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**Working Paper**

## Post Merger Innovative Patterns in Small and Medium Firms

Discussion Papers Series, No. 08-09

**Provided in Cooperation with:**

Utrecht University School of Economics (U.S.E.), Utrecht University

*Suggested Citation:* Cefis, Elena; Ghita, M. (2008) : Post Merger Innovative Patterns in Small and Medium Firms, Discussion Papers Series, No. 08-09, Utrecht University, Utrecht School of Economics, Tjalling C. Koopmans Research Institute, Utrecht

This Version is available at:

<https://hdl.handle.net/10419/322755>

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ontwerp voorblad: WRIK Utrecht

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# Post Merger Innovative Patterns in Small and Medium Firms

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May 2008

## Abstract

This paper investigates whether involvement in mergers and acquisitions (M&As) triggers distinct patterns of innovative behaviour across firms situated at different points on the firm size distribution. Firms use more and more M&As as mechanisms to bridge the gap between where they are and what they want to achieve in terms of innovation and performance. We explore the different impact of M&A activity on the likelihood that firms begin to innovate using an unique dataset combining innovation and economic firm-level data from two different sources: the 4 waves of Community Innovation Survey and the Business Register, for the Dutch manufacturing sector. The analysis is carried out at different size classes. The results show that both new entry and persistence in innovative activities are fostered by M&A involvement. Medium firms are the ones showing the highest probabilities of entering /persisting in innovative activities after M&As. For small firms, M&As do not ease the overcome of "the innovative threshold"; on the contrary they seem to increase the probability of exiting innovative status in the post-merger period.

**Keywords:** Mergers and acquisitions; innovation; small and medium enterprises; transition probabilities; probit models

**JEL classification:** L11, L25, D21, C14

## Acknowledgements

The authors would like to thank Rob Alessie, Adrian Kalwij, Hans Schenk and Utz Weitzel for useful suggestions and comments. The empirical part of this research has been carried out at the Centre for Research of Economic Microdata at Statistics Netherlands (CBS). The views expressed in this paper are those of the authors and do not necessarily reflect the policies of Statistics Netherlands. The authors thank Gerhard Meinen and the on-site staff of the CBS for their precious collaboration. The authors gratefully acknowledge the financial support of NWO (Dynamics of Innovation Programme, grant no.: 472-04-008). Elena Cefis also acknowledges the financial support of the University of Bergamo (grant ex 60%, n. 60CEF108, Dept. of Economics).

## 1. Introduction

In an every day more challenging economic and social environment, innovation becomes a *sine qua non* condition for achieving corporate growth. By ignoring it, not only maintaining high levels of profitability or building competitive advantage in the market becomes difficult, but firms survival itself may be at risk. Building up a successful innovation-based strategy requires important resources and capabilities that are often difficult to develop internally, especially when considering small firms.

Recent literature in the field talks about an “innovative threshold” that is binding especially for small and medium firms. This is the empirical evidence reported by several studies (Geroski et al., 2001; Cefis and Orsenigo, 2001; Cefis, 2003), which seems to offer support to the Schumpeter Mark II hypothesis of large firms innovating more than small firms and showing also higher levels of persistency. The threshold effect is often identified in terms of patenting activity - it is a lot easier to go from  $n$  to  $n+1$  (with  $n$  strictly larger than 1) than from 0 to 1 patents (Cefis, 2003) - or in terms of size and capacity of sustaining R&D investment (Schumpeter, 1942; Cohen and Levinthal, 1989; Gonzalez and Pazo, 2004). Patenting activity appears to be an adequate indicators for evaluating innovative behaviour because applying for a patent indicate that firms are performing innovative activities inside the firms and implies also a major incentive for firms to carry out further work and make the necessary investments needed to bring the inventions to commercial use (Mansfield, 1993).

Still, patenting and carrying out innovative activities often require changes in the pattern of resource deployment at firm level. This implies developing new capabilities (R&D plants, laboratories), investing in hiring and training of new personnel, as well as marketing costs when these innovations are ready to be launched in the market. These changes generally incur irrecoverable starting costs – most often labelled in the literature as “the sunk costs of R&D investments”, as well as a high degree of uncertainty on whether the investments will ultimately pay off. It is therefore clear that large firms possess a higher capability to invest in long run technological processes and to generate innovative outputs (see Kamien and Schwartz, 1982; Syreonidis, 1996; and Cohen and Levin, 1989 for a broad review of firm size effects on innovative performance).

Yet, as underlined in our opening statement and also noted by numerous other researchers (Butler, 1988; Miller, 1989; Schonberger, 1996) innovation has become critical for all firms. The challenges of globalization, the rapid technological changes, the increasing competition and speed with which firms can launch new products or services to the market have led to major transformations in the way innovation is perceived at corporate level. This implied also reconfigurations in firm-level “dynamic capabilities” (Teece and Grindley, 1997) or in their “intermediate transformation ability” (Dutta et.al., 2005). What used to be seen as “the firms ability to build and reconfigure internal competences, resources, assets, to address rapidly changing environments”, has started more and more to emphasize and incorporate a higher external dimension. In-house R&D and “make only” technology sourcing strategies are no longer possible in a world in which managers acknowledge the presence of more capability and innovation in the market place than they could try to create on their own (IBM Institute for Business Value, 2006).

It becomes more and more the case that firms start taking advantage of the rise of “markets for technology” (Arora et al., 2001), relying more on external procurement. One of the most often employed, but also most controversial source of obtaining access to external technologies, is entering M&A agreements. A growing body of literature (Hagedoorn and Cloudt, 2003; Cassiman et al. 2005; Cassiman and Veugelers, 2007) provides evidence on the fact that, when motivated by the goal of acquiring new technology and when complemented by an efficient management of the knowledge transfer and integration process, M&As can indeed positively affect firms innovative performance.

Meyer (2007) sees M&As as adding “a new DNA to the corporate gene pool” and introducing a new way of thinking to the way firms operate. Of course, as also numerous studies analyzing M&As effects on innovation report, we very often assist to what Meyer labels as “a massive organ rejection by the body”. This is mainly due to the fact that it might be the case that M&As are indeed capable of offering an earlier but riskier entry position in developing successful innovations than would for example provide in-house R&D and internal innovative growth, but this takes place only under certain conditions. These conditions imply complementarities in resources (relatedness), similar culture and management styles (organizational fit), post-merger sharing of resources and learning processes following M&A agreements. In short, M&As can provide access to new technologies, but it is up to firms M&A rationale as well as to their ability to benefit from a

post merger integration process conducted in such a way that allows them to learn to manage R&D and innovation in an efficient manner.

In this study, we depart from the M&A and innovation literature focusing on large and very large companies and question whether primary motivations behind M&A agreements performed by SMEs are their efforts to achieve the necessary resources, technologies, capabilities allowing them to overcome the “innovative threshold”. Accordingly we address the relevancy of M&A activities as possible drivers of innovative performance for small and medium firms. Specifically, we are interested whether: (1) SMEs use M&As as a mean for acquiring technology and overcoming the innovative threshold; (2) M&As foster the innovative “transition” over the innovative threshold that is believed to be binding especially SMEs to a non-innovative status.

The analysis is carried out at firm-level, covering the Dutch manufacturing industry over a period of eight years (1994-2002). Sectoral specificities are identified using a refinement of Pavitt’s (1984) taxonomy proposed by Marsili (2001). The originality and the fit of such a taxonomy for our study is given by its inclusion of small and micro firms in mapping the relevant dimensions of technological regimes.

The study brings two main contributions. First, making use of transition probability matrices, we provide new evidence on patterns of entry and of persistence in innovative activities across size classes. We examine whether or not the observed innovation patterns differ for M&A active and non-active firms. The second contribution is to empirically test, by means of probit models whether M&As act as incentive/determinant for firms to cross the “innovative threshold” and/or to remain persistent innovators.

The paper is organized as follows. Section 2 gives a brief review of the theoretical background underlying our research. Section 3 discusses the data construction and the methodology. In section 4, we report the results of both univariate (transition probability matrices) and multivariate analysis (probit regressions). Section 5 concludes with a brief summarizing discussion and final remarks.

## 2. Theoretical background

From a firm-level perspective, innovation represents the outcome of increases in firms knowledge bases (Griliches, 1984, 1990; Pakes and Griliches, 1984). Firms knowledge bases can grow either through in-house R&D made by companies over time or through external acquisitions and licensing (Cohen and Levinthal, 1989).

M&As are more and more employed as mechanisms of learning and of acquiring resources, competences and capabilities from knowledge sources beyond the boundaries of the firm (Cassiman and Veugelers, 1998, and 2002). Though not so much investigated by M&A and innovation literature, this is to a larger extent also the case of small firms, forced to face greater difficulties in becoming innovative or in persisting in these activities. Innovation complexity increases, moving away from focusing on technology *per se*. Laying the foundations for long-term innovation strategies involves more and more a right mix of resources, highly specialized R&D personnel, integrated data for decision making, competences, and capabilities difficult to consolidate and integrate internally in small firms. These difficulties reside mostly in the sunk costs of R&D investment (see Sutton, 1991 or Manez Castillejo et al., 2006). R&D activities generally imply important, usually unrecoverable start-up costs of implementing fully integrated innovation platforms including building R&D labs, specialization of R&D personnel, allocating R&D and innovation budgeting which for small firms represent relevant entry barriers into innovation activities. As a result, small firms, when entering M&A agreements are more prone to using them as means of external sourcing, acquiring new technologies that will allow them to gain access to resources, knowledge and competences needed for developing innovative strategies.

There are several alternative views about the way M&As affect the innovative potential of firms. On one hand, M&As foster innovation by allowing firms to exploit economies of scale and scope in R&D, while on the other hand they may prove detrimental to innovation in the long run, by altering competition in the market. Industrial organizational literature assesses the impact of M&As on innovation studying either post-merger R&D expenditures, or, as more recent studies attempt, by simultaneously tackling a series of research inputs, outputs and dynamic efficiencies (for a review see Cefis et al., 2007 and Schulz, 2007). Yet, when innovation effects are directly targeted, the empirical results are quite diverse succeeding in feeding rather than settling the current debate. Furthermore, most of the existent



studies have generally focused on transactions in which solely large firms were involved (Schenk 2006), ignoring to a large extent the position of small firms.

Ahuja and Katila (2001) draw upon theories of technological innovation, learning, and the Resource Based View theory and synthesize three main effects of M&As on the post-acquisition performance of acquiring firms: (1) M&As increase firms knowledge base, technological know-how and technical capabilities; (2) M&As affect firms innovative output; (3) M&As help redeploying resources into more productive uses.

However, several empirical studies have generally found that M&As have a negative impact on the post-acquisition innovative inputs and outputs of acquiring firms (Cassiman et al., 2005). The contrasting conclusions of the theoretical and empirical studies confirm that both M&A and innovation are indeed very complex phenomena. This complexity makes it difficult to derive patterns or configurations meant at fully explaining their beneficial impact on firm-level innovativeness or to the contrary, the lack of such benefits. Trying to account for these contrasting results requires acknowledging that not all M&As are the same, and their impact depends strongly on size classes and other firm-level characteristics. Recent literature stresses the importance of technological vs. non-technological driven M&A transactions, arguing that if M&As involve technological components, being motivated by reasons like technological renewal and diversity, enlargement of firms knowledge bases, they are more likely to have a positive impact on firms post M&A innovative performance.(Cassiman et al., 2005).

The aim of our study is breaking the effect of M&A activities along size classes, questioning whether it is the case that small firms engage more often in technological driven M&A transactions than their large counterparts, having thus higher probabilities of deriving innovative gains. Starting from these premises, the study explores if and to which extent firm-level innovative patterns are being re-shaped by M&A transactions, and whether this reshaping varies along firm size distribution.

There is still much disagreement in the literature on whether innovation is more fostered by small or large firms. According to the early Schumpeter theory (1934), new small entrepreneurial firms contribute greatly to innovation, the innovative base continually enlarging through the entry of new innovators.. To the contrary, his later theory (1942) identifies as main actors in innovative activities the large firms, which draw on knowledge

accumulation advantages and scale economies in R&D activities, posing relevant entry barriers to innovation for small and medium firms. However, both theoretical (Winter 1984) and empirical studies (Acs and Audretsch, 1987, Santarelli and Vivarelli, 2007) have shown that small firms are likely to respond to different economic and technological environments compared to large companies.

Large firms have an innovative advantage in markets characterized by imperfect competition and seem more prevalent in developing final goods markets through their technological efforts. To the contrary, smaller firms have an innovative advantage in markets more closely approximating the competitive model. They either innovate in market niches or perform quite radical innovations, developing the market for technology themselves and tying their growth to the growth of their smaller market. (Cosh et al., 1998; de Jong and Marsilli 2006). This is in line with their specific comparative advantage: larger R&D and risk spreading capacity, longer planning horizon on behalf of larger firms, but confronted with higher level of inflexibility, bureaucracy or organizational problems (Aiginger and Tichy 1991) and on the other hand flexibility and creativity on behalf of smaller firms, but facing greater R&D, marketing and training of personnel problems

Differences in innovative behaviour are expected to lead also to differences in the way firms exploit external sourcing strategies in order to perform their innovative activities. Evidence shows that faced with higher resources and capability constraints, small innovators are more prone to rely on external sourcing when undertaking innovations, choosing more often a “buy” versus a “make” innovative strategy (Cassiman and Veugelers, 1998). Consequently, their involvement in M&As is more prone to take the form of innovation driven strategic alliances which are more likely to trigger innovative and welfare benefits. This is supported by the recent finding of Cassiman and Colombo (2006) which sustains that “where innovation is itself the main motive of the M&A activity, the results can often be positive and sometimes extremely so.”

We aim to analyze whether involving in M&As benefits to a greater extent small firms compared to large ones, in terms of innovation. By a higher innovative impact in small firms we imply either an increase in the probability of entering in innovative activities or an increase in innovative persistence, following merger activities. The results are important from both theoretical and policy perspectives. From a theoretical point of view, they contribute to the existent literature underlying basic assumptions on firms innovativeness - creative

destruction vs. creative accumulation theories (Schumpeter 1934, 1942) or the existence of a threshold to innovate (Geroski et al., 1999; Cefis, 2003). From a managerial point of view, innovation activities are vital for strengthening competitiveness and ultimately for ensuring firms survival (Cefis and Marsili, 2006). Finally, the analysis can be of use to competition authorities in dealing with mergers scrutiny or to governments in designing innovation-stimulating policy measures.

### **3. Data and methodology**

#### **3.1 The data**

The analysis makes use of an unique longitudinal dataset that combines economic and firm-level data from two different data sources elaborated by the Central Bureau of Statistics in the Netherlands: the Community Innovation Survey (CIS) and the Business Register database (BR). The CIS collects data on activities related to product and process innovation, innovative strategies and sources as well as on M&A activities . The importance of the CIS data resides in allowing to draw a pattern of the innovation process at the firm level in a more accurate and direct way than different innovation indicators allow, as several recent studies have shown (among others, see Cassiman and Veugelers, 2002; Mairesse and Mohnen, 2002; Kleinknecht , 1996, Kleinknecht et al., 2002 )

It is conducted on a four-year basis and each survey reports information on the activities performed by firms in the previous three year period. In the Netherlands, CIS surveys have been conducted every two years, offering thus the possibility of analyzing five waves, pertaining to the periods 1994-1996 (CIS2), 1996-1998 (CIS2.5), 1998-2000(CIS3), 2000-2002 (CIS3.5) and 2002-2004 (CIS4).

The Business Register database consists of all the firms registered for fiscal purposes in the Netherlands. The database reports firms number of employees, sector of activity and the date of entry and exit of a firm in/from the Business Register. Due to its comprehensive nature and fiscal purposes, the dates of inclusion and exclusion are very closely approximating the actual dates of entry and exit in/from the market ( Cefis and Marsili, 2006).

Combining these datasets allowed us to integrate firm-level data on innovation and on their involvement in M&A activities with firm specific demographic characteristics as age

and size. Given that the analysis is focused on the post-merger innovative performance of firms and that CIS 4 does not contain any variable on M&A activities, the resulting unbalanced panel covers the manufacturing industry in the time frame 1994-2002 and uses the data of the first 4 CIS waves. The panel data has a cadence of two years, given the CIS waves, thus it allows accounting for the post-acquisition integration period in studying the effects of M&As.

## **3.2 The variables**

### **3.2.1. The choice of innovation proxies**

The Oslo Manual (1997), including the methodological guidelines for implementing the Community Innovation Survey, defines innovation a new - or significantly improved - product (good or service) introduced to the market and the introduction of a new or significantly improved production process within the firm.

To evaluate the differences in post-merger innovative patterns among Dutch manufacturing firms, we construct a binary proxy ( $y_{it}$ ) defining firms innovative status at each time  $t$ . The variable acts as differentiator for innovative versus non-innovative firms and takes the value 1 if the firm has introduced any innovation materialized in technologically new or improved products, services or processes, or has invested in R&D activities or made innovation expenses at any time in the three year period prior to the survey. By investment in innovation and/or in R&D we include expenses in intra and/or extramural R&D, patents and copyrights applications, acquisitions of external knowledge, expenses related to product design and market introduction, and training of R&D personnel. The choice for such a wide proxy of innovation is motivated by the main aim of our study - that of capturing whether M&As help firms to become innovators in every possible way. Using TPMs we want to analyze whether M&As help overcome the “innovative threshold”, without differentiating whether this innovative transition is a result of introducing a new or improved product or process or the result of investing in different sources of innovation.

For evaluating the distinct innovative patterns along firm size classes the analysis estimates the probabilities of changes in firms innovative status (innovators vs non-innovators). We define firms according to their changes in innovative patterns. If a firm is a non-innovator in

the previous CIS wave, and an innovator in the current CIS wave, we define the firm as a new entrant in innovation activities. If a firm has been an innovator both in the previous and in the current wave, we define the firm as being a persistent innovator.

### **3.2.2. The M&A proxy**

One of the aims of a post-acquisition study on firm-level innovativeness is to comprehend whether acquiring firms show better innovative performance after the M&A. The challenge for companies is not only to acquire knowledge bases, competences and capabilities but also to integrate them into their own resources in order to improve their post-M&A innovative performance (Ahuja and Katila, 2001). For a merger to yield significant positive results, both in terms of static and dynamic efficiency, a sufficiently long post-merger integration period has to be allowed for. Haspeslagh and Jemison (1991) stress the importance of maintaining an optimal level of interaction during the post merger integration process, allowing an efficient transfer of strategic capabilities from the target to the acquiring firm. Jansen (2002) develops a “7-C model of post-merger integration”, emphasizing the key role of early integration planning, the need to define corporate goals and to clearly transmit them to the merged entity. Special attention needs to be paid simultaneously to address corporate differences at the level of the merged firms, as well as to retain both customers and key staff during the initial transition period. The complexity of the whole post merger integration process requires a time span of at least 2-3 years.

As a proxy for M&As activities, we construct a dummy variable that indicates whether or not the company has engaged in the acquisition of or in a merger with another firms during the three years that pertain to the CIS observation period. In order to investigate post-acquisition innovative performance of Dutch manufacturing firms, we have considered the lagged M&A variable - that is the one belonging to the previous CIS wave -, thus allowing for a post-integration period that can vary from 2 up to 4 years.

### **3.2.3. Accounting for sector specificity and firms heterogeneity**

In the multivariate analysis, we introduce some variables to control for sector and firm specificities. . In order to capture and control for differences in the nature of technology, organizational sectoral specificities and opportunity conditions (easier to innovate in certain fields than in others; possibly industry targeted innovation policies) ( Mairesse and Mohnen, 2002), we choose a refinement of Pavitt's taxonomy (1984) proposed by Marsili (Marsili, 2001; de Jong and Marsili, 2006). Pavitt taxonomy gives a greater role to large firms rather than to small and medium ones and therefore is not the optimal taxonomy to account for intra-industry differences across firm size classes. The taxonomy proposed by Marsili overcomes this flaw classifying firms according to their innovative behaviour and directly accounting for firm size, in order to target and include small and micro firms. Applying Marsili's taxonomy we obtain five technological classes suitable for mapping the entire Dutch manufacturing sector: science based, fundamental processes, complex (knowledge) systems, production engineering and continuous processes. A more comprehensive overview of these technological regimes is given in the Appendix. Figure 1 exhibits the percentage of innovators across technological regimes. The majority of SME firms innovate mostly in the production engineering regime, with quite a large share of small firms innovating in the science-based or fundamental process regime. The production engineering technological cluster is characterized by a medium to high level of technological opportunity, low entry barriers and not very high persistence in innovativeness. What particularly distinguishes it is a very high diversity of technological trajectories explored by firms.

Firm characteristics like size and age have been accounted for in analysing firms changes in innovative behaviour. We constructed three distinct size classes according to firms number of employees. Firms have been classified as small if their number of employees ranges from 10 to 49, as medium from 50 to 250 employees and large if their number of employees exceeds 250. The TPMs and probit models were estimated classifying firms in these three size classes according to the average value of the number of employees calculated across all years of the observation period. This variable has been constructed using yearly firm-level data taken from the Dutch Business Register. Furthermore, in the multivariate analysis, the logarithm of the number of employees for each year of observation as been used as proxy for firm size. Firm age is calculated in months as date of entry in the Business Register and its variable is expressed in logarithm values.

Table 1 provides an indication of the composition of the CIS manufacturing sample, according to size classes. The structure of the sample consists of 30% small firms, around 50% medium-sized and 20% large and very large firms. Table 2 shows some descriptive statistics of the number of employees according to the size classification.

The literature analyzing the correlation between firm size effects and innovation activity generally reports mixed results, with a tendency towards a positive but not necessarily linear trend (Cohen and Levin, 1989; Kamien and Schwartz, 1982; Evangelista et al., 1997). The impact of age has also been found to be highly non-linear, with low volatility along size classes – typically higher rates of innovators are found in young and grown-up classes, the rates slowly decreasing for older firms. (Huergo and Juamandreu, 2004).

The sunk costs of R&D investments argument or the need for an efficient post-merger integration would lead us to expect negative gains from mergers and acquisitions at the lower tail of firm size distribution. However, we expect this negative effect to progressively vanish with an increase in firm size. Thus, we predict a curvilinear, inverse U-shaped relation between firm-size and the likelihood of deriving positive gains in terms of innovation activity from M&A transactions. Small firms, in spite of great inducement and quite high levels of innovativeness, lack the financial stability and resources for using external acquisitions as innovation strategies. At the same time, though costs don't prevent large firms from involving in mergers or acquisitions, they might have low inducements to do so, as often are able to opt for a do-it-alone strategy.

### **3.3 The methodology**

We estimate Transition Probability Matrices (TPMs) to analyse changes in firm innovative behaviour among different size classes. The TPM framework is a non-parametric method which allows analysing the intra-distribution mobility of firms (Cefis, 2003) from one state to another in a specific period. The transition period is the cadence of the Dutch CIS waves, namely two years, therefore, by TPMs, we investigate firm innovative patterns estimating the probability that firms have to remain in the same innovative status (innovators or non-innovators) or to pass from the non-innovative status to the innovative status (and *vice versa*) in a two year period. Two innovative patterns will be the main focus of the analysis:

firms passing from being non-innovators to active innovators, as well as firms persistence in innovative activities. TPMs are computed distinctly for small, medium-sized and large firms, for both M&A active and non-active firms.

In the multivariate analysis, we estimate a random effect probit model in order to capture the effects of previous M&A involvement, previous innovative efforts firms unobserved heterogeneity and a set of controls, on the probability of being an innovator at time  $t$ . Our model accounts for the initial condition problem, including firms initial innovative status (innovative status at time 0, namely the first CIS wave in which the firm was observed) (Wooldridge, 2005). Then, the expected change in innovative patterns depends on whether was an innovator in the previous period ( $Innov_{it-1}$ ), on firms initial innovative status (initial condition: ( $Innov_{it0}$ )). To highlight whether M&As play a role in firm's transition from a non-innovative status to an innovative status or on the capability of firms to persistently innovate, we have interact the dummy variable indicating firms involvement in M&As in the previous period ( $M \& A_{it-1}$ ) with two different innovation dummies in order to disentangle the effects, following Wright's (1976) specification of interaction models for the specific cases in which the modifying variable is discrete. Therefore, we have estimated the influence of M&As in helping firm transitions from a non-innovative status to an innovative status ( $M \& A_{it-1} \times NONInn_{it-1}$ ) (with  $NONInn_{it-1} = 1$  when firms were not innovators in the previous CIS wave), and the effects of M&As in enhancing persistent innovation activities (firms remaining in the innovative status ( $M \& A_{it-1} \times Innov_{it-1}$ ) (with  $Innov_{it-1} = 1$  when firms were innovators in the previous CIS wave). Moreover, the model accounts for a set of observable control variables ( $Z_{it}\psi$ ), as technological regimes (according to Marsili's taxonomy), firm lagged R&D intensity, firm size and age. The squared terms of age and size are also included, as we expect a non-linear relationship between both age and size and innovation. We also add an interaction term age-size to our model to test possible heterogeneity in the effect of size as firms mature.

We estimated a Random Effects Probit in order to allow for unobserved heterogeneity, namely



$$P(Innov_{it} = 1) = \Phi[\alpha + \beta_1 Innov_{it-1} + \beta_2 Innov_{it0} + \beta_3(M \& A_{it-1} \times NONInn_{it-1}) + \beta_4(M \& A_{it-1} \times Innov_{it-1}) + \mathbf{Z}_{it}\boldsymbol{\Psi} + \mu_i + \varepsilon_{it}]$$

where  $\mu_i$  is the unobserved firm-specific heterogeneity, and  $\varepsilon_{it}$  is the idiosyncratic error.

## 4. Results

### 4.1 Patterns of innovativeness along size classes

We examine innovative persistence, as well as entry into innovativeness by estimating two state TPMs. Table 3 shows the estimated probabilities across size classes: small, medium, and large firms; while Table 4 distinguishes also across M&A active and non-active firms. Following the definitions given in Cefis (2003), we define persistence as firm's probability of remaining in its initial state and we define occasional innovator a firm that has innovated once and then exit from the innovator state. On the contrary, a systematic innovator is a firm that persistently remain in the innovator state. We devoted special attention to the probability of going from the non-innovator to the innovator state (entering in the innovator state since the aim of the paper is to identify whether M&As help firms (especially, small and medium firms) in overcoming the innovative threshold, that is to entering in the innovator state.

Table 3 shows that, among small firms, the probability of being a persistent innovators is around 60%, but is gradually increasing for medium-sized companies, 74%, and for large and very large companies the probability reaches 84%. The persistence from one wave to another increases steadily with around 10% along size categories. A similar pattern is also shown by the new entry in innovative behaviour. Small firms find it more difficult to make the innovative transition, exhibiting lower than average rates of transition from a non-innovative to an innovative status, being 28% the average rate calculated on the entire population of Dutch manufacturing firms. Yet, this pattern changes gradually along size classes, both medium-sized and large firms showing higher than average rates (around 35% and 43, of new entrant innovators in the medium-sized and large class, respectively).

Similar patterns can be seen when analyzing the percentage of *occasional* innovators. Small firms are more likely to be found in this class of innovators, the rates of exiting the innovative status ranging between 37-40%. On the contrary, medium-sized firms show patterns of innovativeness closer to large and very large firms, only ¼ of the medium-sized firms in our sample qualifying as occasional innovators. For large and very large companies, our analysis confirms the previous finding (Geroski et al., 1997; Malerba and Orsenigo, 1999; Geroski et al., 1997; Cefis, 2003), according to which large innovators tend to remain active for longer periods of time.

Table 4 suggests several remarks related to the way in which innovative patterns are shaped across size classes and along M&A active and non active firms. The results suggest that both innovation persistency and new entry rates are higher for the M&A active firms in our sample. However, there is a strong heterogeneity between size classes, with post merger transitions into innovative status being much more likely to occur in the case of small and medium firms. With regard to the probability to overcome the innovative threshold, that is to go from the non-innovative status to the innovative status, the largest difference between the probability of active M&A firms and non-active M&A firm is in the case of medium firm (39% of new entrants in innovative activities for M&A active firms as opposed to only around 30% for firms not involved in M&As). The results also reflect a positive impact of M&A involvement on the probability of making a transition in the case of small firms (a 23,1% for M&A active firms as compared to a rate of only 21% for passive M&A). However, our analysis seems to pinpoint also towards a lack of a positive effect of M&As on the innovative transitions of large firms: actually the probability for M&A active firms is lower than the one for non-active firms. Therefore, M&As seem to facilitate the transition to the innovative threshold in the case of small and medium firms, while it acts in the opposite direction in the case of large firms.

An interesting pattern can be observed also when analyzing firms persistence in innovative activities. The highest innovative gain of performing M&A activities seems to be derived by medium firms. This is the sample of firms showing the highest difference in the rate of persisting in innovation for firms having undergone an M&A and for firms not active in such activities: 77,16% of M&A active medium firms that have been innovators in the previous period continue to innovate also in the following period , as compared to only 71.6% for M&A non active firms.

Though to a lower extent, M&As seem to also facilitate innovation persistency in the case of small firms, the difference between M&A active and non-active firms being of 1.6%. For large firms, the innovational impact of M&A seems low ( the difference is of only about 0.5%). However, large firms are the ones showing the highest rates of innovation persistency (of around 84%). All in all, our results seem to confirm the previous findings according to which large innovators tend to remain active for longer periods of time (Malerba et al., 1997; Malerba, 2005).

These results seem to support the idea that innovation might drive M&As only when firms involved are of small and medium size, while in case of large firms, M&As seem to be driven by other reason than innovation as, for example, market dominance or entry in new sectors.

## 4.2 Multivariate models of post merger changes in firm innovative behaviour

Random effect probit models are estimated with a special attention on the effects of M&A on entering and on persisting in innovative activities, across the three size classes under review. The model we estimate accounts both for firms heterogeneity and for the dynamic/conditional structure of the framework under analysis.

The estimates of the effects of the explanatory variable of interest, M&A involvement, and of the control variables on the probability of being an innovator at time  $t$  are presented in Table 5.

Our estimates show that firms that have been involved in M&As in the previous CIS wave are more likely to make a transition from the non-innovator to the innovator state or to persist in innovative activities, compared to non M&A active firms. However, there is a strong heterogeneity in post merger innovative patterns across size classes. The highest effect of M&As in helping firms to overcome the innovative threshold, measured by the coefficient of  $(M \& A_{it-1} \times NONInn_{it-1})$ , is registered for the medium sized sample of firms, but it is also very high and significant in the case of small firms.. The coefficient it is not statistically significant for large firms. This seems to confirm the results of our univariate analysis, pinpointing towards a lack of any effect of M&A involvement on the likelihood of making a transition for the sample of large firms.

The coefficients of  $(M \& A_{it-1} \times Innov_{it-1})$  that capture persistence in innovative activities displays a similar pattern. In general, firms that have been involved in M&As have a higher probability of remaining innovators, conditional on having been innovators in the previous CIS wave, as compared to firms that have not been involved in M&As. The effect is positive and significant for the whole sample of Dutch manufacturing firms, for medium firms and for the category of large firms confirming, while in the case of small firms our estimate is not statistically significant. The probability of staying an innovator, conditional on having been an innovator before is 136 percentage points higher for M&A active firms compared to their non M&A active counterparts, when performing the analysis at the level of the whole manufacturing industry. When splitting the analysis into size classes, previous M&A involvement increases the level of innovation persistence by 143% for medium firms, and by 150% for large firms. In the case of small and micro firms, the coefficient of the M&A proxy is not statistically significant, confirming previous results in the literature (Cefis, 2003 ; and Geroski et al., 2001): small firms are those that experience the greatest difficulties in innovating and not even the involvement in M&As helps them in becoming persistent innovator. This effect progressively vanishes with an increase in firm size, medium sized companies deriving innovation gains from M&As, both in terms of entry and persistence in innovation activities.

The multivariate analysis is consistent and confirm the findings derived in the univariate analysis. Firms that have been involved in M&As have higher chances of transiting from a non-innovative to an innovative active status or to remain innovative if firms have been innovators in the previous period. This is verified to a certain extent for all size categories, though the persistence effect increases with size, and is not significant for small firms, while the transition effect is more relevant in the case of medium and small firms and not significant for large firms.

The persistency effect is in line with the hypotheses stated in the theoretical background. Small and micro firms lack the financial capacity of involving and appropriating long-term gains from innovation-driven M&As. For this reason, they are more likely to be found in the category of occasional innovators. However, our results suggest that small and medium firms are also those that are the most likely to engage in M&As driven by innovation, using acquisitions as means of external sourcing and of access to additional resources, knowledge and competences needed for developing innovative strategies.

In order to control for sector specificities, we apply Marsili's taxonomy (2001). The results of our analysis support previous findings in the literature. There is indeed a high technological specificity shaping firms innovative behaviour. Belonging to any of the fundamental process, science based, production engineering or complex system technological class increases the probability of making a transition from a non-innovative to an innovative active firm, as well as the probability of being a persistent innovator. Overall, the analysis seems to confirm that technological regimes shape the pattern of industrial competitiveness by influencing the ability of small and new firms to enter the market via innovation as compared to the ability of established firms to cumulatively build upon their past innovative performance (Nelson and Winter, 1977).

Firm age and firm size, as well as firm lagged R&D intensity do not seem to have a statistically significant effect on the probabilities of changing the innovative patterns. A worth-mentioning effect is the one of firm initial innovative status, that affects positively and significantly firm current innovative status. This is verified across all size classes.

## **5. Conclusions**

In this paper, we provide new evidence on patterns of entry and of persistence in innovative activities across size classes. Using TPMs, we examine whether or not the observed innovation patterns differ for M&A active and non-active firms. By means of probit models, we analysed whether M&As act as incentive/determinant for firms to cross the "innovative threshold" and/or to remain persistent innovators. A unique longitudinal dataset comprising manufacturing firms in the Netherlands, over the period 1994-2002 has been constructed matching firms innovative performance data from four CIS waves with demographic characteristics from the Business Register. The specific feature of the CIS in the Netherlands – being conducted every two years and covering the three year period prior to the survey- allowed us to analyse changes in firms post-merger innovative behaviour over three CIS waves (2.5, 3 and 3.5). Furthermore, we have used a more disintegrated level of analysis, breaking the effect of M&A activities along 3 size classes, considering small firms, medium-sized and large firms.

The empirical analysis shows that previous involvement in M&As influences firms innovative behaviour. Both transitions from non-innovators to innovators status and persistence in innovative status are triggered by M&A involvement, but the effect varies across size classes. We find that M&A involvement increases both the probability of making a transition from a non-innovator to an innovator status and the probability of remaining innovator, conditional on having innovated in the previous period. This is confirmed when the analysis is performed at the level of the whole manufacturing sample, and also, when broken along size classes, for medium and large firms in what persistency is concerned and for medium and small firms in the case of new entry into innovation activities.

For small firms, M&As do ease the overcome of “the innovative threshold”. Indeed, the results show a positive impact of M&A involvement on the probability of making a transition in the case of small firms. When we analyse persistence in innovation, our results show that not even the involvement in M&A activities are enough to help small firms becoming persistent innovators. Small firms are those that encounter the greatest difficulties in innovation on continuous basis and not even external sources of knowledge and capabilities (represented by M&As) allow them to become persistent innovators.

M&As seem to have the highest impact on firm’s innovative performance in the case of medium firms. In fact, medium sized companies are those that are able to profit most from M&A activities both in terms of overcoming the innovative threshold (that is becoming innovators when before M&As they were not) and of persisting in innovative activities.

Finally, large firms benefit from M&As only in terms of innovative persistence. M&As do not help large firms to become innovators if they were not already innovators, but they can help large firms in maintaining a persistent innovative performance, if firms were innovators before carrying out M&A processes.

These results seem to support the idea that innovation might drive M&As only when firms involved are of small and medium size (M&As supplying an external source of new knowledge, competences and capabilities), while in the case of large firms, M&As seem to be driven by other reasons than innovation as, for example, market dominance or entry in new sectors.

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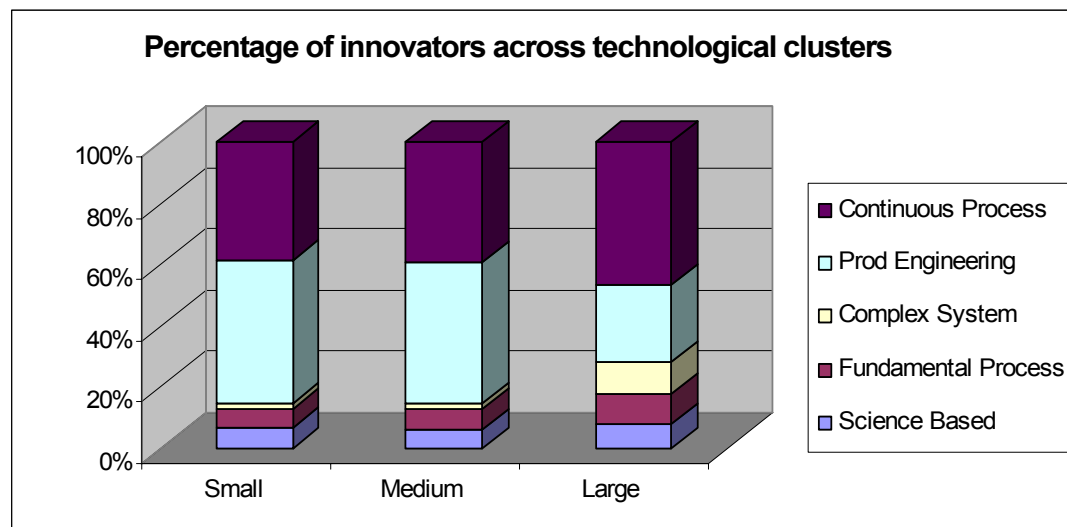
**Table 1. Variables and definitions used to analyse the patterns of firm post-merger innovative behaviour.**

<b>Dimension</b>	<b>Variable</b>	<b>Description</b>
<b>New-entrant innovators</b>	Transition non-innovator <sub>t-1</sub> /innovator <sub>t</sub>	Firms register a change in innovative behaviour, from non-innovative status in the previous CIS wave to innovative status in the present CIS wave
<b>Persistent innovators</b>	Transition innovator <sub>t-1</sub> /innovator <sub>t</sub>	Firms register no change in innovative behaviour, remaining in the innovative status in the previous and in the current CIS wave
<b>Exiting innovators</b>	Transition innovator <sub>t-1</sub> /non-innovator <sub>t</sub>	Firms register a change in innovative behaviour, from innovative status in the previous CIS wave to non-innovative status in the present CIS wave
<b>Persistent non-innovators</b>	Transition non-innovator <sub>t-1</sub> /non-innovator <sub>t</sub>	Firms register no change in innovative behaviour, remaining in the non-innovative status in the previous and in the current CIS wave
<b>Involvement in M&amp;A transactions</b>	M&A status at time t-1	Firms have acquired another firm or been involved in a merger in the previous CIS remaining in the innovative status in the previous and in the current CIS wave
<b>Marsili's taxonomy</b>	Constructed on the basis of 3 digit SIC code	Firm taxonomy: science-based, fundamental-process, complex-systems, product-engineering, continuous process (see Appendix)
<b>Firm size</b>	Number of employees	Size classes: small (10-49), medium (50-249), and large (>250)
<b>Firm age</b>	Expressed in months since the date of entry in the Business Register	

**Table 2. Descriptive statistics of the number of employees of manufacturing firms, by size class (only CIS2)**

	N	Mean	Std.dev.	Kurtosis	Skewness	Median
Small	1072	24.6	12.4	4.6	1.1	22
Medium	1570	112.1	56.4	7.2	1.6	90
Large	633	858.6	2404.1	155.4	11.5	434
All	3275	136.5	1155.07	1107.3	32.3	45

**Figure 1: Percentage of innovators across technological clusters (CIS 2)**



**Table 3: Transition probabilities between innovative states**

	Innovative status at time $t+1$ small firms (<50 employees)		Innovative status at time $t+1$ medium firms (51-250 employees)		Innovative status at time $t+1$ large firms (above 250 employees)	
One step transitions starting point: 1996	<b>Non-innovator</b>	<b>Innovator</b>	<b>Non-innovator</b>	<b>Innovator</b>	<b>Non-innovator</b>	<b>Innovator</b>
<b>Non-innovator</b>	77,87%	22,13%	64,82%	35,18%	57,10%	42,90%
<b>Innovator</b>	38,57%	61,43%	25,80%	74,20%	16,14%	83,86%

**Table 4: Transition probabilities between innovative states**  
**split analysis between M&A active and M&A non active firms**

<b><u>M&amp;A active firms</u></b>	Innovative status at time $t+1$ small firms (<50 employees)		Innovative status at time $t+1$ medium firms (51-250 employees)		Innovative status at time $t+1$ large firms (above 250 employees)	
One step transitions starting point: 1996	<b>Non-innovator</b>	<b>Innovator</b>	<b>Non-innovator</b>	<b>Innovator</b>	<b>Non-innovator</b>	<b>Innovator</b>
Non-innovator	76,89%	23,11%	61,43%	38,57%	57,91%	42,09%
Innovator	37,79%	62,21%	22,84%	77,16%	16,26%	83,74%
<b><u>M&amp;A non-active firms</u></b>						
Non-innovator	78,86%	21,14%	69,02%	30,98%	53,60%	46,40%
Innovator	39,36%	60,64%	28,37%	71,63%	15,94%	84,06%

**Table 5: Post merger innovative patterns**

*Random effect probit models*

<b>Dependent Variable: INNOVATIVE STATUS <math>t</math></b>				
	<b>ALL FIRMS</b>	<b>SMALL FIRMS</b>	<b>MEDIUM FIRMS</b>	<b>LARGE FIRMS</b>
Innovator $t-1$	3,19*** (0,25)	2.54*** (0.69)	3,12*** (0,29)	1,77*** (1,12)
Innovator $t0$	1.96*** (0,173)	1.38*** (0.47)	1,85*** (0,2)	2.5*** (0,53)
M&A $t-1$ *Innovator $t-1$	1,36*** (0,172)	0,78 (0.51)	1,43*** (0,2)	1,5*** (0,43)
M&A $t-1$ *Non-Innovator $t-1$	3,6*** (0,237)	3.02*** (0.61)	3,87*** (0,27)	0,78 (1,06)
R&D intensity	0,06 (0,04)	4,3 (6.4)	0,047 (0,047)	3,91 (4,9)
Fundamental process	2.89*** (0,504)	1,004 (2.5)	1,6* (1,03)	2,65*** (0,8)
Science based	3.43*** (0,571)	2,35 (2.6)	1,87* (1,1)	2,52*** (1,03)
Production engineering	3.82*** (0,602)	1,14 (2.66)	2,76*** (1,14)	3,33*** (1,07)
Complex system	3.11*** (0,508)	-0.13 (0.96)	2,14** (1,03)	2,63*** (0,91)
Firm Size	1,23 (1.09)	0,005 (0.014)	-1,8 (2,8)	-0,95 (5,03)
Firm age	0,247 (1,9)	3,85 (6.2)	2,43 (2,6)	-3,9 (5,4)
Square of size	-0,053 (0,06)	-0.75** (0.043)	0,209 (0,25)	0,23 (0,27)
Square of age	-0,105 (0,16)	-0.509 (0.554)	-0,3* (0,2)	0,46 (0,36)
Age*Size	0,22*** (0,02)	0.45*** (0.146)	0,25 (0,32)	-0,18 (0,45)
Wald chi2	554.8***	56.78***	391,8***	71,48***
Rho	0,91	0,9	0,91	0,89
Number of observations	5571	976	3967	628

Appendix:

**Table 1: Marsili (2001) classification of technological regimes**

Technological Regime	Characteristics	Typical for:
Science based	High technological opportunity High entry barriers High cumulativeness of innovation	Pharmaceuticals; electrical/electronics industries
Fundamental process	Medium technological opportunity High entry barriers Strong persistence of innovativeness	Chemistry based technologies
Complex(knowledge) system	Medium/High technological opportunity  Entry barriers in knowledge/scale  High degree of differentiation	Mechanical, Electrical, Electronics, Transportation
Production Engineering	Medium/high technological opportunity   Low entry barriers	Mechanical engineering, non-electrical mechanics
Continuous Process	Low technological opportunity   Low entry barriers  Low persistence of innovativeness	Metallurgic process industry, chemical process industry ( food, textiles, tobacco, paper)