&As). Technologically motivated firm acquisitions are, however, found to often fail in the sense that post-merger innovation performance as measured at the firm level declines. By focusing on the inventor level this study provides additional insights into the channels through which M&As influence technology performance at the firm level. M&As constitute a disruption to the working environment of the inventive labor force of the acquired company. If inventors would respond with a decline of their patent productivity or departure from the merged firm this can be detrimental to the innovative process within the merged entity and can be contradictory to the aims of the firm acquisition.

This paper provides empirical evidence on post-merger mobility and productivity of 673 inventors employed by European acquisition targets in the years 2000 and 2001. The empirical results show that 1.) the most productive and experienced individuals stay with the merged entity; 2.) inventors that left the acquired firm are less productive in post-merger years than those that stayed with the merged entity; 3.) M&As trigger inventor mobility, but do not lead to a decline in patent productivity if compared to a control group of inventors that have not been involved in a firm acquisition. The finding that the productivity of inventors is not affected contradicts a widespread hypothesis. The paper concludes with a summary of its contribution and management implications that can be derived from the analysis.

# Inventors' Response to Firm Acquisitions

By Katrin Hussinger[1]
(University of Maastricht, KU Leuven, ZEW Mannheim)

December 2007

**Abstract**

Mergers and acquisitions (M&As) constitute a disruption to the working environment of the inventive labor force of the acquired company. If inventors would respond with a decline of their patent productivity or departure from the firm this can be detrimental to the innovative process within the merged entity and can be contradictory to the aims of the firm acquisition. This paper provides empirical evidence on post-merger mobility and productivity of 673 inventors employed by European acquisition targets in the years 2000 and 2001. The empirical results show that 1.) the most productive and experienced individuals stay with the merged entity; 2.) inventors that left the acquired firm are less productive in post-merger years than those that stayed with the merged entity; 3.) M&As trigger inventor mobility, but do not lead to a decline in patent productivity if compared to a control group of inventors that have not been involved in a firm acquisition.

**Keywords:** M&As, inventor mobility and productivity

**JEL: G34, O32, C24**

---

[1] Contact details: University of Maastricht, Department of Organization and Strategy, Tongersestraat 53, 6211 LM Maastricht, k.hussinger@os.unimaas.nl
For helpful comments I thank Rene Belderbos, Dirk Czarnitzki, Dries Faems, Bronwyn Hall, Derek Lemoine, Georg Licht, Konrad Stahl, Andy Toole, Frank Verboven and Reinhilde Veugelers and, further, the participants at the KUL Steunpunt O&O Indikatoren Brown Bag Seminar, the Innovation Seminar at the UC Berkeley, the "Economics of Technology Policy" Conference at Monte Verita, and the CEBR's Workshop on "Human Capital Patenting Activity and Technology Spillovers" in Copenhagen and the Workshop on "Corporate Intellectual Property: environmental; constraints, strategic antecedents, and organizational routines as drivers of firm-level performance" in Copenhagen. I also acknowledge Thorsten Doherr for providing his search engine for the data merges. Financial support under the grant KUL – OT/04/07A is gratefully acknowledged.

# 1 Introduction

In times of increasing technological competition the access to technological knowledge is one of the major objectives for mergers and acquisitions (M&As) (Chakrabati et al., 1994, Capron et al., 1998). Accelerated by the increasing importance of timing in innovation the acquisition of external knowledge as a complement to in-house development of technologies is often essential for firms in order to enhance or defend their position in a competitive market environment. Along with technology alliances (Teece, 1992, Hagedoorn, 1993) and licensing agreements (Teece, 1986), acquisitions of innovative firms are a fast and efficient way to access important technologies. Technologically motivated firm acquisitions are, however, found to often fail in the sense that post-merger innovation performance as measured on the firm level declines (e.g. Ravenscraft and Scherer, 1987, Hitt et al., 1991, 1996). A post-merger reduction in research and development (R&D) activities can be explained by decreased incentives to innovate through enhanced market power after the merger (Arrow, 1962, Reinganum, 1983), on the one hand; but also by refinancing efforts of the M&A that can imply cuts in investments in other projects as for example in R&D projects (Hitt et al., 1996). In the post-acquisition period, the management is likely to focus more on the acquisition and the integration of the acquired firm so that decision making on routine technological matters can be delayed and efforts being supplied to day-to-day operations even in the technological core of the company can be minimal (Pritchett, 1985, Hitt et al., 1996). If technology performance suffers in response to the merger, post-merger integration of the R&D activities of both firms might be inefficient suffering from insufficient ex-ante planning and the inability to cope with differences in corporate culture (Larsson and Finkelstein, 1999, Paruchuri et al., 2006). In consequence, the working climate can worsen and the productivity of individual inventors can decline. At worst, inventors leave the merged firm.

The departure of inventors after a firm acquisition or a decline in their productivity harms the technology creation process within the merged entity and is often contradictory to the aims of the acquisition. Firm acquisitions often aim at accessing technological developments of acquisition targets in order to complement or strengthen their technological portfolio through M&As (Ahuja and Katila, 2001, Cassiman et al., 2005, Cloodt et al., 2006). M&As can also target on certain intellectual property rights of rivals (Lerner et al., 2003) that are important to continue ongoing research activities (O'Donoghue et al., 1998). Also, firm acquisitions can be used to set up barriers for competitors in technology markets and to reduce patent barriers firms face through the acquisition of patents with blocking potential (Grimpe and Hussinger, 2008). Furthermore, the technological know-how of the target firm's inventive labor force can be an essential factor for the acquisition decision (Ernst and Vitt, 2000, Paruchuri et al., 2006).

Indeed, outstanding people employed by the acquired firm can be an important criterion for firm acquisitions. For example, the acquisition of Groove by Microsoft in 2005 was motivated by closing a gap in Microsoft's product line, on the one hand, as Groove offered products that were complementary to Microsoft's products and were not provided by Microsoft itself.[2] On the other hand, with the acquisition of

[2] Groove offered products that were complementary to Windows Sharepoint Services (WSS) and Microsoft's Portal Server (SPS), namely tools that made possible off-line access to WSS and SPS.

Groove Microsoft got Ray Ozzie, the founder of Groove, developer of Lotus Notes, and one of the most admired and respected individuals in the software industry, and his highly regarded team of software architects and developers. Microsoft believed that the compatibility of the existing and the newly acquired team of software specialists would lay a foundation for promising future innovations.[3] In the case of Microsoft/Groove, the preconditions for post-merger integration were optimal from the acquired developer team's point of perspective because Ray Ozzie became the new Chief Software Architect, the successor of Bill Gates. Hence, the acquired inventor team had an important advocate among the most powerful persons in the firm. This is, however, not the typical situation. A closer look at the vita of Ray Ozzie shows that it often happened that he left a company after it had been acquired, often his own start-up, to jump onto new projects. For example, he left his successful foundation Iris Associates three years after it has been acquired by Lotus Development in 1994. One year later this company was acquired by IBM. Apparently, there were more attractive opportunities for him outside the merged company. The example shows how important individual inventors and inventor teams can be for acquisition decisions and that there is a significant threat that those experts leave the firm in response to a take-over.

This paper provides empirical evidence on post-merger mobility and patent productivity of the inventive labor force of acquisition targets in the first five post-merger years. It is investigated whether the most productive and most experienced inventors of the acquired firm can be kept in the merged entity or whether those are most likely to leave after an acquisition. Further, this study compares the post-

[3] See http://spaces.live.com/editorial/rayozzie/pub/pages/who.html, http://www.microsoft.com/presspass/features/2005/mar05/03-10GrooveQA.mspx.

merger patent productivity of inventors that stayed and of those that left the merged entity. The departure of inventors can constitute a significant loss of knowledge for the merged entity and the situation can be worse if the flown-out knowledge would be exploited in a new firm. The hypotheses are tested for a sample of 673 inventors that were working for European firms that were subject to an acquisition in the years 2000 and 2001. A selection model is applied to account for systematic differences between inventors that stayed and those that left the merged firm during the first five post-merger years in order to control for a potential selection bias in the estimation for inventors' post-merger patent performance. Finally, the productivity of inventors involved in M&As is compared to a control group of inventors that were not involved in firm acquisitions in the same period in order to investigate whether post-merger inventor behavior is actually the response to the firm acquisition rather than an effect of general mobility and patent productivity patterns in the market. This paper is the first to provide a comparison between inventors involved in M&As and a control group of inventors not involved in M&As.

The remainder of the paper is organized as follows: The next section presents the conceptual framework; section three describes the construction of the sample and section four shows descriptive statistics for the sample; section five motivates the empirical model and shows the estimation results; the final sections conclude with a discussion of the results, implications for management and technology competition, and limitations and topics for future research.

## 2 Conceptual framework

Although nobody would doubt that technologies are an important motive for M&As (Capron et al., 1998, Graebner, 2004, Grimpe and Hussinger, 2007, 2008) and that the technology performance of a firm is affected by firm acquisitions (Hitt et al., 1991, Ahuja and Catila, 2001, Cassiman et al., 2005), the existing evidence on the relationship between M&As and technological performance is rather scarce and the empirical findings are often conflicting as Veugelers (2006) summarizes her survey of the state of the art.[4] The ambiguity of previous findings indicates that the understanding of how M&As affect technological firm performance is still limited. Veugelers (2006) points out a number of weaknesses of previous studies ranging from methodological issues (see also Valentini, 2004) over small sample sizes to difficulties with the interpretations of the results. Further, she criticizes that previous studies do not take into account the "full set of fundamental conditions", for which she develops a proposal.

[4] Scholars that focus on the contribution of firm-specific innovative assets to the expected value of the acquisition find mixed results. To give some examples: For large firms in the US (Hall, 1990) and Europe (Frey and Hussinger, 2006) the impact of technological assets and patenting on the probability of being acquired is negative. In a previous paper, Hall (1988) finds that acquiring firms with own research and development (R&D) activities value the R&D of their targets higher than the market does. Ali-Yrkko et al. (2005) find that there is a positive correlation between patenting activities and the likelihood of being acquired for a sample of Finnish firms. The same conclusion is drawn by Valentini (2004) and Ornaghi (2005) for two particular high-tech sectors. A robust finding in the literature is that firms seek to complement their own technology portfolios and output market share through acquisitions of firms that are active in related industry and technology sectors (Ahuja and Katila, 2001, Cassiman et al., 2005, Hussinger, 2005).
Further, empirical evidence for the actual post-merger R&D performance is mixed as well. Ravenscraft and Scherer (1987), Hall (1990) and Hitt et al. (1996) find a decline of the R&D intensity in response to the merger with focus on US M&As. For a small sample of European M&As, Capron (1999) concludes that 50% of the M&As lead to an increased R&D performance of the firms involved. Based on case study evidence Chakrabarti et al. (1994) find that M&As enhance innovative outputs. Ahuja and Katila (2001) find a positive impact on the acquirer's R&D for technological acquisition and a negative impact for non-technological acquisition for a small sample of worldwide M&As in chemistry. For the US pharmaceutical sector, Ornaghi (2005) finds that there is no increase in R&D efficiency after the acquisition, especially for M&As among technologically related parties. Based on case study evidence Cassiman et al. (2005) draw exactly the opposite conclusion.

Building on her critique and being aware of the fact that post-merger integration within a merged firm is often a black box for the researcher I argue that the firm level of analysis, which is typically chosen by previous studies in order to investigate effects of the merger on technology performance, might not always lead to new and meaningful insights. The ambiguity of previous findings illustrates the diversity of M&As objectives, which is also reflected in different integration actions taken post-merger. Therefore, I see two ways how to improve the understanding of the effects of a merger on technology performance. First, it would be helpful to gather in-depth information on M&A deals and restructuring of R&D after the merger (e.g. Cassiman et al., 2005). Such case-based investigations can shed light on the black box of post-merger integration. However, case studies are typically limited to small sample sizes. Second, and on a large scale, additional insights can be gained by shifting the focus to more narrowly defined units of analysis than the firm level, as for example business lines, firm departments and employees and the productivity of those units after an acquisition. Going in the latter direction, this paper targets the inventor level of analysis. The response of inventors to M&As contributes to the understanding of post-merger technology performance by providing insights from a very narrowly defined perspective.

### Assumptions on knowledge creation within the firm

Firm level analyses make some important assumptions. First, they imply that all more narrow levels of analysis, as business lines, departments and employees, are homogeneous (Felin and Hesterly, 2007). The objectives of a merger are, however, typically correlated with the fact that some subunits within the firm are more or less important than others. For example, firms engage in M&As to strengthen their core competences or they implement M&As notwithstanding structural remedies employed by competition authorities, like divestures of profitable business lines. Second, a firm-level approach implies the assumption that knowledge and technologies are created by the firm as a collective organization (Klein et al., 1994, Felin and Hesterly, 2007). This is a strong and debatable assumption. Arrow (1962) already pointed out that there is "no need to consider the firm as the fundamental unit of organization in invention" and that "there is plenty of reason to suppose that individual talents are more important". In this spirit, a large literature evolved that emphasizes the role of individuals and specialized human capital for knowledge creation (e.g. Zucker et al., 2002, Song et al., 2003, Felin and Hesterly, 2007, Teece et al., 1997, Kogut and Zander, 1992).

Focusing on the process of knowledge creation within the firm, Dosi (1982) and Nelson and Winter (1982) argue that knowledge in the firm is created through highly embedded, path-dependent processes, which are difficult to imitate. In order to support these path-dependent R&D processes the firm develops routines. The individual inventors are used to work with and within these defined contexts that encompass physical setting, formal and informal procedures, colleagues, communication flows, monitoring and control systems etc. (Szulanski, 1999). They develop their own routines within the knowledge creation process. From this point of view, firm acquisitions that involve some kind of integration of the acquiring and acquired firm constitute in any case a disruption for the established routines and the working environment of the target firm. Individual inventors are supposed to react to these changing routines with changes in their productivity or departure from the company (Ernst and Vitt, 2000, Paruchuri et al., 2006).

### Inventor heterogeneity and inventor response to acquisitions

Inventors' response to disruption through firm acquisitions is found to be heterogeneous depending on inventor characteristics and the degree of post-merger restructuring (Ernst and Vitt, 2000, Paruchuri et al., 2006). While previous studies focus on the centrality of the inventor within the acquired firm and the relatedness of his/her knowledge to the firm's knowledge stock, this paper focuses especially on inventor performance and experience as those are key determinants for inventor productivity as well as for his/her bargaining power in job negotiations with the merged entity as well as with outsider firms in the market.

In general, the move of an inventor to another company can be regarded as the result of a better job offer by another firm and the inventor's willingness to move. M&As can trigger inventor mobility as firm acquisitions provide the acquiring firm an opportunity for personnel restructuring and are also supposed to trigger mobility from the inventor's perspective. The announcement of an acquisition causes uncertainties for the inventors involved in the acquired firm, which might lead to a worsening of the working climate (Souder and Chakrabarti, 1984, Ernst and Vitt, 2000). During the integration phase after the M&A, the investment of managerial time and efforts in R&D might be minimal (Pritchett, 1985, Hitt et al., 1996), which can worsen the situation. Further, duplicated research efforts have to be avoided after the merger so that some R&D projects might be stopped (Veugelers, 2006). In a similar vein, acquired inventors might have a very similar profile as their colleagues employed by the acquiring firm. This can lead to rivalries among inventors, degradation for inventors in leading positions and a loss in centrality for some inventors within the merged entities (Paruchuri et al., 2006). Hence, it is expected that:

> Hypothesis 1: M&As trigger inventor mobility as compared to inventors that are not affected by M&As.

For an outsider firm, hiring a new employee is an investment under uncertainty as the employer is not sure about the individual's capabilities (Spence, 1973). Certain characteristics, however, signal the employee's abilities and capabilities to potential employers as for example experience and, in the case of inventors, his/her patent productivity. Inventors with a high experience and an above-average patent productivity are more likely to receive job offers from outside the firm than others. This leads to mobility only if the former employer, the merged entity, cannot or does not want to outbid the offer made by the new firm. The highest bid is made by the firm that expects the employee to have the highest marginal productivity in its working environment (Palomeras, 2004).

From the inventors' point of view, the decision is presumably more complex as the personal situation, as for example family status, might play an important role for the decision to accept or reject a job offer. Given that the utility functions of inventors are unobserved and assumingly heterogeneously, inventors are, on average, assumed to accept a job offer if it is better than her/his current labor contract. Hence, it is expected that more productive employees are more mobile than others (Hoisl, 2007a,b, Palomeras, 2004). However, the larger the knowledge stock of an inventor the larger is the probability that she/he receives a good offer by the merged entity. Given that individuals can play a major role in firm acquisitions and given that an outsider firm faces higher uncertainty with respect to the skills and capabilities of an inventor it is likely that we observe the star scientists staying with the merged firm, whereas inventors with an intermediate productivity can be more likely to move. The latter might not be of special interest for the merged entity and might get a better job offer by an outsider firm.

> Hypothesis 2: More productive employees are more likely to move; but only up to a certain threshold, beyond which the likelihood of moving decreases in patent productivity.

A somewhat countervailing effect is expected from inventor experience. Although experience can be a positive signal to outsider firms, gathering experience goes often hand in hand with the accumulation of significant firm-specific knowledge and a firm-internal individual career that decreases people's mobility. Therefore it is hypothesized that:

> Hypothesis 3: The likelihood to move decreases in experience.

The fact that the highest job offer is made by the firm that expects the employee to have the highest marginal productivity in its working environment (Palomeras, 2004) provides an explanation for the finding that inventor productivity, on average, increases after a move (Hoisl, 2007a,b). However, there are at least two arguments illustrating that this must not necessarily be the case. First, labor contracts with the former employer can prohibit the exploitation of knowledge for a new employer, at least for a certain time period (Biger and Plaut, 2001). Second, the inventor has to get acquainted to the new working environment (Paruchuri et al., 2006). Both factors constitute a countervailing effect to the expected post-move productivity increase for the immediate years after the move. In addition, in case of M&As not all inventors might leave the merged firm because of a better job offer. Some have to leave because of structural changes within the new firm or because their knowledge becomes obsolete after the integration of two R&D departments. The labor market literature argues that displacement leads to significant salary reductions, which can be interpreted as an indication for barriers to knowledge transferability into a new firm (Becker, 1962, Parson, 1972, Kriechel and Pfann, 2005).

> Hypothesis 4: Post-merger patent productivity is higher for inventors that stayed with the merged entity than for those that left.

Finally, inventors involved in M&As - independent of whether they stay with the merged entity or whether they change employer - have to deal with a new or modified working environment, which is likely to affect their productivity.

> Hypothesis 5: The patent productivity of inventors involved in M&As is lower than the patent productivity of inventors not involved in M&As.

**Evidence on inventors' response to firm acquisitions**

To my knowledge, there are only two empirical studies that focus on inventor mobility and productivity against the background of M&As. A pioneering paper on the behavior of key inventors after firm acquisitions is provided by Ernst and Vitt (2000). Their focus is on 19 acquisition targets in Germany that were subject to an acquisition in the years 1989 and 1990. 61 key inventors were involved in those acquisition targets, a third of which left the firm after acquisition. Based on a univariate statistical analysis Ernst and Vitt (2000) conclude that inventors' post-merger patenting performance declines in terms of patent quantity and quality. Further, they find that fluctuation of inventors was observed especially in cases with large cultural differences between the R&D departments of merger parties and where the acquisition target was large.

The second paper on the behavior of inventors after firm acquisition focuses on 62 acquisition targets in the US pharmaceutical industry in the period 1979-1994 (Paruchuri et al., 2006). The authors investigate under which conditions the 3,933 inventors involved in these acquired companies leave in the post-merger period and, further, trace patent productivity of the subsample of 1,090 inventors that stayed with the merged company. Paruchuri et al. (2006) find that inventors react differently on acquisitions depending on their position in the acquired firm. They conclude that the disruptive effect of a merger is strongest for individuals that loose their status and centrality within the new firm and for those whose technology expertise does not match the technological core competence of the acquiring firm.

This paper contributes to the literature by investigating the behavior of inventors after an acquisition for a sample of firms located in Europe across different industry sectors. The focus is not so much on organizational factors that determine inventor mobility and productivity as this has been shown by previous research, but rather on the question whether the most experienced and most productive inventors leave the company after an acquisition and if their patent productivity is affected. The hypotheses are tested in a multivariate framework controlling for selectivity of inventors that left the firm after the acquisition. The paper adds on previous empirical evidence not only by comparing the patent outcome of inventors that left the merged firm with the post-merger performance of the survivors within the firm, but also by comparing inventor patent productivity to a control group of inventors that were not involved in M&As in the same period. This analysis shows whether the changes in inventor behavior are indeed reactions to the M&A or rather reflect general mobility and productivity dynamics.

## 3 Data

The analysis is based on a newly created data set that contains information on firms that have been subject to majority acquisitions in Europe and their inventive labor force. The data allows identifying mobility of the inventors involved in the acquisition targets based on their patenting activities (see also Ernst and Vitt, 2000, Palomeras, 2004, Trajtenberg et al., 2006, Paruchuri et al., 2006, Hoisl 2007a,b).

### Construction of the sample and identification of unique inventors

The sample is based on the M&A database of Bureau van Dijk Electronic Publishing, in which all European firms that were subject to a majority acquisition in 2000 and 2001 were identified. This yielded a sample of 9,913 acquisition targets distributed over a range of different industries and European countries.

The next step was to check whether those acquisition targets were active in patenting. In order to do so, the acquisition targets were linked to the patent data base of the European Patent Office (EPO). The match of firms and their patent records was supported by a computer supported text-based search algorithm that creates a "similarity score" for firms and patent applicants based on firm names and addresses. Each match proposed by the search engine with a similarity of at least

90% was manually checked.[5] The matching procedure revealed that 919 of the acquisition targets applied for a patent at the EPO at least once since firm foundation.

Next, the names and addresses of the inventors were identified from the patent application files. As the interest of this paper is to analyze inventor mobility around the time of the acquisition it was checked whether, how often, and when the inventors changed their affiliation over their entire patenting career. This was done based on the EPO patent data. A problem in tracing inventors in this way is the identification of unique inventors. Although the EPO database contains information as inventor names, addresses, patent applicants, and technology classes, there is no unique identifier for individual inventors. Hence, this identifier had to be created taking into account possible spelling differences and potentially missing parts of inventor names, as for example a second first name that does not appear on every patent application (Trajtenberg et al., 2006). In order to identify all patents of the inventors involved in the acquired companies, again, a text-based search algorithm was used to match the inventor sample with the complete list of inventors that applied for EPO patents since foundation of EPO in 1977. The matching criterion was only the name of the inventor in order to minimize the risk of losing correct matches due to changes in inventor addresses. This led to a huge number of proposed patents for each inventor. As there were many inventors with similar and a few with identical names, manual checks were done based on similarity of inventor addresses, applicant names, application dates and technology fields in order to identify whether the names in question indeed belong to the same person. Manual

[5] If only a particular division of the firm was acquired only the division's patents were taken into account.

checking was possible as the number of patents was relatively small as compared to inventor mobility studies that focus on all inventors at the United States Patent and Trade Mark Office (USPTO) (see Trajtenberg et al., 2006). Subject to the manual check were those matches with a similarity in names of at least 90% as determined by the search algorithm. Although information on patent applicants, application dates and technology classes of the patents was used to support the accuracy of the manual checks, in some cases, it was not always possible to identify unique inventors based on this information from the EPO patent database. That was the case for a few very common surnames like "Clarke", "Möller" or "Davis" that appeared with a common first name as for example "John". Those few cases, less than 5% of the patent records, were excluded from the patent and inventor list. The result of the manual check was a list of unified inventors, which applied for an EPO patent under the acquired company at least once in their career. From this list, further inventors were deleted if they were active for the firms of interest, but not during the time period of interest. Concretely, inventors that were active for the firm after 2003 only or before 1995 only were dropped. Last, inventors with only one patent application were deleted as the patent data base does not provide information on their mobility.

The final sample consists of 673 uniquely identified inventors that applied for patents under the targets' names in the relevant period. Those inventors correspond to 396 different firms. In other words, 43% of the target firms with a patent portfolio have at least one inventor with more than one patent application. On average, each target firm in the final sample employs 1.7 of those inventors. In total, the inventors applied for 6,471 patents during their whole patenting career. The average (median) inventor filed 10 (6) EPO patents over her/his entire patenting career until 2005 and the target company appears as the applicant on 72% of all their patent applications. Every second inventor has patent applications with the target company only.

**Identifying Inventor Mobility**

Based on the sample of unique inventors their mobility was traced in the next step. In line with previous studies (Ernst and Vitt, 2000, Palomeras, 2004, Trajtenberg et al., 2006, Paruchuri et al., 2006, Hoisl 2007a,b), inventor mobility is defined as a change of the patent applicant on the inventor's patents over time according to the EPO patent data.

There are three major problems in tracing inventors in patent data:

1. *An inventor shows up on another firm's patent application but did not move*: An example is research alliances between firms. Under such agreements it can happen that an inventor working for firm A appears on a patent of alliance partner B. A further issue is past M&As, which often infer a change of the applicant on the inventor's patents without corresponding to any move of the inventor. Further, an inventor can be employed by a university or an institution and be involved in a temporary research projects in collaboration with the business sector, which makes his name appearing on one or more companies' patents. In order to identify all those cases that do not correspond to an inventor move the history of patent applicants on inventor patent records has to be taken carefully into account. The sample size of this study allowed conducting manual checks for each observation indicating a move based on information taken from the World Wide Web, mainly newspaper and firm homepages, to exclude cases

that do not exhibit inventor moves.[6] Hence, the mobility definition in this paper can be considered as pretty accurate if compared to large-scale inventor mobility studies that have to rely on purely algorithm-based inventor tracing and are, hence, likely to overestimate the number of moves by inventors.

2. *An inventor moves and does not show up on patents anymore*: This type of inventor mobility cannot be identified based on patent data. In order to overcome this shortcoming, the empirical section provides robustness checks for the sample of "known survivors" only, i.e. for those inventors that appear again on a patent after the firm acquisition. The major findings do not change.

3. *An inventor does not move and does not show up on a patent after the M&A*: Again, in such cases, patent data do not allow detecting mobility. Some inventors, for example, left the lab after the acquisition for a position in the management of the merged entity. Although his study is focusing on tracing mobility of inventors, not on inventor research careers and how they are impacted by firm acquisitions, the fact that some inventors change their job after firm acquisition can cause some noise in the data, only part of which is picked up by the robustness check for the sub-sample of "known survivors".

In total, the majority of 449 inventors stayed with the new company after the acquisition. As in Ernst and Vitt (2000), who also did a careful checking of the mobility pattern, this corresponds to two thirds of the sample.[7] 129 inventors do not appear again on patent documents after the firm acquisition.

---

[6] Still it cannot be claimed that all research alliances are accounted for as not every research alliance is disclosed. However, the mobility definition is as accurate as possible.

[7] To give a comparison, Paruchuri et al. (2006) who rely on algorithms only to identify inventor mobility find that two thirds of the inventors leave after the acquisition.

## 4 Definition of variables and descriptive statistics

A look at the descriptive statistics shows that inventors that stay with the merged company and those that leave after firm acquisition differ systematically. Table 1 compares the mean values of the variables of interest for the 224 inventors that left after the acquisition (or quit their inventor career) and for their 449 colleagues that stayed with the merged entity until 2005.[8]

*Inventor pre-merger patent productivity*: Pre-merger patent productivity is defined as the number of patents inventors filed before the acquisition took place. A first thing to notice is that there is little difference between the pre-merger patent productivity of both groups of inventors. On average, inventors that stayed with the acquired company had about one patent more before the acquisition took place than inventors that left. If the skewness of inventors' patent productivity is taken into account by comparing the logs of their pre-merger patent applications, the leaving inventors did better in the past and the difference in mean values is statistically significant from zero at the 1%-level.

*Inventor's ties to the acquired company*: Inventors that stayed with the acquired company had significantly more patents with the target company in the pre-merger period. On average, 81% of their total patents were applied for with the acquired firm, whereas only 66% of the patents of inventors that left the firm after the acquisition were filed with the acquisition target. Inventors that have more patents with the acquired firm are supposed to have closer links to their employer and that they might be on a promising firm-internal career track.

[8] Table 5 in the Appendix shows the mean values of the variables for inventors that stayed with the merged firms, those that left to another firm and those that quit their patenting career.

*Inventor post-merger patent productivity*: Focusing on post-merger patent productivity, defined as the number of patents per inventor in the period 2002-2006, Table 1 shows that inventors that left are significantly less productive than their colleagues. The difference holds if skewness in the patent productivity is taken into account using the log of post-merger patents per inventor.[9] Note that the significant difference in post-merger patent productivity is not driven by the fact that the group of leaving inventors contains also those that stopped their patenting career after the acquisition: taking into account the "known survivors" only the patent productivity of inventors that left the acquired company is still significantly smaller than the performance of their colleagues with 2.89 patents, on average (see Table 5 in the Appendix).

*Inventor experience*: Table 1, further, shows that inventors that stayed with the company after the take-over are, on average, significantly less experienced than others. Experience is measured as the number of years since the inventor's first patent application at the EPO.

*Inventor excellence*: To control for the value of the pre-acquisition patent output of an inventor a binary variable indicates whether the pre-acquisition patents of an inventor received citations by other patents within a 5-years window after application. This measure takes a positive value for only a few inventors. Less than 20% of the inventors receive citations, which reflects the well documented skewness of the patent citation distribution (Harhoff et al., 1999, 2003).[10]

[9] For inventors with zero post-merger patent applications the log is computed as log(post-merger patents +1).

[10] Harhoff et al. (1999) find for a sample of patent applications by German inventors in 1977 that 69.5% of those patents receive no citation at all. As in another paper (Harhoff et al., 2003), the authors

*Inventor independence*: The percentage of private patents over total patents per inventor measures the ability or preference to work independently. Leaving inventors have a significantly higher share of private patents than their colleagues that stayed with the merged firm.

*Inventor technological diversification*: A further control variable is a technological diversification index for the individual inventor's pre-acquisition patent portfolio. This measure is calculated as follows based on the IPC (International Patent Classification) 3-digit technology classes *j*:

$$diversity_i = 1 - \sum_j \left( \frac{N_{ij}}{N_i} \right)^2 \qquad (1)$$

*N* refers to the number of pre-acquisition patents per inventor *i* and per inventor and technology class *ij*, respectively. The measure takes high values (close to one) for inventors with a diversified technology portfolio and the lowest value (zero) for inventors that patent exclusively in one particular technology class. Table 1 shows that inventors that left in the post-acquisition period are more diversified than their colleagues. The difference is statistically significant at the 1%-level.

*Inventor centrality with respect to the acquired firm*: Another control variable is the centrality of the inventor for the acquired firm, as a measure that reflects how closely the inventor's research is related to the target firm's technology portfolio. In order to calculate this measure inventor *i*'s technology portfolio $F_i$ is defined as the assemblage of his/her patent stocks for all 3-digit IPC technology classes. The technology portfolio of the acquired firm *k* is defined analogously. This yields two

find that the patent value distribution as measured by citations and the estimated value of patents from the inventors' point of perspective is very skew and follows a log-normal distribution.

technology vectors, one for the inventor *i*, $F_i$, and one for the acquired firm *k*, $F_k$. The patent stocks per technology field are formulated as percentages of the total patent stock of the inventor (and the firm, respectively) in order to control for size differences of patent portfolios of inventors and companies. Technological relatedness of patent portfolios of inventors *i* and firms *k*, $T_{ik}$, is calculated as:

$$T_{ik} = \frac{F_i F_k}{\sqrt{(F_i' F_i)(F_k' F_k)}}; \qquad 0 \leq T_{ik} \leq 1 \tag{2}$$

Table 1 shows that the patent portfolio of inventors that stayed with the merged entity is significantly more related to the technologies of the acquisition targets than is the patent portfolio of those that left.

*Inventor centrality with respect to the acquiring firm*: Analogously, the centrality for inventors *i* with respect to the acquiring companies' *l* patent portfolios is calculated as $T_{il}$. Table 1 shows that there is a small but also significant difference between both groups of inventors with respect to their average centrality to the acquiring firm: the patent portfolio of leaving inventors is less related to that of the acquiring firms than that of staying inventors. Paruchuri et al. (2006) have shown that centrality is a key determinant of post-merger inventor mobility and productivity.

*Time since inventors' last patent application*: Further, time since inventors' last patent application before the take-over is taken into account. This variable is an attempt to control for the fact that an employee might have stopped her/his inventor career before the firm acquisition took place. Table 1 shows that the last patent application of the inventors that left is significantly longer ago than that of the individuals that stayed with the merged entity.

*Control variables for the M&A deal*: Besides those inventor characteristics, some information on the M&A itself is taken into account as the acquired stake, whether the deal was horizontal, i.e. whether the merging firms were affiliated with the same 3-digit NACE sector, and whether the M&A was cross-border.

*Acquiring firm characteristics*: With respect to firm characteristics, firm size of the acquiring firm is taken into account as the number of total patents applied for by the firm as information on total assets or total labor force is not available. As an R&D related firm size measure this variable is supposed to be an appropriate size definition from the inventor's point of view. There is no significant difference in the average number of patents of acquiring firms for both groups of inventors, neither in absolute number nor in logs.

*Target firm characteristics*: For the acquisition target, two dummy variables control for the total number of inventors in the acquired firm in the pre-acquisition period. More than 20% of the inventors worked for an acquisition target with more than four active inventors as could be identified from the firms' total patent application stock. The share of inventors that were part of large inventor teams is lower among those that left the firms. More than 30% of the inventors were involved in firms with a smaller number of inventors. The majority of inventors was involved in firms with only one active inventor with more than one patent in the period of interest. For this reason, target firm size cannot be proxied by the total number of firms' pre-acquisition patents as there is a high correlation with the inventors' pre-merger patents. Further, dummy variables show the most frequent target NACE classes and target home countries.

## Table 1: Descriptive Statistics for Inventors Involved in M&As

| | Inventors | | |
|---|---|---|---|
| Behavior after the acquisition | stay with acquired or merged entity | leave or quit their patenting caree | t-tests on difference of mean values |
| Number (#) of observations | 449 | 224 | |
| | mean (std. deviation) | mean (std. deviation) | difference (std. error) |
| Inventor characteristics: | | | |
| # pre-acquisition patents | 6.88 | 5.93 | -0.95 |
| | (11.22) | (5.27) | (0.79) |
| log(# pre-acquisition patents) | 1.23 | 1.50 | 0.26*** |
| | (1.10) | (0.74) | (0.08) |
| pre-acquisition patents of the inventor for acquired firm over total patents (%) | 0.81 | 0.66 | -0.15*** |
| | (0.30) | (0.34) | (0.03) |
| # post-acquisition patents | 4.16 | 1.23 | -2.93*** |
| | (5.38) | (2.71) | (0.38) |
| log(# post-acquisition patents) | 1.35 | 0.49 | -0.86*** |
| | (0.03) | (0.05) | (0.06) |
| citations received (yes/no) | 0.15 | 0.17 | 0.02 |
| | (0.36) | (0.38) | (0.03) |
| private patents (yes/no) | 0.07 | 0.17 | 0.10*** |
| | (0.26) | (0.37) | (0.02) |
| experience | 8.79 | 9.92 | 1.13** |
| | (6.69) | (6.21) | (0.53) |
| pre-acquisition techn. diversity | 0.32 | 0.41 | 0.09*** |
| | (0.31) | (0.30) | (0.02) |
| centrality (target) | 0.22 | 0.07 | -0.15*** |
| | (0.37) | (0.17) | (0.03) |
| centrality (acquirer) | 0.03 | 0.03 | 0.00* |
| | (0.04) | (0.04) | (0.00) |
| time since last patenting | 0.65 | 1.36 | 0.71*** |
| | (1.21) | (1.06) | (0.10) |
| M&A deal characteristics: | | | |
| acquired stake | 94.13 | 94.33 | 0.20 |
| | (14.88) | (14.11) | (1.20) |
| horizontal M&A (same 3-digit NACE) | 0.48 | 0.45 | -0.03 |
| | (0.50) | (0.50) | (0.04) |
| cross-border M&A | 0.44 | 0.58 | 0.13*** |
| | (0.50) | (0.50) | (0.04) |
| Acquiring firms' characteristics: | | | |
| # patents of acquiring firm | 118.47 | 87.96 | -30.51 |
| | (1,146.17) | (291.32) | (77.83) |
| log(# patents of acquiring firm) | 1.77 | 1.78 | 0.01 |
| | (2.05) | (2.05) | (0.17) |
| Target firms' characteristics: | | | |
| group of 2-4 inventors (yes/no) | 0.32 | 0.41 | 0.09** |
| | (0.47) | (0.49) | (0.04) |
| group of more than 4 inventors (yes/no) | 0.27 | 0.20 | -0.07** |
| | (0.45) | (0.40) | (0.04) |
| target in NACE 24-26 | 0.14 | 0.08 | -0.06** |
| | (0.35) | (0.18) | (0.03) |
| target in NACE 29 | 0.15 | 0.16 | 0.01 |
| | (0.36) | (0.37) | (0.03) |
| target in NACE 30-33 | 0.19 | 0.14 | -0.05* |
| | (0.40) | (0.35) | (0.03) |
| German target | 0.37 | 0.29 | -0.08** |
| | (0.48) | (0.45) | (0.04) |
| French target | 0.17 | 0.15 | -0.02 |
| | (0.37) | (0.36) | (0.03) |
| UK target | 0.18 | 0.24 | 0.06** |
| | (0.38) | (0.43) | (0.03) |

## 5 Empirical model and results

The empirical analysis of the paper has two parts. In the first section it is investigated whether the most productive and most experienced inventors stay in the merged entity after a firm acquisition (Hypotheses 2 and 3). Further, the post-merger patent productivity of inventors that stayed in the merged firm is compared with the patenting performance of those inventors that left for a new employer (Hypothesis 4). In section 5.2 it is investigated whether the results hold if inventors involved in M&As are compared to a random sample of inventors that were not involved in M&As in the period of interest in order to show whether firm acquisitions, in fact, increase inventor mobility and impact their patent outcome (Hypotheses 1 and 5).

**Inventors' response to M&As: mobility and patent productivity – empirical model**

In order to investigate whether the most productive and most experienced inventors leave a probit model is estimated for the inventor decision to stay with the merged entity:

$$s_i = I\{patent\ productivity_i \alpha_1 + experience_i \alpha_2 + Z_i \alpha + u_i > 0\} \tag{3}$$

$s_i$ depicts the inventor's post-merger mobility and equals one if the inventor stays with the merged entity. Mobility depends on the inventor's pre-merger patent productivity, experience and further control variables on the inventor, the M&A deal and both firms, $Z_i$. $u_i$ is the error term of the model.

In the second part of the estimation, post-merger patent productivity of inventors that left vis-à-vis those that stayed is investigated. In order to account for systematic differences between leaving and staying inventors identified in the probit model (3) that might correlate with their post-merger productivity a selection model is applied following Heckman (1974, 1976, 1979). Selection models take into account potential selectivity based on observable factors, like inventor patent productivity, and unobservable factors, as for example a change in the firm's technology strategy after the merger or a worsening of the working climate etc. In order to do so, a selection correction term $\lambda_i$ is introduced into the estimation for post-merger patent productivity:

$$\textit{patent productivity}_i = X_i\beta + s_i\delta + \gamma\lambda_i + \varepsilon_i \qquad (4)$$

$X_i$ depicts a vector of inventor, M&A deal and firm characteristics. The decision to stay in the company is depicted by $s_i$. The estimated coefficient for this binary variable indicates post-merger productivity differences between inventors that stayed and those that left. The error term of the model is denoted by $\varepsilon_i$. Following Heckman (1974, 1979) the selection correction term $\lambda_i$ is parametrically specified as the inverse hazard rate. For inventors that stayed with the merged company $\lambda_i$ equals $\phi(Z_i'\alpha)/\Phi(Z_i'\alpha)$; for those that left $\lambda_i$ equals $-\phi(Z_i'\alpha)/(1-\Phi(Z_i'\alpha))$. $\lambda_i$ is calculated based on the estimates of the selection equation (3).[11]

In theory, Heckman's parametric selection model is identified by the nonlinear shape of the inverse hazard rate. In application, however, $\lambda_i$ is often almost linear. In order to achieve identification in applications exclusion restrictions, i.e. variables that affect the selection equation (3) but not the outcome equation (4), have to be specified. The list of exclusion restrictions covers the share of pre-acquisition patents, centrality of the inventor for acquired firm, a dummy for cross-border acquisitions

[11] Hussinger (2008) shows that selection model estimates are quite robust with respect to less restrictive specifications of the selection correction.

and industry sector dummies. Those variables have an impact on the likelihood to leave the merged entity, but non on inventors' post-merger patent productivity. The share of pre-acquisition patents reflects the quality of the pre-acquisition inventor-firm match. Inventors that are productive within their firm are likely to enjoy their working environment and are often doing well in firm-internal career paths. This is likely to decrease inventor mobility, but has not necessarily implications for inventors' patent productivity. The centrality variable indicates that it is important that the inventor's profile fits to the firms' technology portfolio; otherwise the inventor is more likely to look for a better inventor-firm match (Paruchuri et al., 2006). Further, inventors involved in cross-border M&As are supposed to be more likely to leave after the acquisition than others because the corporate culture in the acquired firm might differ significantly more than for domestic M&As. There is no statistically significant effect of those variables on inventors' post-merger patent productivity.

### Inventors' response to M&As: mobility and patent productivity – empirical results

Table 2 shows the estimation results for equation (3) and (4) for the full sample and provides two robustness checks. The first two columns present the estimated coefficients for the full sample (model Ia), where the first column shows the results for the likelihood to stay with the merged entity and the second column shows the results for inventors' post-merger patent outcome. The estimation results for the likelihood to stay with the merged entity reveal that pre-acquisition patent productivity as measured by the log of the total number of patents the inventor applied for before 2000 matters in a nonlinear way (Hypothesis 2 cannot be rejected). The most productive inventors, which are supposed to be of high value to the new firm, but also for other firms in the market, are likely to stay with the acquired company. Medium productive inventors are most likely to leave after an acquisition and the least productive inventors have a high probability of staying with the merged entity again. A possible explanation for the latter finding is that the least productive people in terms of patent outcome might be technical assistants that do an important job by running the lab and that appear on a patent only here and there. Medium productive inventors seem to have the largest incentive to look for a job outside the firm. This can be explained by the fact that: first, they can be more easily replaced than star scientists and are presumably more expensive than technical staff; second, those inventors might see the acquisition as a chance to advance in their career and look for a new job in another environment.

The results further show that experience decreases the probability of leaving the merged entity after a firm acquisition (Hypothesis 3 cannot be rejected). This shows that experience is often accompanied by a firm-internal individual career that decreases people's mobility. The result is in line with previous empirical findings (see Palomeras, 2004).

With respect to the further control variables the results suggest that inventors with private patents are less likely to stay after a merger than others showing that the ability or preference to work independently matters. Moreover, inventors that filed their last patent a long time before the acquisition are more likely to leave the firm after the take-over than colleagues that were active in patenting more recently. This variable is an attempt to control for having left the inventor position in the target firm already before the acquisition took place. Centrality of the inventor for the acquired firm with respect to the relatedness of their patent portfolios is important for the likelihood to stay. The more the inventors' technology portfolio is related to target firm's technology portfolio the less likely is a move. Inventors that have a high share of their previous patents with the acquisition target are likely to stay with the merged entity. Those inventors might be central for the acquired firms and might have sound career opportunities within that firm. Further, inventors are more likely to leave after a cross-border acquisition and there are industry sector differences for mobility. In particular industry sectors, namely in chemistry (NACE 24), rubber and plastic (NACE 25), non-metallic mineral products (NACE 26) and electrical and optical equipment (NACE 30-33), inventors are more mobile after a firm acquisition than in other sectors. There is no effect of centrality of the inventor for the acquiring firm as was found in Paruchuri et al. (2006). Lastly, there is no effect of technological diversity of the inventor's patent portfolio, firm size of the acquired firm in terms of previous patent applications, and patent quality measured by a dummy variable that indicates whether the inventor's patents received citations.

The results for post-merger patent outcome of the inventors can be found in the second column of Table 2. The estimated effects indicate that inventors that stayed with their company are more productive than their colleagues that left the merged firm after the acquisition (Hypothesis 4 cannot be rejected). On average, they file more than one patent application more in the post-merger period. This productivity difference in the immediate post-merger years might be due to the fact that inventors have to get acquainted to a completely new research environment if they leave the merged firm, on the one hand. On the other hand, inventors are often not allowed to exploit the knowledge they gathered in the old firm for a new company, at least for a certain time period. This is often explicitly contracted with the former employer.

The selection correction term is statistically significant showing that the likelihood to leave after the acquisition is correlated with the inventor's post-acquisition patent performance. The selection correction term captures unobservable effects that drive both the likelihood to stay in the acquired company and the post acquisition patent outcome. As we observe a negative coefficient of the selection correction term it might measure factors like loyalty to the acquisition target or the success of post-merger integration. Unobservable inventor-firm characteristics like loyalty and a successful post-merger integration are likely to negatively affect both the likelihood to leave and the patent outcome in a new or changed environment.

With respect to inventor characteristics, Table 2 shows that past patent productivity has a strong impact on post-merger patent productivity. This variable is an attempt to control for individual-specific fixed effects like inventors' creativity and motivation. In a similar vein, inventors that worked independently of firms in the past, as measured by a dummy that indicates whether the inventor had private patents in the pre-merger period, are more productive in the post-merger period. The dummy for inventors' cited patents is a further predictor for post-merger patent productivity. Besides the value of the inventor's patent stock this variable captures whether there is a demand for the technologies the inventor is developing.

Further, patent productivity decreases with experience. This is likely to reflect the productivity life cycle pattern of scientists. Typically scientists experience their productivity climax in their younger days and afterwards productivity declines over the rest of the career (Levin and Stephan, 1991).[12] The negative coefficient can also measure that inventors, which are active already for a long time, are potentially less able to cope with a new environment than their younger colleagues.

**Table 2: Estimation Results from a Selection Model**

| | Ia | | Ib | II | |
|---|---|---|---|---|---|
| endogenous variable | stay | log(pat) [A] | log(pat) [A] | stay | log(pat) [A] |
| estimation method | probit | OLS | OLS | probit | OLS |
| sample | full sample | | known survivors | patents > 4 | |
| | | | estimated coefficient (standard error) [B] | | |
| stay (yes/no) | | 1.19*** | 0.39** | | 1.11*** |
| | | (0.15) | (0.19) | | (0.21) |
| □ | | -0.28*** | -0.12 | | 1.18** |
| | | (0.09) | (0.11) | | (0.23) |
| log(# pre-acquisition patents) | -1.33*** | 0.24*** | 0.29*** | -1.90*** | 0.13*** |
| | (0.24 | (0.03) | (0.03) | (0.56) | (0.05) |
| log(# pre-acquisition patents)$^2$ | 0.40*** | | | 0.47*** | |
| | (0.07) | | | (0.13) | |
| private patents (yes/no) | -0.53*** | 0.18** | 0.08 | -0.42*** | 0.12 |
| | (0.19) | (0.08) | (0.09) | (0.21) | (0.11) |
| log(experience) | 0.21** | -0.13*** | -0.18*** | 0.35** | -0.22*** |
| | (0.10) | (0.03) | (0.04) | (0.15) | (0.06) |
| pre-acquisition techn. diversifity | 0.10 | 0.06 | -0.01 | -0.19 | -0.04 |
| | (0.24) | (0.10) | (0.10) | (0.31) | (0.15) |
| citations received (yes/no) | -0.03 | 0.17** | 0.17** | -0.16 | 0.17** |
| | (0.16) | (0.07) | (0.07) | (0.17) | (0.08) |
| group of 2-4 inventors | -0.16 | -0.32*** | -0.31*** | -0.41** | -0.49*** |
| (yes/no) | (0.13) | (0.06) | (0.06) | (0.18) | (0.08) |
| group of more than 4 inventors | -0.11 | -0.31*** | -0.23*** | -0.48** | -0.39*** |
| (yes/no) | (0.16) | (0.07) | (0.07) | (0.22) | (0.10) |
| time since last patenting | -0.27*** | -0.12*** | -0.13*** | -0.28*** | -0.17*** |
| | (0.05) | (0.02) | (0.02) | (0.06) | (0.04) |
| pre-acquisition patents of inventor for | 0.65*** | | | 0.99*** | |
| the acquired firm over total patents (%) | (0.21) | | | (0.25) | |
| centrality (target) | 0.62** | | | 2.60 | |
| | (0.31) | | | (2.15) | |
| centrality (acquirer) | -0.74 | | | 0.90 | |
| | (1.89) | | | (2.61) | |
| | | | | ... to be continued | |

[12] Note that Levin and Stephan (1991) found that the productivity peak in terms of publications happens later in the scientists' career. Hall et al. (2007) show that there can exist identification problems arising from vintage, age and time that make it difficult to predict the exact peak of scientists' productivity peak.

| … continued | | | | | |
|---|---|---|---|---|---|
| | Ia | | Ib | II | |
| endogenous variable | stay | log(pat) [A] | log(pat) [A] | stay | log(pat) [A] |
| estimation method | probit | OLS | OLS | probit | OLS |
| sample | full sample | | known survivors | patents > 4 | |
| | | | estimated coefficient (standard error) | | |
| acquired stake | 0.00 | | | 0.00 | |
| | (0.00) | | | (0.01) | |
| log(patents of the acquiring firm) | 0.00 | | | 0.00 | |
| | (0.03) | | | (0.04) | |
| cross-border M&A | -0.27** | -0.04 | -0.02 | -0.01 | -0.10 |
| | (0.12) | (0.05) | (0.05) | (0.16) | (0.07) |
| horizontal M&A | 0.12 | 0.00 | 0.04 | 0.04 | 0.06 |
| | (0.11) | (0.05) | (0.05) | (0.15) | (0.07) |
| target in nace 24 - 26 | 0.35** | | | 0.39 | |
| | (0.20) | | | (0.27) | |
| target in nace 29 | 0.05 | | | 0.07 | |
| | (0.16) | | | (0.22) | |
| target in nace 30 - 33 | 0.47*** | | | 0.25 | |
| | (0.16) | | | (0.20) | |
| constant | 0.43 | 0.44*** | 1.16*** | 1.21 | 1.18*** |
| | (0.52) | (0.15) | (0.18) | (0.80) | (0.22) |
| number of observations | 673 | | 544 | 395 | |
| Wald-$\chi^2$-stat | 463.62*** | | 244.95*** | 286.33*** | |

**, **, * indicates statistical significance on the 1%, 5% and 10% level.
The endogenous variable log(pat) is defined as the logarithm of the sum of post-merger patents per inventors +1 order to handle the observations for which the post-merger outcome is zero.

Moreover, inventors that have been employed by acquisition targets with more than one active inventor are less productive after a take-over than individuals that were the only active inventor in the acquired company. There are no significant effects for the merger deal characteristics.

Two robustness checks for the results are presented. First, the empirical findings for patent productivity might be upward biased due to the fact that some inventors quit their patenting career after the merger and, hence, have a zero post-merger patent outcome. Those individuals were so far labeled as leaving the company because they stopped inventing for the merged company. In some cases, however, those inventors stayed with the merged entity but left the lab and took a job in the management. As it is, hence, not clear, how to treat those individuals a robustness check is done for the subsample of known survivors, i.e. those inventors that applied for at least one patent after the acquisition took place. The third column (model Ib) shows the results for the post-merger patent outcome for this subsample. It turns out that the estimated coefficients are quite robust. There is still a significant productivity premium for inventors that stayed with the merged company (Hypothesis 4). However, the productivity advantage is, as expected, smaller than for the full inventor sample. Whereas inventors that stayed had, on average, more than 100% patents more in the post-merger period than their colleagues for the full sample, this effect more than halves for the sample of inventors that continued to patent after the take-over.

The second robustness check shows that the estimation results are robust if a more narrow definition of key inventors is applied. A subsample that covers only inventors with more than four patents in total is defined. Column four (model II) shows the probit estimates for the likelihood to leave after an acquisition for this subsample and the last column of Table 2 shows the estimates for the patent outcome equation. Again, the results are quite robust with respect to the underlying sample. The probit estimates, however, show that the effect of centrality of the inventor's patent portfolio for the target firm's patent portfolio disappears for the key inventors. This is due to the fact that there is less variation in the centrality variables for the most productive scientists. Further, key inventors that worked for firms that employed other inventors are more likely to leave the acquired firm than others. The estimates for the patent outcome show that the effect of staying with the merged company is the same as for the full-sample. If the inventor or the key inventor stayed with the merged entity she/he applies for, on average, more than 100% more patents in the post-merger period than an inventor that left.

### Inventor post-merger mobility and productivity compared to a control group

The previous results have shown that inventors react on M&As in terms of mobility and patent productivity. Now, it remains to be shown that inventors involved in M&As behave differently than inventors that have not been involved in firm acquisitions in the same year (Hypotheses 1 and 5). If there would be no significant difference in mobility and productivity patterns of M&A inventors and a control group the observed inventor behavior in post-merger years would reflect rather general mobility dynamics in the market than a response to the firm acquisition. A comparison of M&A inventors with a control group has not been provided by the previous studies on inventor behavior after firm acquisitions (Ernst and Vitt, 2000, and Paruchuri et al., 2006).

This study uses a control group of 741 inventors that was randomly drawn from the list of all inventors that applied for an EPO patent in 2000/2001 with a company that was not involved in a M&A then.[13] The sample of control inventors was treated as described in section 3 for the M&A inventor sample. Table 3 shows some descriptive statistics for the variables of interest for M&A inventors and controls. 8% of the inventors in the control group left the firm after the year 2000/2001. If compared to the inventors involved in firm acquisitions, where 33% left the firm in the same period, this suggests that inventor mobility is an actual response to the

[13] It would have been optimal to draw the control group from as a sample of firms that were not involved in a merger in the same industry class in the same years and trace the inventors employed by those firms. This was, however, not possible as a complete list of European private and public firms from which the sample could have been drawn does not exist. Hence, I have to stick to a random sample of inventors rather than firms in the same year.

M&A. With respect to the further variables there is, on average, no big difference between inventors involved in M&As and the control group. Maybe most interesting, inventors in the control group have, on average, about one patent more before and after the acquisition period.

**Table 3: Descriptive Statistics for M&A Inventors and Control Group**

| | Inventors | |
|---|---|---|
| | Involved in M&A | Control group |
| Number (#) of observations | 673 | 714 |
| | mean (standard deviation) | Mean (standard deviation) |
| stay | 0.67 (0.47) | 0.92 (0.28) |
| # pre-acquisition patents | 6.56 (9.66) | 8.07 (9.41) |
| pre-acquisition patents of the inventor for acquired firm over her total patents (%) | 0.76 (0.32) | 0.87 (0.24) |
| # post-acquisition patents | 3.18 (4.87) | 5.41 (5.85) |
| citations received (yes/no) | 0.16 (0.37) | 0.24 (0.43) |
| private patents (yes/no) | 0.10 (0.30) | 0.06 (0.23) |
| experience | 9.16 (6.54) | 8.04 (5.16) |
| pre-acquisition techn. diversity | 0.35 (0.31) | 0.31 (0.29) |
| centrality (employer in 1999) | 0.17 (0.33) | 0.35 (0.19) |
| time since last patenting | 0.88 (1.20) | 0.28 (0.45) |

The estimation strategy is the same as before: first, the likelihood to leave the firm in the period after 2001 is estimated; and in a second step, an estimation for the patent productivity in the same period is estimated taking selectivity into account. A binary variable is introduced into the specification defined by equations (3) and (4) in order to distinguish between M&A inventors and the control group, which implies that a merger is assumed to be exogenous for the individual inventor:

$$s_i = I\{patent\ productivity_i \alpha_1 + experience_i \alpha_2 + M\ \&\ A_i \alpha_3 + Z_i \alpha + u_i > 0\} \quad (5)$$

$$patent\ productivity_i = X_i \beta + s_i \delta + M\ \&\ A_i \gamma + \gamma \lambda_i + \varepsilon_i \quad (6)$$

The estimation results are presented in Table 4. Again, a robustness check is provided for inventors with more than four patents. A robustness check for known survivors only cannot be presented as none of the known survivors in the control group left the firm after the time period of interest. This can be interpreted as a strong indication for the fact that firm acquisitions are a significant reason for inventor mobility.

The estimated effects for the likelihood to leave the firm after 2001 (first and third column of Table 4) confirm that a firm acquisition significantly increases the likelihood that inventors as well as key inventors with more than four patents leave the firm (Hypothesis 1 cannot be rejected). The further estimated coefficients for the likelihood to stay in the company are in line with the results discussed in the previous section.

With focus on the patent outcome after the year 2001 the second column of Table 4 shows that inventors that stay with their firm beyond the year 2001 are more productive than those that change their employer. There is no significant difference for inventors that have experienced a firm acquisition and the control group (no empirical support for Hypothesis 5). Hence, the productivity decline after moving might be due to the fact that inventors have to get acquainted to a new research environment independent of having been involved in a merger, on the one hand. On the other hand, independent of having been involved in a merger inventors are often not allowed to exploit the knowledge they gathered in the old firm within a new company, at least for a certain time period.

## Table 4: Estimation Results from a Selection Model with Control Group

| | I | | II | |
|---|---|---|---|---|
| endogenous variable | stay (yes/no) | log(pat) [A] | stay (yes/no) | log(pat) [A] |
| estimation method | probit | OLS | probit | OLS |
| sample | full sample | | patents > 4 | |
| | estimated coefficient (standard error)[A] | | | |
| stay (yes/no) | | 0.97*** | | 0.89*** |
| | | (0.15) | | (0.20) |
| □ | | -0.20** | | -0.20* |
| | | (0.09) | | (0.11) |
| M&A | -0.71*** | -0.07 | -0.42*** | -0.04 |
| | (0.12) | (0.05) | (0.16) | (0.06) |
| log(# pre-acquisition patents) | -0.96*** | 0.27*** | -0.93*** | 0.20*** |
| | (0.20) | (0.02) | (0.38) | (0.03) |
| pre-acquisition patents of the inventor fo e target over her total patents (%) | 0.30*** | | 0.25*** | |
| | (0.06) | | (0.09) | |
| private patents (yes/no) | -0.34** | 0.18*** | -0.26 | 0.13* |
| | (0.15) | (0.06) | (0.16) | (0.08) |
| log(experience) | 0.15** | -0.15*** | 0.13 | -0.21*** |
| | (0.07) | (0.03) | (0.10) | (0.03) |
| pre-acquisition techn. diversity | 0.15 | 0.00 | -0.06 | -0.06 |
| | (0.17) | (0.06) | (0.21) | (0.08) |
| citations received (yes/no) | 0.02 | 0.09** | -0.02 | 0.07 |
| | (0.12) | (0.04) | (0.13) | (0.08) |
| time since last patenting | -0.28*** | -0.20*** | -0.29*** | -0.25*** |
| | (0.04) | (0.02) | (0.06) | (0.03) |
| patents for the acquired firm | 0.91*** | | 1.07*** | |
| | (0.16) | | (0.18) | |
| centrality (employer in 1999) | 0.65*** | | 1.09** | |
| | (0.24) | | (0.45) | |
| constant | 0.85*** | 0.60*** | 0.87* | 1.08*** |
| | (0.30) | (0.15) | (0.45) | (0.19) |
| number of observations | 1,414 | | 1,027 | |
| Wald-□$^2$ | 948.29*** | | 485.60*** | |

***, **, * indicates statistical significance on the 1%, 5% and 10% level.
[A] The dependent variable log(pat) is defined as the logarithm of the sum of patents per inventors +1 after 2001 in order to handle the observations for which the post-merger outcome is zero.

To summarize, a merger increases the likelihood that inventors leave the merged firm, but there is no effect of M&As on their patent productivity if compared to an inventor control group. The latter finding contrasts previous literature (Ernst and Vitt, 2000, Paruchuri et al., 2006). However, in previous papers inventor mobility and productivity was not compared to a control group.

## 6 Discussion

In summary, this paper reveals several interesting findings: 1) inventors react differently on firm acquisitions; the most productive and most experienced individuals are, however, most likely to stay with the merged entity; 2) post-merger patent performance of inventors that stayed with the merged entity is higher than the patent outcome of the inventors that left after the M&A; although 3) M&As trigger inventor mobility 4) patent productivity of inventors involved in M&As is not lower if compared to a control group of inventors that were not affected by firm acquisitions.

### Contribution

This study has perceptive implications for research on the impact of M&As on technology performance. Previous empirical research, which typically focused on the firm level of analysis, has found ambiguous results for the implications of M&As for innovation activities of the firms involved (Veugelers, 2006). For this reason different perspectives can be helpful in order to get further insights into the channels through which M&As influence innovation within the merged entity. One way to get more insights would be in-depth case studies (Cassiman et al., 2005). However, case studies are typically limited to small samples of analysis. Another possibility is to shift the focus of analysis towards more narrowly defined levels of analysis than the firm level. Evidence from the level of the business unit, the firm department and the employee level can lead to new results that can be helpful for understanding the different findings of previous empirical studies.

Focusing on the inventor level, this study quantifies the loss of knowledge through inventor mobility and declines in their productivity after M&As. The empirical results show that inventors react differently on firm acquisitions depending on their pre-merger performance, their experience, and the intensity of their ties to the acquired company. Star inventors with a large patent portfolio and a rich experience can be an important factor for the decision to acquire a particular firm and their departure after an acquisition could conflict with the acquisition motivation. Such inventors have significant bargaining power within the merged entity, but also in negotiations with other companies in the market. The empirical findings show, however, that the most productive and most experienced inventors can be kept in the merged entity after firm acquisitions. Further, close ties to the acquired company work in favor for the merged entity hindering inventors to leave the company in the post-merger period.

The analysis further reveals that inventors' response to the firm acquisition as a disruption to their working environment and their established working routines is heterogeneous. While productive inventors have less difficulties to catch up with their pre-merger performance, inventors that are already for a long time in the patenting business and those that have been working in a research environment with other inventors before are less productive in the post-merger period than others, independent on whether they stayed with the merged entity or left for a new challenge. An important finding is that the patent productivity of inventors that left after the acquisition is significantly lower than the patent outcome of their colleagues that stay with the merged firm. This finding shows that the knowledge outflow through inventors leaving the company is limited. Reasons for that can be that inventors need a certain period to get acquainted to a new working environment, on the one hand. On the other hand, labor contracts might inhibit the exploitation of the knowledge gathered in the old firm for a new employer, at least for a certain time period.

A further important contribution of this study is that it compares the post-merger behavior of inventors involved in M&As with a control group of inventors that was not affected by M&As in the same time period. The empirical findings confirm that mobility is indeed a response to firm acquisitions and not a pattern of general industry dynamics. However, the results show that inventors involved in M&As are not less productive than others in the post-merger period as is hypothesized by the previous literature, but never explicitly tested. This leads to the conclusion that inventor mobility after M&As is rather explained by inventor heterogeneity and just triggered by the firm acquisition rather than caused.

# 7 Management implications

Two management implications can be derived: First, M&As trigger inventor mobility, but the most experienced and most productive inventors can be kept with the merged firm. This can be explained by the fact that the uncertainty about the skills and capabilities of the inventors is smaller for the acquired firm than for a potential new employer. Hence, acquiring firms should make sure to exploit this advantage. They can enhance their advantage in making more suitable job offers to inventors they want to keep than outsider firms by getting a detailed picture of the inventive labor force of the target company, their technological skills, and knowledge, and also of their working routines in the acquired firms. The same knowledge about acquired inventors can be used to limit disruptive effects to their working routines, which should positively affect their productivity. Acquiring firms should keep in mind that the threat of leaving is largest for inventors with a medium patent productivity. An early screening of inventor profiles can help to keep individual inventors among those that are most likely to leave after an acquisition in case this is expected to be beneficial.

Further, the fact that inventors that stay with the acquired company are, on average, more productive than their colleagues that left in response to a merger shows that although the departure of inventors constitutes a significant knowledge outflow the lost knowledge cannot be exploited in the new firm without any difficulties. On the one hand, the new employer of the inventor might lack the necessary capacities to fully use the acquired knowledge. On the other hand, it might be that labor contracts with the old employer hinder the inventor to make use of her knowledge in the new company, at least for a certain time period. Moreover, the inventor might need some time to get acquainted with the technologies and the working environment of the new firm. A look at the patent portfolio of the acquired inventors provides detailed information on their previous work. This information can be used when developing the design for post-merger integration. For example, it can help to find out with which technical equipment the inventors were working before, it can show whether the inventor worked alone or in a team of inventor (which can be seen from the presence of co-inventors on his patent filings), and, hence, can be used to define an appropriate position for the individual inventors within the new firm.

## 8 Limitations and future research

An obvious limitation of this study is the limited availability of firm data. Most debatable is maybe the fact that firm size has to be proxied by the size of the firms' patent portfolio, which doesn't really allow to control for size differences because the firm size of the acquired firm is highly correlated with the patent portfolio of the (often few) inventors involved. As the data covers not only large and public firms it would be extremely difficult, if at all possible, to find firm information for small and private firms that have been acquired several years ago.

A second limitation of the study, like of any, is its boundedness in scope. It would be interesting to have information about the actual post-merger integration activities within the merged firm and on potential changes in the merged entity's technology strategy after the acquisition. Such detailed information could be helpful to explain parts of inventors' post merger mobility and productivity. As it is doubtful that such information can be collected on a large scale it would be important to have some case study evidence on post-merger integration in firms. Case study evidence could also be helpful for getting more insights into the reasons behind inventor mobility after M&As. Are most of them leaving for a better job offer or is the decision rather made by the acquiring firm?

For future research it would also be interesting to focus in addition on inventors that leave the acquiring firms and on those inventors that get hired after the acquisition. This would allow answering some more questions as, for example, whether inventors that left after an acquisition are replaced at all; and if so whether they are replaced by more productive colleagues or by inventors with a very different profile. This could lead to interesting results about changes in technology activities as visible in changes in the profile of the inventive labor force after M&As.

# References


Ahuja, G. and R. Katila (2001). Technological Acquisitions and the Innovation Performance of Acquiring Firms: A Longitudinal Study. *Strategic Management Journal* 22(3): 197-220.

Ali-Yrkkoe, J., A. Hyytinen and M. Pajarinen (2005). Does Patenting Increase the Probability of Being Acquired? Evidence from Cross-Border and Domestic Acquisitions. *Applied Financial Economics* 15: 1007-1017.

Arrow, K.J. (1962). Economic Welfare and the Allocation of Resources for Invention. In: R.R. Nelson (Ed.), *The Rate and Direction of Inventive Activity:* 609–625. Princeton, NJ: Princeton University Press.

Becker, G.S. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy* 70(5): 9-49.

Biger, N. and S.E. Plaut (2000). Trade Secret, Firm-Specific Human Capital abd Optimal Contracting. *European Journal of Law and Economics* 9: 49-71.

Capron, L. (1999). The Long Term Performance of Horizontal Acquisitions. *Strategic Management Journal* 20, 987–1018.

Capron, L., P. Dussauge and W. Mitchell (1998). Resource Redeployment Following Horizontal Mergers and Acquisitions in Europe and the United States 1988–1992. *Strategic Management Journal* 19: 631–661.

Cassiman, B., M. Colombo, P. Garrone and R. Veugelers (2005). The Impact of M&A on the R&D Process. An Empirical Analysis of the Role of Technological and Market relatedness. *Research Policy* 34(2): 195-220.

Chakrabarti, A.K., J. Hauschildt and C. Süverkrüp (1994), Does It Pay to Acquire Technological Firms?, *R&D Management* 24 (1): 47-56.

Cloodt, M., J. Hagedoorn, and H. van Kranenburg (2006).Mergers and Acquisitions: Their Effect on the Innovative Performance of Companies in High-tech Industries. *Research Policy* 35: 641-654.

Dosi, G. (1982). Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change. *Research Policy* 11(3): 147–162.

Ernst, H. and J. Vitt (2000). The Influence of Corporate Acquisitions on the Behavior of Key Inventors. *R&D Management* 30(2): 105-119.

Felin, T. and W.S. Hesterly (2007). The Knowledge-Based View, Nested Heterogeneity, and New Value Creation: Philosophical Considerations on the Locus of Knowledge. *Academy of Management Review* 32(1): 195-218.

Frey, R. and K. Hussinger (2006). *The Role of Technology in M&As: A Firm Level Comparison of Cross-Border and Domestic Deals*. ZEW Discussion Paper No. 06-069, Mannheim.

Graebner, M. (2004), Momentum and Serendipity: How Acquired Leaders Create Value in the Integration of Technology Firms*, Strategic Management Journal* 25, 751-777.

Grimpe, C. and K. Hussinger (2007). *Firm Acquisitions and Technology Strategy: Corporate versus Private Equity Investors*. ZEW Discussion Paper No. 07-066, Mannheim.

Grimpe, C. and K. Hussinger (2008). Pre-empting Technology Competition through Firm Acquisitions. *Economics Letters*, forthcoming.

Hagedoorn, J. (1993). Understanding the Rational of Strategic Technology Partnering: Inter-organizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal* 14: 371-385.

Hall, B.H. (1988). The Effect of Takeover Activity on Corporate Research and Development. In: A. Auerbach (ed). *The Economic Effects of Takeover Activity. Chicago*: University of Chicago Press.

Hall, B.H. (1990). The Impact of Corporate Restructuring on Industrial Research and Development. *Brookings Papers on Economic Activity* 1990(1): 85-136.

Harhoff, D., F. Narin, F.M. Scherer and K. Vopel (1999). Citation Frequency and the Value of Patented Inventions. The Review of Economics and Statistics 81(3): 511-515.

Harhoff, D., F.M. Scherer and K. Vopel (2003). Exploring the Tail of the Patented Invention Value Distributions. In O. Granstrand (ed): *Economics, Law and Intellectual Property: Seeking strategies for research and teaching in a developing field*. Kluwer Academic Publisher, Boston/Dordrecht/London, 280-308.

Heckman, J.J. (1974). Shadow Prices, Market Wages and Labor Supply. *Econometrica* 42(4): 679-694.

Heckman, J.J. (1976). The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for such Models. *Annals of Economics and Social Measurement* 5(4): 475-492.

Heckman, J.J. (1979). Sample Selection Bias as a Specification Error. *Econometrica* 4(7): 153-162.

Hitt, M.A., R.E. Hoskisson, R.D. Ireland and J.S. Harrison (1991): Effects of Acquisitions on R&D Inputs and Outputs. *Academy of Management Journal* 34(3): 693-706.

Hitt, M.A., R.E. Hoskisson, R.A. Johnson and D.D. Moesel (1996): The Market for Corporate Control and Firm Innovation. *Academy of Management Journal* 39(5): 1084-1119.

Hoisl, K. (2007a). Tracing Mobile Inventors - The Causality between Inventor Mobility and Inventor Productivity. *Research Policy* 36(8): 1107-1127.

Hoisl, K. (2007b). Does Mobility Increase the Productivity of Inventors? *Journal of Technology Transfer*, forthcoming.

Hussinger, K. (2008). R&D and Subsidies at the Firm Level: An Application of Parametric and Semi-Parametric Two-Step Selection Models. *Journal of Applied Econometrics*, forthcoming.

Hussinger, K. (2005), *Did Concentration on Core Competencies Drive Merger and Acquisition Activities in the 1990s?* ZEW Discussion Paper No. 05-41. Mannheim.

Klein, K. J., F. Dansereau and R.J. Hall (1994). Levels Issues in Theory Development, Data Collection, and Analysis. *Academy of Management Review* 19: 195–229.

Kogut, B. and U. Zander (1992). Knowledge of the Firm, Combinative Capabilities, and the Replications of Technology. *Organization Science* 3(3): 383-397.

Kriechel, B. and G. Pfann (2005). The Role of Specific and General Human Capital after Displacement. *Education Economics* 13(2): 223-236.

Larsson, R. and S. Finkelstein (1999). Integrating Strategic, Organizational, and Human Resource Perspectives on Mergers and Acquisitions: A Case Survey of Synergy Realization. *Organization Science* 10(1): 1-26.

Lerner J., J. Tirole and M. Strojwas (2003). *Cooperative Marketing Agreements between Competitors: Evidence from Patent Pools*. NBER Working Paper 9680.

Levin, S. and P. Stephan (1991). Research Productivity Over the Life Cycle: Evidence for Academic Scientists. *American Economic Review* 81(1): 114-132.

Nelson, R.R. and S.G. Winter (1982). *An Evolutionary Theory of Economic Change*. Belknap Press, Cambridge, MA.

O'Donoghue, T., S. Scotchmer, and J.-F. Thisse (1998). Patent Breadth, Patent Life and the Pace of Technological Progress. *Journal of Economics and Management Strategy* 7: 1–32.

Ornaghi C. (2005). *Mergers and Innovation: the Case of the Pharmaceutical Industry*. University of Southampton Discussion Papers in Economics and Econometrics 0605.

Palomeras, N. (2004). *Markets for Inventors: Examining Mobility Patterns of Engineers in the Semiconductor Industry*. Mimeo. Universitat Pompeu Fabra, Barcelona, Spain.

Parson, D.O. (1972). Specific Human Capital: An Application to Quit Rates and Layoff Rates. *Journal of Political Economy* 80: 1120-1143.

Paruchuri S., A. Nerkar and D. C. Hambrick (2006). Acquisition Integration and Productivity Losses in the Technical Core: Disruption of Inventors in Acquired Companies. *Organization Science* 17(5): 545 - 562.

Pritchett, P. (1985). *After the Merger: Managing the Shockwaves*. New York: Dow Jones, Irwin.

Ravenscraft, D.J. and F.M. Scherer (1987). Life after Takeover. *Journal of Industrial Economics* 36, 147–157.

Reinganum, J.F. (1983). Uncertain Innovation and the Persistence of Monopoly Reply. American Economic Review 74: 741-748.

Song, J., P. Almeida, and G. Wu (2003). Learning-by-Hiring: When is Mobility More Likely to Facilitate Inter Firm Knowledge Transfer? *Management Science* 49(4): 351-365.

Souder, W.E. and A.K. Chakrabarti (1984). Acquisitions: do they really work out? *Interfaces* 14(4): 41-17.

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics* 87(3): 355-374.

Szulanski, G. (1999). Appropriability and the Challenge of Scope: Banc One Routinizes Replication. In G. Dosi, R.R. Nelson and S.G. Winter (eds.): *Nature and Dynamics of Organizational Capabilities*. Oxford University Press, New York, 69–98.

Teece, D.J. (1986), Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy* 28: 63-80.

Teece, D.J. (1992), Competition, Cooperation and Innovation. *Journal of Economic Behavior and Organization* 18: 1-25.

Teece D.J., G.P. Pisano and A. Shuen (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal* 18: 509–534.

Trajtenberg, M., G. Shiff and R. Melamed (2006). *The Names Game: Harnessing Inventors' Patent Data for Economic Research*. NBER Working Paper 12479.

Valentini, G. (2004). *Mergers and Acquisitions and Technological Performance*. mimeo. IESE Business School.

Veugelers, R. (2006). Literature Review on M&A and R&D. In: Cassiman, B. and M.G. Colombo (eds.). *Merger and Acquisitions - The Innovation Impact*.

Zucker, L.G., M.R. Darby and J.S. Armstrong (2002). Commercialization Knowledge: Capture, and Firm Performance in Biotechnology. *Management Science* 48(1): 138-153.

# Appendix

## Table 5: Descriptive Statistics: Leaving versus Quitting Inventors.

| | | Inventors | |
|---|---|---|---|
| Behavior after the acquisition | stay | leave | quit patenting |
| Number (#) of observations | 449 | 95 | 129 |
| | mean (std. deviation) | mean (std. deviation) | difference (std. error) |
| Inventor characteristics: | | | |
| # pre-acquisition patents | 6.88 (11.22) | 6.57 (5.40) | 5.47 (5.14) |
| pre-acquisition patents of the inventor for acquired firm over total patents (%) | 0.81 (0.30) | 0.51 (0.34) | 0.77 (0.29) |
| # post-acquisition patents | 4.16 (5.38) | 2.89 (3.55) | 0 (0.00) |
| citations received (yes/no) | 0.15 (0.36) | 0.23 (0.42) | 0.13 (0.34) |
| private patents (yes/no) | 0.07 (0.26) | 0.23 (0.42) | 0.12 (0.32) |
| experience | 8.79 (6.69) | 10.91 (6.06) | 9.20 (6.23) |
| pre-acquisition techn. diversity | 0.32 (0.31) | 0.45 (0.31) | 0.38 (0.29) |
| centrality (target) | 0.22 (0.37) | 0.05 (0.10) | 0.09 (0.21) |
| centrality (acquirer) | 0.03 (0.04) | 0.03 (0.03) | 0.04 (0.04) |
| time since last patenting | 0.65 (1.21) | 1.11 (1.48) | 1.54 (0.52) |
| Deal characteristics: | | | |
| acquired stake | 94.13 (14.88) | 94.10 (14.50) | 94.50 (13.87) |
| horizontal M&A (same 3-digit NACE) | 0.48 (0.50) | 0.43 (0.50) | 0.46 (0.50) |
| cross-border M&A | 0.44 (0.50) | 0.49 (0.50) | 0.64 (0.49) |
| Acquiring and target firms' characteristics: | | | |
| # patents of acquiring firm | 118.47 (1,146.17) | 123.00 (374.52) | 62.15 (208.00) |
| group of 2-4 inventors (yes/no) | 0.32 (0.47) | 0.28 (0.45) | 0.50 (0.50) |
| group of more than 4 inventors (yes/no) | 0.27 (0.45) | 0.14 (0.35) | 0.24 (0.43) |
| target in NACE 24-26 | 0.14 (0.35) | 0.13 (0.33) | 0.05 (0.23) |
| target in NACE 29 | 0.15 (0.36) | 0.11 (0.31) | 0.20 (0.40) |
| target in NACE 30-33 | 0.19 (0.40) | 0.21 (0.41) | 0.09 (0.29) |
| German target | 0.37 (0.48) | 0.26 (0.44) | 0.31 (0.46) |
| French target | 0.17 (0.37) | 0.13 (0.33) | 0.17 (0.38) |
| UK target | 0.18 (0.38) | 0.27 (0.49) | 0.22 (0.41) |