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Do Mergers of Potentially Dominant Firms foster Innovation?
An Empirical Analysis for the Manufacturing Sector

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Abstract
We investigate the effects of M&A on innovation in the specific context of potential or realized market dominance. Authorities are challenged by balancing both detrimental and beneficial effects of mergers on innovation, especially when a merger threatens to result in market dominance, while firms would wish to uncover all the potential benefits arising from M&A. The effects of M&As on innovation have been tested on a panel dataset, constructed from the Dutch Community Innovation Survey and the Dutch Business Register, including around 1000 manufacturing companies. We have adopted a comprehensive approach, taking into consideration three dimensions of innovation: innovation inputs, innovation outputs and efficiency. The results show that M&As performed in the previous 3-5 years have a positive and significant effect on innovation except R&D expenses and innovation efficiencies. The results also suggest that technological regimes are critical to understanding the patterns of innovation.

Keywords: Mergers and Acquisitions, Innovation, Market Dominance

JEL classification: C14, D21, L11, L25

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1. Introduction

The present paper explores whether mergers and acquisitions (M&As) affect innovation in the specific context of potential market dominance.

The impact of M&As on the national global economy is remarkable. In the last century, five waves of M&As took place and the last one (1995-2000) has seen a worldwide investment of around 12,000 billion dollars (Schenk, 2006). Policy makers aim at stimulating the economy increasing the competitiveness of nations to preserve national wealth. Under the basic assumption that society benefits from a situation of structurally low concentration, M&As alter the structure of the market substantially if they generate dominant firms. They can therefore affect the competitiveness of an economy, and as a consequence, they can plague long run societal well being (George and Jacquemin, 1992; Lopez 2001). It is not surprising that authorities monitor closely whether M&As reduce competition through the abuse of market power. A different approach suggests that the downsides in terms of an increase of market power should be weighted against potential positive effects of the transaction in a case-by-case assessment (Williamson 1968, George and Jacquemin, 1992). In particular, the potential positive effect concerns innovation. The European Commission has stressed in several occasions that to support employment, competitiveness and the growth of the economy as a whole, it is essential to strengthen innovation (European Commission, 1995). An M&A can harm societal wealth by hampering competition but innovation can promote societal welfare by allowing consumers to benefit from new products, better quality or lower prices. If M&As generate market power but foster innovation, policy makers are challenged by the need of identifying the effects of M&As on innovation in the context of potential market dominance.

Furthermore, M&As represent a consistent investment at the corporate level. The corporations' rationale for engaging in such relevant financial transactions has evolved over the years. Whereas innovation may not have been brought forward as an explicit legitimisation for merger in the first M&A waves, it surely has become one in the last ones (DeMan & Duysters, 2005). According to Schumpeter's point of view, like the cells regeneration process that takes place in an organic structure, an economy can grow only if it is renewed by innovations (Kamien and Schwartz, 1975). Firms need to innovate not only to grow in a prosperous way but to survive (Cefis and Marsili, 2006). Companies do not need to innovate exclusively with their internal efforts but they can acquire knowledge and resources for innovating from external sources like M&As, thus generating an "open innovation

framework" (Chesbrough 2003). This consideration is even more relevant for companies that have the size and the potential to become dominant in their market. Consequently, M&As with such an effect are subjected to the authorities' assessment. In the context of the new EC Merger Regulation (2004), M&As that would have been prohibited basing on the traditional analysis of static efficiencies, might obtain an approval if the proposed transaction will foster innovation. In this perspective, the positive effects on innovation (dynamic efficiencies) balance the negative effects due to increased market concentration.

The implications of the analysis have therefore practical relevance. Results are noteworthy for policy makers as well as for corporations, the first ones being concerned by balancing anticompetitive effects of M&As with their potential function of stimulus for economic growth, the second ones being concerned by exploiting all the possible benefits of M&A activities.

Linking four waves of the Dutch Community Innovation Survey (CIS) and the Dutch Business Register, we have constructed a panel dataset from 1992 to 2002 including around 1000 manufacturing firms. We use this unique dataset to test the impact of M&As on three dimensions of firms' innovative activities, namely innovation inputs, outputs and efficiencies. In order to focus on firms that have the potential to become dominant in their market, we select the firms above the 85^{th} percentile of the size distribution calculated for each 3-digit sector. The results show that M&A activities performed in the previous 3-5 years have generally a positive and significant effect on all the proxies of innovation input, output and efficiencies used. The only exception is on total cost of innovation efficiencies (negative and significant) in terms of new products for the market. Moreover, the results suggest that the effects of M&As on innovation strongly depend on technology specificities and therefore that technological regimes are critical to understand the patterns of innovation.

This paper is structured as follows. In section 2, we present the theoretical background. Section 3 derives the hypotheses to be tested, while section 4 introduces the research design, the data, and the variables. The model and the methods used in the analysis are defined in section 5. Results are discussed in section 6 and the concluding remarks are in section 7.

2. Theoretical Background

The focus of the present study is to analyze the effects of M&As on innovation in the context of market dominance. Market dominance is often associated with large size and, therefore, we start by briefly mentioning the main considerations present in literature on the relationship

between market structure, size and innovation.

Industrial Organization debates on this issue date back to Schumpeter (1934, 1942). Industries develop innovations according to two main patterns based on a distinction proposed by Schumpeter (1934, 1942). These two basic regimes describing the link between size and innovation are defined as Schumpeterian Mark I (SM-I) and Schumpeterian Mark II (SM-II).

Under SM-I, a pattern of "creative destruction" or "widening" regime is characterized by the entry in the market of new innovators, by the persistent "erosion of the competitive and technological advantage of the established firms" (Malerba and Orsenigo, 1996) and by less favourable appropriability conditions (Breschi et al., 2000). In this regime, innovation, derives from the relevant knowledge base available to everybody, technical change is promoted by entrepreneurs and new small firms continuously entering in the market. As a result, the market displays low levels of concentration. (Malerba and Orsenigo, 1996). In SM-I, higher levels of technological opportunities, less favourable appropriability conditions and lower levels of knowledge accumulation explain the pattern of innovation (Breschi et al., 2000)

On the contrary, in SM-II, a higher level of innovation is reached when large firms operate in a concentrated market. Under SM-II, the prevailing mechanism is defined as "creative accumulation". In this framework, also referred to as "deepening" regime, innovation results from the firm-specific, tacit, and cumulative nature of the knowledge base that, over time, builds high barriers to entry. Few large firms eventually come to dominate the market in a stable concentrated market (Malerba and Orsenigo, 1994 and 1996).

Both company size and market power are relevant in the context of our research as a merger has an effect on size, fusing two corporate entities into a single one or enlarging an existing firm, as well as on market structure, inducing higher levels of concentration and potentially market dominance. Several arguments, other than those attributed to Schumpeter, have been used to assert that innovation benefits from highly concentrated markets (market concentration being typically used as proxy for market power) and large size companies (Syrneonidis, 1996).

The reasons why size could have a positive effect on innovation can be summarized as follows (Cohen and Levin, 1989): large firms can i) better afford the risks of R&D, financing their activities with internal funds ii) have easier access to financial markets in order to finance their innovation activities; iii) exploit economies of scale and scope in R&D activities; iv) better profit of synergies between R&D and other complementary activities (i.e.,

financial planning, marketing and products distribution); v) spread fixed costs of innovation over higher levels of sales.

On the other hand, there are at least two reasons to expect a positive effect of market power on innovation (Syrneonidis, 1996). First, firms that have higher levels of market power can better finance their R&D activities using their own profits. This argument is in line with the assumption that innovative companies with higher market power have higher levels of cash flows and therefore they dispose of more internal funds to invest in innovation and R&D activities. Second, firms with higher market power can better appropriate the benefits of innovation and therefore their incentive to innovate is higher. Companies with higher market power are in a better position to take advantage of their innovations protecting them with patents or other mechanisms like secrecy, control of distribution channels, investments in marketing and customer services.

In Schumpeter's framework, appropriability conditions are linked to the incentive to innovate. Arrow (1962) has approached the effect of market structure on innovation in terms of incentives by arguing that, contrary to Schumpeter's point of view, firms operating in market structures with low levels of competition have little incentive to innovate. Companies will engage in innovative activities if returns from innovation will be higher than the existing returns and the costs associated with the innovation development. Therefore, companies that are already close to a monopolistic situation will have little stimulus to actively pursue higher levels of innovation. Firms in a competitive situation will, on the contrary, experience a positive difference between the levels of profits before and after the innovation and will therefore try to use innovation to "escape competition" (Aghion et al., 2001 and 2002).

Empirical studies have, along the years, found mixed or inconclusive results supporting both Schumpeter and Arrow points of views (Kamien and Schwartz 1975, Damanpour, 1996). Some studies have found that the effect of market concentration and innovation is different when the analysis focuses only on small companies or on large companies. In particular, it seems that large firms innovate more in concentrated, capital intensive markets, while the contrary is true for small companies (Koeller 1995, Acs and Audresch 1987). In the specific framework of manufacturing, Blundell et al. (1999) explores the relation between innovation, market share and stock market value. Their empirical findings show that firms with higher market share are more innovative and benefit more from those innovations in terms of higher stock market value. These results suggest that potentially dominant companies have greater incentive to pre-emptively innovate in order to maintain their dominant position. Moreover,

firms with higher market share seem to have greater capability to appropriate the results of their innovative activity resulting in higher market values (Acs and Audresh, 1987, Blundell et al. 1999). However, results supporting a positive effect of market share and firm size on innovation should be interpreted with caution considering that other factors, like sector characteristics of the industry, appear to have a greater impact on the levels of innovation (Crepon at al. 1995).

A conciliation of the Schumpeter and Arrow perspectives is proposed by the empirical work of Aghion et al. (2002) who found evidence that competition and innovation are linked in an inverted U-relationship. At lower levels of competition, Arrow's point of view is predominant while, for high levels of concentration, Schumpeterian effects are more likely. Recently, Tang (2006) pointed out that previous empirical tests of the Schumpeterian hypothesis are biased by inappropriate measures of market competition. Market power can not be assessed directly and therefore it is necessary to rely on proxies like seller concentration or market share. The author proposes instead to use a new measure aimed at evaluating the perceptions that companies have about their competitive environment. The results confirm that a high level of competition stimulates innovation and that large firms are more likely to engage in innovative activities than small ones.

The variety of the findings and often the difficulty to reconcile the results from both theoretical and empirical studies suggests that there is not a clear *a priori* expectation about the relationship between market power or market concentration and innovativeness. The present paper adds to the debate about the link between competition and innovation focusing on the effects of M&As on innovation in the context of market dominance.

The effect of M&As on firms' innovative activities has been tackled by surprisingly few studies. According to De Man and Duysters (2005), the existing literature can be divided in two main groups: those that have studied the conditions for M&As to have a positive effect on innovation and those that have considered the impact of M&As on proxies of R&D activities. In the former group, the studies mention three main conditions. The first one is the relatedness of the companies. Companies that, before the M&As, have similar technological knowledge seem to display ex-post higher levels of R&D efficiency. In the opposite situation, where companies have, ex-ante, non-related technologies, they seem to remarkably reduce levels of R&D after the M&A process (Cassiman et al. 2005). The second condition able to alter the impact of M&As on innovation refers to the post merger integration process. The knowledge bases of the companies engaged in M&A need to be integrated. This process, although

unavoidable, can be extremely complex and risky. The way it is conducted, for example in terms of communication and team building (Epstein 2004), can have a dramatic impact on the ex-post innovation performance (Ahuja and Katila 2001, Cloodt et al. 2006). The third factor refers to the size of the merging companies. There is no agreement with respect to the optimal size of the companies involved in a merger that favours ex-post innovation. Some studies have found that similar size of the acquirer and the acquired are associated with higher levels of innovative performance (Chakrabarti et al. 1994, Hagedoorn and Duysters, 2002), while other empirical tests found evidence of the contrary (Ahuja and Katila, 2001).

The present paper can be located in the second research line proposed by De Man and Duysters (2005) that focuses more directly on the effects of M&As on innovation. Innovation is a complex phenomenon that is, by its own nature, difficult to be captured. In order to account for the multidimensional nature of innovation, we have simplified the innovation process in three dimensions: innovation input, innovation output and innovation efficiency. In the next section, we derive our hypothesis from the previous literature distinguishing these three dimensions of innovation.

3. Hypothesis

In order to be able to grasp the effects of M&A on innovation in a meaningful way, it is advisable to consider the different dimensions of the innovation process: inputs, outputs and efficiencies. Moreover, for each activity in the innovation process, it is useful to have several measurements. Patel and Pavitt (1995) argued that firms can display very diverse patterns of innovation activities. Differences may depend on their sector of activity, the specific nature of the technologies developed and/or their size. As a matter of example, R&D is appropriate for science based sectors like chemicals, but it is a poor proxy of innovation inputs for production-based technological classes of activity (like mechanical) because innovations are generated by Design Offices, Production Engineering as well as by R&D Departments (Patel and Pavitt, 1995). Moreover, among the same technological class, small companies tend not to have a formal R&D department and the need arises to consider other innovation inputs like the total cost of innovation. The same reasoning is applicable for innovation output and for innovation efficiencies representing the relationship between inputs and outputs.

3.1 M&A and innovation inputs

In the literature, R&D expenses have been the favourite proxy for innovation inputs. From

economic theory two mechanisms should affect the impact of M&As on R&D: economies of scale and economies of scope (Cassiman et al. 2005; Henderson and Cockburn, 1996). Economies of scale refer to the possibility to reduce the average costs by increasing the amount of output and economies of scope refer to the cost reduction that is achieved when producing two goods jointly is cheaper than producing them separately. Firms should be keen to increase research expenditures if they can profit from economies of scale and to expand the number of R&D projects if they can profit from economies of scope. In order to minimize costs, firms have also incentives to reduce expenses or maximize efficiencies (production efficiencies). Companies that have merged are expected to avoid unnecessary duplications by closing redundant laboratories or by redeploying research personnel to other departments/tasks or by interrupting R&D projects (Cassiman et al. 2005, Capron 1999).

With the exception of Ikeda and Doi (1983), empirical studies have mainly reported negative effects of M&As on R&D intensity (de Man and Duysters, 2005, Hitt et al, 1991). Hitt at al. (1989) reported an increase of R&D expenditures in absolute terms but this was due to a general increase of research expenditures at the industry level (in relative terms merging firms reduced their R&D efforts). A possible explanation of this finding is that managers have used so much funds in the merger process that they have become less willing to make long term (expensive) additional investment like R&D (Hitt et al. 1996). Another explanation could be that acquisition of technology through M&As is considered a substitute for internal R&D. The same kind of argument can be advocated not only for specific R&D expenses, but also much wider for innovation expenses in general (see Hitt at al., 1996). In the present study, we consider R&D expenses as a proxy for innovation inputs and, in broader terms, the costs of innovation, including intramural and extramural R&D expenses, industrial design costs, and investments in other acquisitions of external knowledge like trademarks or software, marketing for innovations, training of personnel for innovation purposes. Hence, we formulate the following hypothesis:

H1a : In potentially dominant firms, there is a negative relationship between M&A and innovation inputs.

H1b : In potentially dominant firms, there is a positive relationship between M&A and innovation inputs.

3.2 M&A and innovation outputs

It has been argued that in order to increase innovative output, firms are more and more relying

on M&As. Perhaps, this applies especially to dynamic sectors where technological developments are continuous (Hagedoorn and Duyster 2002, Bannert and Tschirky 2004). A possible reason to expect M&As to have a positive effect on innovation output is that often technological knowledge has a strong tacit component and tacit knowledge can only be absorbed acquiring the whole company (De Man and Duysters 2005, Bresman 1999). Furthermore, two merging companies might own different knowledge bases that need to be combined in order to be able to generate an innovation that otherwise would have not been achievable (De Man and Duysters 2005, Gerpott 1995). M&As also can allow the acquiring company to introduce more innovations in the market by shortening the time required to develop new products or to launch the products in the market (Chaudhuri 2004).

Empirical tests have generally failed to prove the positive effects of M&As on innovation output (Hitt et al, 1991, Ernst and Vitt 2000, De Man and Duysters 2005). In fact, innovation output might be reduced by the post-merger integration process that absorbs energy and resources that could have been devoted to other activities (De Man and Duysters, 2005). An exception to this stream of empirical studies is Ahuja and Katila (2001) who argue that technology-driven M&As could increase innovation output especially when the absolute size of the acquired knowledge base is large. Hence, we formulate the second hypothesis as follows:

H2a: In potentially dominant firms, M&A affects negatively innovation outputs.

H2b: In potentially dominant firms, M&A affects positively innovation outputs.

3.3 M&A and innovation efficiency

The economic literature recognizes that M&As can stimulate different types of efficiencies: a) allocative, b) productive c) transactional and d) dynamic (Kolasky and Dick 2003). Allocative efficiencies refer to the use of resources at the highest valued level among all possible alternative uses. Productive efficiencies refer to the capability to obtain the same output using less input. Transactional efficiencies result from reducing the transaction costs that are those costs associated with the protection of the company economic returns from opportunistic behaviours or information asymmetries. Dynamic efficiencies are the efficiencies of interest in the present study and refer to the processes aimed at generating more innovations. M&As can stimulate dynamic efficiencies providing the resources needed to innovate or providing them at a lower cost. The size reached by the companies, however, does not seem to play a significant role in obtaining higher levels of efficiency (Grupp, 1997).

In a dynamic efficiency context, the same observed output of new/improved products is obtained with lower levels of R&D inputs. According to Gugler et al. (2003) this can take place even if only in a small number of cases. This phenomenon could be due to post merger capability to manage innovation better at the corporate level. It has been shown that companies using R&D more efficiently are also likely to be more innovative (Boone, 2000). Bughin and Jacques (1994) have also argued that "failure to innovate …is also linked to the inability of firms to obey to some key managerial principles… like R&D efficiency". Hence, we formulate the following:

H3a: In potentially dominant firms, M&As have negative effects on innovation efficiencies.

H3b: In potentially dominant firms, M&As have positive effects on innovation efficiencies.

4. Research design

4.1 The Data

The descriptive and explanatory analyses that will be used throughout this research study are based on data from the Business Register (ABR) and the five waves of the Community Innovation Survey (CIS) that have been made available until this moment for the Netherlands.

The Business Register (ABR) is a database that includes all firms listed in the Netherlands for fiscal reasons. ABR reports detailed information about the sector of the company at the 6-digit standard industrial classification (SIC), the number of employees and the date of entry and exit from the register itself. The Community Innovation Survey is an international comparative firm-level database produced as a result of a joint action of the Commission's services Enterprise DG and Eurostat with the intention of obtaining comparable data on the innovative behaviour of European firms. It includes the European Union and EFTA member states, and it is conducted on a four-year basis, covering the three years period prior to the year of the survey. The Netherlands represents an exception in this respect, as CIS surveys have been conducted every two years, offering thus the possibility of analysing five waves, pertaining to the periods 1994-1996 (CIS2), 1996-1998 (CIS2.5), 1998-2000(CIS3), 2000-2002 (CIS3.5) and 2002-2004 (CIS4). CIS 1 has been a pilot survey and it has been carried out in The Netherlands by SEO Economic Research Amsterdam.

The Community Innovation Survey represents an important source of information due to:

(i) its multi-dimensional coverage of a range of input, output and organizational indicators of innovative activities;(ii) its longitudinal design in which information is gathered to study changes over time at the micro level; (iii) its standardized procedures since surveys are carried out at national level using a common methodology and further on processed by Eurostat to increase cross country comparability.

The statistical unit of the target population is the enterprise. In the Netherlands, each wave includes information on more than 10,000 companies. The threshold to be included in the population sample is a minimum of 10 employees (Eurostat, 2001). In the Netherlands, however, CIS 2.5 and 3 have been sponsored by the Ministry of Economic Affairs and they have included also companies with less than 10 employees. CIS are surveys conducted on samples stratified by firm size. Therefore large and very large firms are over represented with respect to small firms.

4.2 The construction of the panel data

As reported by De Man and Duysters (2005) the typical time horizon adopted in the literature to measure the effect of an M&A is 3 - 5 years. In order to account for such a lag and exploit the time dimension of the Community Innovation Survey, a panel data set has been constructed using the 5 CIS waves. Despite the fact that Eurostat has provided a common guideline for the Community Innovation Survey, the national statistical institutes were allowed to adapt or to slightly modify it yielding in waves that slightly differ from one another. After having homogenised the variables of interest across waves, the preliminary panel dataset has been integrated with the Dutch Business Register database (ABR) in order to have at our disposal not only the details of firms' innovative behaviour, but also relevant information on firm specific demographic characteristics. The resulting dataset gives firm level data on about 3,500 Dutch manufacturing firms over the period 1994 – 2002.

The distinguishing feature of the present research is to focus on M&As that are likely to create dominant firms in the manufacturing sector. Therefore we have confined our analysis to a sub-sample of firms that are potentially dominant in their relevant market. The selection of these firms has been done on the basis of the size criterion, identifying the relevant market with the 3-digit sector in which firms operate. We selected, in each CIS wave, firms above the 85th percentile of the size distribution calculated for each 3-digit sector. The size distributions have been computed using as a proxy of a firm's size the total sales in the last year of the CIS.

The final dataset is an unbalanced panel of 1079 firms.

4.3 The Variables

4.3.1 Dependent variables

Innovation is a complex and multidimensional phenomenon that is, by its own nature, difficult to be captured. Hagedoorn and Cloodt (2003) noticed that using multiple indicators to measure innovation has the double advantage that it is not necessary to rely on the goodness of fit of a single variable and that a more comprehensive assessment of innovation performance is possible.

The present paper distinguishes between three main proxies for innovation: innovation inputs, outputs and efficiency.

Innovation input proxies

As innovation inputs we consider two types of indicators: (i) expenses devoted to R&D, and (ii) total cost of innovation.

R&D departments have been traditionally considered the location where new (especially technological) knowledge is generated and embedded in innovative output. Following the literature, we use the log of total R&D expenses as our first innovation input proxy (see for example, Hitt and al, 1996, Hall 1990, Mairesse and Mohnen 2005, Frenz and Ietto-Gillies 2007).

R&D is however just one input of the innovation process and a company can engage in other type of investments that are determinant for generating innovation. CIS reports a variable, namely the total cost of innovation, which is the sum of firm expenses for intramural and extramural R&D, the acquisition of hardware or machinery, the acquisition of external knowledge like licenses or the rights to use patents. It also includes the cost of personnel training directly aimed at innovation, the cost of marketing activities in order to launch a new product in the market and the cost of procedures or technical preparation to realize innovation. Roughly, the total cost of innovation refers to all investments and expenses made for innovation. The total cost of innovation is our second proxy for innovation input.

Innovation output proxies

In line with previous studies that have used CIS data (among others, Evangelista et al. 1998,

Mairesse and Mohnen, 2005, Frenz and Ietto-Gillies, 2007), we choose, as a proxy of innovation output, firm's sales due to new or improved products introduced into the market. Compared to other innovation output measures (like patents), sales due to new products has the advantage that it indicates also the success of the innovation (Kleinknecht et al., 2002). In the CIS questionnaire, this proxy is the percentage of firm's total sales that can be attributed to innovative products. We transformed the variable multiplying the percentage by firm's total sales in order to have a continuous variable not bounded between 0 and 1.

For product innovations, two levels of newness are considered. The products/services can be new for the company, or new for the whole market. Products new for the firm indicate that the firm has been able to imitate innovations already introduced in the market thus improving its competitiveness. New products for the markets signals that the firm is an innovator in a strict sense, that is, it is able to generate complete new products and successfully launch them in the market.

Innovation Efficiency proxies

We are interested in understanding how much innovative input has been necessary to generate the observed innovative output. As a proxy for efficiency, we have constructed two variables. The first new variable, innovation cost efficiency, is obtained dividing total sales due to new products in the current period (t) by the total expenditures devoted to innovation in the previous period (t-1). The second new variable, R&D efficiency, is constructed dividing total sales due to the new products in the current period (t) by R&D expenses in the previous period (t-1)

These efficiency indicators, namely the total cost of innovation efficiency and R&D efficiency account for the time lag necessary for investments on innovation to generate returns. According to the two levels of newness (products new for the firm or new for the markets), we construct 4 variables as efficiencies proxies: R&D efficiency in terms of new products for the firm, R&D efficiency in terms of new products for the market, innovation cost efficiency in terms of new products for the firm and innovation cost efficiency in terms of new products for the market

4.3.2 Independent variables

Our main variable of interest is the occurrence of an M&A. We are interested in identifying whether M&A activities, previously performed, affects our dependent variable. For this

purpose, we have constructed a dummy variable that indicates if the firm had acquired or not another firm in the previous CIS wave. The lagged M&A proxy allows us to account for the time span necessary for the merger to display its effects on innovation. Using a lagged M&A variable means to allow for a time span that ranges from a minimum of 3 to a maximum of 5 years. This interval is consistent with the period reported in literature for an M&A to potentially show its effects on innovation (De Man and Duysters, 2005).

4.3.3 Control variables

Characteristics specific of the technological regimes in which firms operate are controlled for using Pavitt's (1984) taxonomy. We construct 4 dummy variables, classifying our sample according to the technological regimes proposed by Pavitt, in: science-based firms, specialized suppliers, scale intensive and supplier dominated firms. The last category (supplier dominated) acts as reference category in our estimates.

In addition, in order to control for firm specificities other than technology, we introduce firms' age and firms' size as explanatory variables. The age proxy has been constructed using the difference in months between the year of entry of the company in the Business Register and the year in which the Community Innovation Survey took place. Firms' date of entry in the Business Register has been employed as it very closely approximates firms' actual date of entry in the market (Cefis and Marsili, 2006).

Concerning size, we had at disposal two proxies: firms' total sales and the number of employees. Due to quite a high non-response level for both of these proxies in CIS surveys, we use as proxy for firm size the number of employees as reported in the ABR files in each of the years under analysis .In order to account for non-linear relationships betweeen firm age and size and the innovation proxies, we also include the squared terms of both age and size in all regression models. Finally, we also add to our analysis an interaction term age-size to account for a possible interaction between the two variables.

5. Empirical Model and Methodology

We have estimated a model for each innovation proxy descried in the above section. Each model considers the specific innovation proxy as a function of a lagged M&A variable (M&Ait-1) and firms' specific characteristics as age and size.

Accordingly, the model can be written as:

$$ln(innovation)_{it} = \alpha + \beta_1(M\ \&\ A)_{it-1} + \beta_2\, ln(size)_{it} + \beta_3\, ln(age)_{it} + \beta_4\, ln(size^2)_{it} + \beta_5\, ln(age^2)_{it} + \beta_6\, ln(age_{it} * size_{it}) + \beta_7 science-based + \beta_8 specialized-sup. + \beta_9 scale-int. + u_{it},$$

where the error term is:

$$u_{it} = \mu_i + \nu_{it},$$

with μ_i representing unmeasured individual factors which affect innovation proxies - or the so-called unobserved random effect, and ν_{it} as the remaining error component.

The M&A coefficient captures the causal effect of mergers on one of the three dimensions of innovativeness at firm level.

The choice of the estimation technique was based on the context of the data, among other factors. Specifically, panel data may create analytic problems in the form of error terms containing heteroskedasticity, autocorrelation, or cross-sectional correlation. (Wooldridge, 2003). We perform several statistical tests to check for heteroskedasticity (Breusch-Pagan test), the appropriateness of random-effects (the standard Lagrange multiplier test) and for autocorrelation of the residuals.[1] Since we find autocorrelation of first order, models accounting for first-order autocorrelation (AR1) are estimated.

We estimate both random effects models (REM), assuming $cov(u_i, x_{it}) = 0$, and fixed effects models (FEM), assuming $cov(u_i, x_{it}) \neq 0$. These regression models allow exploiting the panel structure of our dataset and control for unobserved heterogeneity. The presence of autocorrelation makes the Hausman (1978) test for choosing between FEM and REM inappropriate (Baltagi, 1995; Matyas, 1996). Conversely, the Mundlack (1978) approach of modeling explicitly the ui-xit dependence by inclusion of group means, followed by F-tests, is applied. Snijders and Bosker (1999) pointed out that the inclusion of group means as explanatory variables in panel models can yield interesting substantive results. Modelling this dependence explicitly allows for unbiased random-effect estimations, regardless of whether X and u are independent or not. The results of the F-tests accept as adequate for our data the random-effect estimates accounting for first-order autocorrelation (AR1).

The use of this model is also supported by the structure of our panel dataset with a short time series and a large number of cross-sectional observations. Furthermore, the choice between fixed and random effects is due to the fact that most of the variability in our

[1] Results of the statistical tests are available on request.

dependent and independent variables is across firms and not within firms over time, see Table 3 (Hsiao, 1986; Vernon, 2003).

6. Results

6.1 Descriptive statistics

Table 1 shows the characteristics of our sample of interest, the manufacturing potentially dominant firms (MPD) with respect to the entire population and the sub-sample constituted by potentially dominant firms (PD). The entire sample has a number of observations ranging from 10664 firms (CIS2) to 13465 firms (CIS2.5) across waves while the PD firms sample has obviously less observations varying from 1658 firms (CIS3) to 2526 (CIS 2.5). When we focus on manufacturing sector the number of observations decreases subsequently ranging from 482 (CIS 3.5) to 726 (CIS2.5).

----------Insert Table 1 around here----------

Table 1, not surprisingly, shows that, in all the waves the means and the median are remarkably larger in PD firms than in the entire sample. The mean is always larger in all dominant firms in all CIS waves than in MPD sector only. On the contrary, the median behaves the other way around: it is higher for MPD than for all the PD firms (with the exception of CIS 4). This suggests that the largest firms in the population that raise the mean are not manufacturing firms. In every wave the median is lower than the mean suggesting that the firm size distribution is skewed toward the smaller firms. The skewness and the kurtosis in MPD are much smaller than in the entire sample and in the PD sample, implying that firms size distribution is less skewed and contains fewer firms in the tails.

Table 2 presents descriptive statistics of the variable of interest for MPD firms across the CIS waves. The table follows the distinction between innovation input, innovation output and efficiency. The table shows that the total R&D expenses increase as time passes by, while the total cost of innovation decreases along the waves. It means that the share of total internal R&D expenses on the total cost of innovation increases. Despite the fact that the investment in R&D increases during the years, the percentage of total sales due to new and improved products decreases of 28 % between CIS 2 and CIS 2.5. Quite surprisingly, R&D efficiency

and cost efficiency decrease along the years for the MPD firms.

In the entire sample, on average we observe that the 10,02 % of firms are involved in M&A activities during the previous three years across waves. Among PD firms this percentage raises to 14.92 % and among the PDM to 13.66 %. There is a higher involvement in M&A activities for firms that are likely to generate dominant positions in the manufacturing sector, suggesting that firms tend to rely more on external growth (M&As) instead of internal growth to dominate the market.

----------Insert **Table 2** around here

Table 3 shows that the statistics of the dependent variables, distinguishing between firms involved in M&A activities and those not involved. The last column reports the results of a *t-test* on the means of the two firms' groups.

The statistics reported in the table highlight the striking differences among these two groups of firms. The results of the *t-test* confirm that the means do indeed differ significantly for all the variables except for R&D and cost efficiency in terms of new products for the market. M&A active companies display higher levels of R&D and cost efficiencies for products new to the firm compared to non M&A active firms. When we consider products new to the market, M&A active companies are more efficient only with respect to R&D investments while non M&A active firms perform better in terms of cost efficiencies. Our results suggest that MPD firms involved in M&A are intensive investors in R&D and innovation. This is confirmed by the fact that R&D and innovation expenses are much higher (from a minimum of 2,6 times to a maximum of 5,4 times, depending on the waves) for M&A active firms than for M&A non-active firms in all the waves.

----------Insert **Table 3** around here---------- -

Innovation output also seems to be higher for M&A active firms than for non M&A active companies. Companies involved in M&As have higher levels of sales from products new for the market and for the firm. Indeed, the mean for the M&A active firms is higher for a percentage ranging from a minimum of the 6% to a maximum of the 50% than the mean of the M&A non-active firms.

It is worth noting that the between variance for all the dependent variables is remarkably higher than the within variance for both M&A active firms and M&A non active firms. Indeed the between variance is on average at least twice the within variance and in certain cases (total R&D expenses) it is 47 times the within variance. This result confirms that the use of the random effect model is the most adequate for our data.

6.2 Multivariate analysis

Tables 4 and 5 show the effects of M&As on the proxies of innovation input, innovation output and innovation efficiencies respectively. Table 4 focuses on the innovation inputs and outputs. The first two columns show that M&A activities performed in the previous 3-5 years have a positive and significant (10% level) effect on R&D expenses and on the cost of innovation. We consequently support our hypothesis H1b (and reject H1a) affirming that M&A activities have a positive effect on innovation inputs. Not surprisingly, the technological characteristics significantly affect the inputs of innovation, suggesting that science-based, specialized suppliers and scale intensive firms have higher levels of investments on R&D and innovation costs than supplier dominated firms. Our findings suggest that the size of the company influences positively the total expenses on innovation but not the intensity of the R&D investments. Large companies therefore have higher levels of costs associated with innovation other than simply R&D activities. There is no evidence that companies present in the market for longer time have higher levels of innovation inputs. Indeed, age does not appear to be significant. However, we observe that when size and age are associated together, their interaction has a positive impact on innovative inputs.

----------Insert **Table 4** around here--------

The results of the random effect model estimation on innovation output proxies (Table 4, 3rd and 4th columns) suggest that M&A activities can enhance the level of innovativeness of a corporation increasing their level of sales from products new for the firm. This increase of innovation levels, however, seems to takes place only in relation to the company. When we concentrate on the degree of firm's innovativness, considering the sales from products new for the market, the situation is different. M&A activity appears to have a positive but not significant effect on the dependent variable of interest. In this case, M&A activities do not seem to be relevant in increasing the sales from products new to the market. This result seems

to suggest that M&As enhance the internal renewing of a firm, strengthening its capabilities to introduce products that were already present in the market, but not produce by the firm. In a certain sense, M&As semms to increase the competitivness of the firm in the market, makng it able to imitate products that before were not produce internally. However, M&As do not seem to improve the firms capabilities and competences necessary to produce and sell in the market a completely new product. We do not know whether M&As do not affect the firms knowledge base or its technological, organizational and commercial competencies and capabilities. Indeed, what we observe is the level of sales due to products new to the market. Such a proxy indirectly measures also the commercial success of an innovation. It is possible that M&As do not affect other factors (like marketing activities) than R&D investments that are important in supporting the commercial success of completely new products.

Our results suggest that size is important to display higher levels of sales from products that are new for the company. When size is considered in combination with the age of the company, the same applies also to total sales due to products new to the market suggesting that older and larger companies are more likely to display higher levels of sales from products new for the market. Positive and highly significant are, again, the Pavitt variables for all the innovation output proxies considered.

Summarizing, the above findings lead us to accept hypothesis H2b affirming that M&A has a positive effect on innovation output with respect to total sales due to new products to the firm but not with respect to the total sales due to products new for the market.

----------Insert **Table 5** around here--------

Table 5 shows the results of the regression for the efficiency variables. We distinguish two cases. The first one considers the R&D and the total cost of innovation efficiencies for products new to the firm. The second case considers R&D and the total cost of innovation efficiencies for products new to the market. M&As is a significant factor in explaining the levels of both R&D and the total cost of innovation efficiencies in terms of new products for the firm. This suggests that companies can use M&As to optimize internal investments and expenses especially with respect to innovativeness at the firm level. When we consider the R&D and innovation efficiency in terms of new products for the market, the picture that we get from our analysis is remarkably different. The findings suggest that companies are not supported by M&As to improve the effectiveness of their innovation expenses for products

new for the market: on the contrary, M&As have even a detrimental effect on the total cost of innovation efficiency. R&D activities oriented to new products for the market do not seem either to benefit appreciably from M&As. Indeed, M&As have a positive but insignificant effect on R&D efficiency.

Large companies seem to have an advantage compared to small firms in using R&D investments and innovation expenses to generate products new for the company while size is not significant when considering efficiencies for products new for the market. The technological characteristics are, once again, positively and significantly correlated with all the efficiencies' measures considered.

In conclusion, we can accept H3b that M&As have a positive effect on innovation efficiencies only with respect to the total cost of innovation and R&D efficiencies in terms of new products for the firm. Instead, Hypothesis H3a holds for innovation efficiencies in terms of new products for the market.

7. Discussion and concluding remarks

In the present paper we have tested empirically several hypotheses about the impact of M&A activities on innovation in the specific context of market dominance. In order to account for the multidimensional nature of innovation, we have considered three aspects of the innovative activity: innovation inputs, innovation outputs and innovation efficiencies. For our analysis, we have used a panel dataset constructed linking the Dutch Business Register Database and the waves of the Dutch Community Innovation Survey carried out from 1994 until 2002. We have exploited the panel nature of our dataset to account for the time gap necessary for the M&As to have an effect on the corporate innovation performance.

Our analysis shows that, with few exceptions, M&A activities have a positive and significant effect on the innovation dimensions investigated, i.e. both R&D investments and, more in general, innovation expenses. In contrast with previous studies, we have found no support for the argument that M&As are detrimental to, or substitutes for, internal efforts to innovate, at least in potentially dominant firms. We can argue that for firms that are potentially dominant in their markets, M&As do not reduce the incentive or the willingness to innovate. This may be consistent with a Resource Based View framework in which firms achieve competitive advantage through resources that are valuable, rare, imperfectly imitable

and non-substitutable (Barney, 1991). Obviously, dynamic capabilities—which refer to the adapting and renewing of resources—might be of importance especially in rapidly changing technological sectors (Barney et al. 2001, Eisenhardt and Martin, 2000). The findings might suggest that potentially dominant firms use M&A to build new competences and capabilities or to expand the existing ones in order to innovate. M&As, however, do not seem to have the potential to provide direct support to develop products new for the market. M&As appear to be more appropriate in sustaining the process of internal renewal of the firm's products base.

The above considerations seem to be reinforced by the fact that M&As enhance especially efficiencies in terms of innovations that are new to the firm. In line with the reasoning in Cefis et al. (2005), we propose a possible explanation why M&As fail to support efficiencies in innovations new for the market derived form the theory of innovation adoption postulated first by Everett Rogers (1962) and from the product life cycle theory (Utterback and Abernathy, 1975, Klepper 1996). When a new product is introduced into the market, it normally shows a slow rate of adoption among consumers. The competition is mainly aimed at specifying the distinguishing features of the product and this is associated with initially low levels of sales and high development costs. Once the product is widely adopted, the competition focuses on prices and cost decreases (Utterback, 1994). Only at this point, higher levels of efficiencies can be observed.

It is worth noting that the variables, used to control for specific technological characteristics, based on Pavitt's taxonomy, have been constantly confirmed to be highly significant in explaining innovation patterns. This seems to support previous findings that "innovative activities in an industry can be explained as the outcome of different technological (learning) regimes" (Breschi et al. 2000).

The findings of our analysis contribute to better understand the effects of M&A in the context of potential market dominance and are valuable for managerial and policy implications. From a managerial perspective, our research confirms that, contrary to conclusions from previous empirical research, M&As can be considered an appropriate tool to foster innovation at the different stages of the process. From the authorities' perspective, our empirical evidence suggests that M&As might actually enhance innovation. Authorities are therefore challenged to balancing M&As' potential anticompetitive effects on market structure with their capability to stimulate competition through innovation. For this positive effect to be visible a considerable time lag (3-5 years) is necessary. Long run societal well-being can be harmed if the merger evaluation does not take into careful consideration the full

range of potential effects of a merger, including those on innovation. At the European level, the evolution of the recent legislation constitutes advancement in this direction.

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