

Delft University of Technology

Economics and Management of Innovation

EMI Discussion Paper Series #2009-02

ISSN 1877-3834

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Acquisitions, Divestitures and Innovation Performance in the Netherlands

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January 2009

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Abstract

This aim of this paper is twofold. First it examines the determinants of acquisitions and divestitures of Dutch firms in the period 1996-2004. Second, it investigates the impact of acquisitions and divestitures on the firm's innovative output performance. An econometric model is specified and estimated with Community Innovation Survey data for the Netherlands in the period 1996-2004.

The main findings of this study are as follows. First, innovating firms are significantly more involved in acquisition activities than non-innovating firms, which suggests that acquisitions are a strategy to gain access to new technologies or knowledge. Second, lack of knowledge as a barrier to innovate increases the chance of acquiring assets of other firms although not significantly. Lack of finance as a barrier to innovate increases significantly the chance of divesting assets. Third, acquisitions motivated by knowledge barriers in the innovation process affect the probability of positive innovative sales positively while acquisitions motivated by other reasons than innovation barriers affect this probability negatively. No effect of knowledge barriers induced acquisitions on the level of the innovative sales could be found.

1. Introduction

In theoretical and empirical research on mergers and acquisitions (M&A) two questions are important: 1) why do acquisitions occur (e.g. Andrade *et.al*, 2001); and 2) what is the impact of acquisitions on firm's performance (e.g. Gugler *et.al*, 2003).

The first question deals with the determinants of acquisitions. These determinants include the motives and hence strategies of firms to start acquisition of (assets of) other firms. Acquisition activities can arise from different motivations like conglomerate building, market dominance or access to technical knowledge. The latter motive is particularly important if rapid technological change – as experienced in the last two decades – leads to a fast changing external environment. Through acquisitions the management of the acquiring firm brings a part of the external environment under internal control in order to reduce external uncertainty for the acquiring firm.

The second question is dealt with empirically by investigating the impact of acquisitions on post- acquisitions profits and sales. The effectiveness of acquisitions as a strategy for acquiring firms to become (more) innovative has received increasing attention since Hitt et.al. (1991).

Firms expand through acquisitions but also re-structure their productive activities through divestitures. Selling parts of the production process to other firms can release resources that can be used for the innovation process. Not much attention has been paid to this issue yet (e.g. Brauer, 2006).

Another issue is that the value of many empirical studies is limited by the causality issue: do acquisition activities increase the innovative performance of the firm or do innovative firms hunt for acquisition activities in order to get access to new technologies?

Therefore these studies provide evidence for correlations in stead of causal relationships (e.g. van Beers and Sadowski, 2003).

This paper's aim is threefold. First, it investigates whether innovative firms are more involved in acquisitions and divestitures than non-innovative firms. Using Community Innovation Survey (CIS) data for the Netherlands for the period 1996-2004 we investigate whether or not innovativeness is a driving force for actively purchasing (acquisitions) or selling (divestitures) to other firms. The second goal is to address whether firms that experience barriers in innovation activities are provoked to change their corporate structure through acquisitions and/or divestitures. A distinction is made in knowledge-, financial- and other barriers. Particularly the impact of knowledge-related innovation barriers on acquisition activities provides information on acquisitions as a strategy to gain access to the lacking knowledge. The third goal of this study is to investigate whether acquisition and/or divestiture activities affect the innovative performance of the firm. Especially when these activities are motivated by lack of knowledge as an innovation impeding factor, a positive effect of acquisitions and/or divestitures on innovative performance can be expected.

The empirical analysis in this paper is based on Community Innovation Survey (CIS) data of the Netherlands in the periods 1994-1996, 1996-1998, 1998-2000, 2000-2002, 2002-2004. The advantage of CIS-data is that these are specifically designed for investigating innovation behaviour of firms. The CIS-data allow us to estimate a model with acquisitions as a determinant of innovation performance while controlling for other firm characteristics.

The main findings of this study are as follows. First, innovating firms are significantly more involved in acquisition activities than non-innovating firms, which suggests that acquisitions are a strategy to gain access to resources relevant for innovation. Second, lack of knowledge as a barrier to innovate increases the chance of acquiring assets of other firms although not significantly. Hence we find weak evidence of the lack-of-knowledge barriers in the innovation process as a motivation for acquisitions. Lack of financial means as a barrier to innovate increases significantly the chance of divesting assets. This is strong evidence of divestitures as a strategy to free up financial means that can be used in innovation processes. Third, acquisitions motivated by knowledge barriers in the innovation process affect the probability of positive innovative sales per employee positively while acquisitions motivated by other reasons than innovation barriers affect this probability negatively. No effect on the level of the innovative performance could be found.

In the next section we review the theoretical and empirical literature on the relationship between acquisition and/or divestitures activities and the innovation performance at the firm level. Section 3 formulates relevant hypotheses and an econometric model to test the hypotheses. The data used for testing the hypotheses are presented and discussed in section 4. In section 5 the empirical testing and estimation results are shown. The final section concludes.

2. Theoretical and empirical background

2.1 Theoretical background

Why firms restructure their assets through acquisitions and divestitures can be motivated by a variety of reasons like e.g. the search for more efficiency in the internal organisation of the restructuring firm, the search for market power by creating oligopolies or monopolies, managing risks by creating more diversification in the acquiring firm's activities but also the strategy to gain control over an external environment that is governed by external shocks.

Several authors have pointed out that the most important fundamental forces behind a firm's restructuring activities are specific external shocks at the industry level (e.g. Morck *et.al,* 1988; Jensen, 1993; Mitchell and Mulherin, 1996). Examples of such external shocks are oil price shocks as in the 1970s, leading to the merger wave in the 1980s, deregulation and technological innovation shocks in the 1990s.

Andrade *et.al* (2001) investigate the impact of deregulation on the merger wave in the 1990s in the USA but does not pay attention to technological innovation shocks.[2] The rapid technological change observed in the last decade of the previous century shifted the focus of firms' restructuring activities to the hunt for new knowledge and technology (e.g. Sorensen, 2000).

With regard to the relationship between acquisitions/divestitures and economic performance of firms, contributions from different fields have been made, i.e. the industrial organization literature, the corporate control and finance literature and the technology management literature.

[2] It is hard to disentangle the effects of technological and deregulation shocks on the restructuring activities in the 1990s. Both phenomena are related to each other. Deregulation can lead to the application of new technologies but also technological shocks might force authorities to remove obsolete or choking regulations.

The industrial organization literature emphasises that acquisitions leads to the exploitation of economies of scale and scope and hence to a better economic performance in terms of productivity or profitability (Röller, 2005).

In the corporate control and finance literature acquisitions are expected to affect the internal organisation and production structures and hence the profitability of the acquiring firm. If managers of merging companies seek to maximize profitability or shareholder wealth, it is important to investigate how acquisitions influence profitability (see Gugler et.al, 2003).

In the technology management literature attention is focused on technological synergies in the internal production- and R&D-processes of the firm, which leads to more technological or innovative output. Acquisitions can be part of a strategy to acquire technology of other firms. In order to make this strategy successful the acquiring firm's management should be familiar with the technological processes in the target firm. This technology-searching motive affects the innovation performance directly and indirectly (Cassiman, 2005). The direct effect is on R&D inputs, processes and outputs of the acquiring firm. The indirect effect originates from the – a priori assumed – positive impact of the changed innovation performance on the productivity and profitability of the firm (Geroski *et.al*, 1993). This results in scale and scope advantages and hence more financial means that lead to an additional improvement of the innovation performance.

Acquisitions that are not motivated by technology search like e.g. entry into a new market, diversification and risk reduction also affect the R&D process and innovation performance but only in an indirect way. These types of acquisitions directly affect the

production process and the output produced, which leads to economies of scale and scope providing more financial means available for the R&D process.

The impact of acquisitions on innovation performance can be positive or negative, depending on 1) the distinction between direct and indirect effects, 2) the kind of innovation performance used (R&D input or innovation output like patents or sales of technologically new products) and 3) whether the ultimate goal of the acquisition is innovation- or not innovation-related.

Negative effects of acquisitions on R&D input, which point at deteriorated innovation performance can occur through the following three direct mechanisms. First, an acquisition is a project that distracts managerial time and efforts from R&D projects (Hitt et. al, 1996). Second, acquisitions can lead to a more bureaucratic internal R&D organisation. The innovation potential of the acquisitions is eroded by high internal resistance, less effective decision-making, etc. Scientists and researchers often leave the firm after an acquisition, particularly if the integration process after the merger is managed badly (Ernst and Vitt, 2000). Third, acquisition activities require finance, which might increase debt financing giving debtors a stronger voice in investment decisions. As debtors are more risk-averse than shareholders, this makes the firm less inclined to start risky projects. Cassiman et.al (2005: 202) argue that these negative effects show up when the motivation to purchase other firms is not innovation-related.

An ambiguous effect of acquisitions on R&D input can be expected when acquisitions lead to higher market power in the output market, especially when both acquirer and acquired are large. On the one hand a positive effect can be expected as more resources for innovation are available and – in order to continue benefiting from market power in

the future – will be used to increase R&D input and hence innovation output. This argument is related to Schumpeter II and is still a central theme in academic debate. On the other hand the Schumpeter I argument is also valid as a negative effect can emerge because competition is reduced and hence the incentive to innovate. Even stronger, it might be the ultimate objective to reduce R&D input in order to remove potential or actual competition from a rival firm (Katz and Shelanski, 2004).

A positive effect on innovation performance can emerge from two indirect effects of acquisitions leading to a lower R&D input. First, R&D inputs measured by R&D expenditures as a percentage of firm sales might go down as a result of acquisitions due to scale economies. Scale and scope advantages in both R&D and non-R&D activities also imply more efficient use of R&D input resources, which leads to less R&D input while still achieving the same number of patents and/or output with technologically new products. Increased efficiency of R&D is the result. Second, if acquirer and acquired are active in the same technological field R&D input might be reduced as wasteful and duplicated R&D are removed (Cassiman *et.al*, 2005). This effect is expected when the target firms are in the same technological field as the acquiring firm.

Improved innovation performance defined as innovation output like patents and/or sales of technologically new products can be expected through the following two indirect mechanisms. First, scale economies achieved in the output market due to the increased size after the acquisition lead to spreading fixed costs over more output. This improves the efficiency of the R&D process and leads to more new products. Second, acquisitions can lead to synergies between the acquiring and target firms that in the pre-acquisition

time could only be benefitted through knowledge spillovers. Acquisitions are a means to internalize knowledge spillovers and will lead to more innovation output.

Divestitures or the selling of (parts of) the firm do influence its innovation performance for two reasons. First, the decision to sell off originates from the wish to focus the core business of the divesting firm. All activities that are not directly related to the core business of the firm reduce the learning effects and hence the innovation performance. In other words, divestitures decrease learning inefficiencies and can be expected to increase innovation performance positively. Second, divestitures might be the result of earlier mistakes in the acquisition process. For example, in the take-over process of complete firms or divisions the bureaucracy might increase as some parts of the acquired firm might not completely fit into the core business of the acquiring firm. This leads to divestitures and can be expected to influence the innovation performance by enforcing the innovation performance of acquisitions (Jensen, 1988).

2.2 Empirical Studies

Empirical research on the determinants of acquisitions and divestitures has mainly focused on the acquisition activities. Blonigen and Taylor (2000) investigate the impact of a firm's R&D-intensity on the number of acquisitions it performed in the electronics and electrical equipment sector. This study addresses the issue whether firms with low innovation activity use acquisitions as a way to increase their innovativeness by gaining access to external innovation activity. The authors found a robust negative relationship between R&D-intensity and the number of acquisitions performed. In other words, firms

with relatively low R&D-intensity are more likely to acquire. This argument is related to a 'make or buy' strategy (see Veugelers and Cassiman, 1999).

Evidence for the importance of the technology sourcing motive for the impact of acquisitions on innovation performance is found by Ahuja and Katila (2001). They distinguish between non-technological and technological acquisitions in the chemical industry. A negative or no impact of non-technological acquisitions on innovation output as measured by patent counts is hypothesized and their empirical investigation finds no significant effect. Technological acquisitions are hypothesized as influencing the number of patents positively, which is found empirically. Relatedness of the knowledge bases of acquiring and acquired firms is in a curvilinear way related to the number of patents. Moderate levels of relatedness affect innovation output superior to high levels of relatedness and unrelatedness (Ahuja and Katila, 2001).

Cloodt et.al (2006) replicate the study of Ahuja and Katila (2001) to four other high tech sectors, aerospace and defence, computers and office machines, pharmaceuticals and electronics and communications. Their findings support those of Ahuja and Katila (2001).

Other empirical studies focus on the impact of mergers and acquisitions on innovation performance. Many of these concentrate on R&D-intensity and conclude pessimistically that acquisitions work out negatively or not at all on post-merger/acquisition innovation performance. Many of these studies are in-depth analyses of small sample studies in a sector. The big advantage of this approach is the level of detail in the analysis (Capron, 1999; Cassiman *et.al*, 2005; Chakrabarti, 1994). A disadvantage is that no attention can be paid to general determinants describing the relationship between acquisitions and

innovation performance. A limited number of studies use larger datasets (Blonigen and Taylor, 2000; Ahuja and Katila, 2001; Cloodt et.al, 2006; Hitt *et.al*, 1991, 1996). These studies generally report negative relationships between acquisitions and post-acquistion R&D input and output of acquiring firms.

Hitt *et.al* (1991) investigate the impact of acquisitions on both R&D inputs and R&D outputs. R&D inputs are defined as R&D-intensity i.e. R&D-investment divided by sales. They hypothesize and found a negative relationship between firm's acquisitions and its R&D intensity relative to average industry R&D intensity. With regard to R&D output they also found a negative relationship between acquisitions and R&D outputs, measured as the number of patents divided by sales. These results were motivated and explained by the argument that resource constraints in an innovating firm forces management to make a choice, either through innovating internally or innovating by acquiring innovating firms. The latter strategy may be an alternative to internal development of innovations as measured by R&D investments.

Capron (1999) uses a sample of 253 acquiring and divesting firms in the USA and Europe in 1988-1992 to investigate how technical resource deployment leads to enhanced innovation capabilities. She finds that divestitures seem to work out negatively on innovation capabilities.

Cassiman et.al (2005) investigate how technology- and market-relatedness of acquisition partners affects inputs, outputs, performance and organisational structure of R&D. They find a decrease of R&D levels after the acquisition when the merging partners are technologically substitutive and an increase when they are technologically complementary.

Chakrabarti et al. (1994) find that large acquiring firms that take over small acquired firms reduce the innovation performance of the former. Moreover, acquisitions between firms of equal size perform better than those between firms of unequal size. Hagedoorn and Duysters (2002) argue that in the international computer industry the growth of patent-intensity is affected positively by related acquisitions, i.e. horizontal and vertical acquisitions in contrast to conglomerate acquisitions. Horizontal acquisitions imply relatedness of the product-markets between acquired and acquiring firms, which leads to economies of scale and scope and are therefore expected to affect technological performance of the acquiring firm positively. Vertical acquisitions produce cost reductions through integrating upstream or downstream partners and release means that can be used for innovative research.

Van Beers and Sadowski (2003) and Prabhu *et.al* (2005) used sales with technologically new products as the innovation performance indicator and they found positive effects of acquisitions on the probability to innovate respectively innovation performance. This corresponds with the notion that findings of the innovation literature are in contrast with those from the corporate control tradition as the latter generally find negative effects on the post-acquisition innovation of acquiring firms (Ahuja and Katila, 2001).

3. Hypotheses and model

3.1 Hypotheses

The first research question to be examined is whether innovative firms are more involved in acquisitions and divestitures than non-innovating firms. Firms that innovate operate in a more dynamic external environment than non-innovating firms and have a stronger

incentive to exert control over the external environment either to eliminate competitors or to search for (new) knowledge and technologies. Acquisitions are a means to gain such control. Therefore we expect that innovative firms will reveal a higher probability to be involved in acquisitions activities than non-innovative firms. We also expect a higher probability of divestitures to occur when firms innovate as operating in a dynamic external environment can force firms to reduce part of their assets in order to re-focus their business and innovation efforts.

Hypothesis 1a: *Innovating firms have a higher probability to acquire other firms than non-innovating firms.*

Hypothesis 1b: *Innovating firms have a higher probability to divest other firms than non-innovating firms.*

The second research question deals with the motives of acquisition and divestiture activities. As shown in Section 2 technology- and market related motives are predominant in empirical studies. As we are interested in technology-searching motives for restructuring the firm's assets our focus is on investigating the impact of knowledge barriers in the innovation process on the probability to acquire. Firms that experience barriers to innovation that originate from a lack of knowledge are expected to be more involved in acquisitions of (assets of) other firms in order to overcome these barriers. Selling (parts of) firms or divestitures is a means to free up financial means. Therefore we expect that firms that experience innovation barriers driven by a lack of financial means have a higher probability to divest assets. This brings us to hypotheses 2a and 2b:

Hypothesis 2a: *Firms that experience innovation barriers due to lack of knowledge have a higher probability to acquire firms than firms that do not experience these barriers.*

Hypothesis 2b: *Firms that experience innovation barriers due to lack of finance have a higher probability to divest firms than firms that do not experience these barriers.*

The third hypothesis deals with the impact of acquisitions and/or divestitures on the firm's innovation performance. Acquisitions and/or divestitures – particularly large ones – are restructuring activities that affect many aspects of the firm's internal processes and therefore influence its (innovative) performance (Cassiman et.al, 2005). More specifically, we assume that firms acquiring other firms in order to overcome innovation barriers due to lack of knowledge in their innovation processes increase their innovation performance as compared with non-acquiring firms and firms that acquire for different reasons than overcoming these barriers. With regard to divestitures we assume that firms divesting other firms in order to overcome innovation barriers due to lack of finance show a higher innovation performance than non-divesting firms and firms that divest for other reasons than overcoming financial barriers. Hypotheses 3a and 3b are:

Hypothesis 3a: *Acquisitions that go together with innovation barriers due to lack of knowledge affect the innovation performance positively.*

Hypothesis 3b: *Divestitures that go together with innovation barriers due to lack of*

finance affect the innovation performance positively.

3.2 The econometric model

The model consists of two equations. First, the probability to acquire or divest (assets of) other firms is explained by a number of explanatory variables in a logit model. Second, the innovation performance as a dependent variable is related to explanatory variables in a regression model.

The first equation is presented in (1a) and (1b):

$$\begin{aligned} Acquisitions_t &= \alpha_0 + \alpha_1 \ln(Size)_{t-n} + \alpha_2 Exports_{t-n} + \alpha_3 Innovation_{t-n} \\ &+ \alpha_4 Divestitures_{t-n} + \alpha_5 KnowLack_{t-n} + \alpha_6 FinLack_{t-n} + \alpha_7 OtherLack_{t-n} \\ &+ \alpha_8 Sectordummies + \alpha_9 Timedummies \end{aligned} \quad (1a)$$

$$\begin{aligned} Divestitures_t &= \beta_0 + \beta_1 \ln(Size)_{t-n} + \beta_2 Exports_{t-n} + \beta_3 Innovation_{t-n} \\ &+ \beta_4 Acquisitions_{t-n} + \beta_5 KnowLack_{t-n} + \beta_6 FinLack_{t-n} + \beta_7 OtherLack \\ &+ \beta_8 Sectordummies + \beta_9 Timedummies \end{aligned} \quad (1b)$$

In (1*a*) the dependent variable, $Acquisitions_t$, measures whether or not the firm purchased (assets of) another firm in the period *t*. In (1*b*) $Divestitures_t$ is the dependent variable and measures whether or not the firm sold (assets of another firm) in the period *t*. The first independent variable is the natural logarithm of the firm size, measured as the number of employees at time *t-n*, with *n* taking the values 2 or 4. In this study the data allow us to distinguish between a lag of two or four years. Larger firms have a larger capacity to absorb and shed the assets of other particularly smaller firms. Also the financial means at their disposal – either through own liquidities, shares or bank loans – are larger than in case of small firms. We expect both α_1 and β_1 to have a positive value. The variable

$Export_{t-n}$ shows a value of 1 when the firm exports in period *t-n*, and 0 otherwise. As exporting leads to exposure of the firm to world market competition it can be expected that exporting firms are more active in restructuring their assets in order to deal with their dynamic external environment. Both α_2 and β_2 are expected to be positive.

The variable $Innovation_{t-n}$ is 1 if the firm is reported to be an innovator in the period *t-n*, and 0 otherwise. This is a variable of main interest as it is used to test the hypotheses 1*a* and 1*b*. Based on these hypotheses positive coefficients for both coefficients α_3 and β_3 are postulated.

In equation (1*a*) the variable $Divestitures_{t-n}$ is included in order to pick up the effect that divestitures in the past are done in order to free up financial means to be used for acquisitions later on. It is considered as an indicator that firms aiming for acquisitions carefully plan these take-overs by taking preparing actions in the periods before. The sign of coefficient α_4 is expected to be positive. Equation (1*b*) incorporates whether or not a firm acquired other firms in the period *t-n* ($Acquisitions_{t-n}$). This variable describes how acquisitions in the past lead to new restructuring later on through divestitures. Mismanaged acquisitions that lead to inefficiencies and more bureaucracy lead to divestitures at a later time in order to become leaner.

The variables $KnowLack_{t-n}$ and $FinLack_{t-n}$ have a value 1 if the firm reported innovation barriers due to lack of knowledge respectively lack of finance and 0 otherwise. Lack of knowledge is composed of lack of specific technical knowledge and lack of qualified personnel. Lack of finance consists of lack of financial resources and innovation costs that were too high compared with the initial budget. These two variables are meant to test hypotheses 2*a* and 2*b*. Based on these hypotheses we expect α_5 and β_6 to be positive. The

coefficient α_6 is expected to be negative as lack of finance for innovation is quite likely also lack of financial means necessary to finance the purchase of assets of other firms. The coefficient β_5 is assumed to be positive as lack of knowledge as an innovation barrier can lead to divestitures aimed at getting financial means that can be used for purchasing the lacking knowledge components. The variable $OtherLack_{t-n}$ is a dummy variable that picks up the innovation barriers to other causes than lack of knowledge or finance.

Both sector- and time dummies are included in order to control for the sector distribution of the sample and business cycle effects.

The second equation examines the impact of acquisitions and divestitures on the innovative output and is presented as:

$$
\begin{aligned}
&Ln(Turn\_empl)_t = \gamma_0 + \gamma_1 Ln(Size)_{t-n} + \gamma_2(\exp ort - \text{int} ensity)_{t-n} + \gamma_3 Cooperation_{t-n} \\
&+ \gamma_4(R\,\&\,D - permanent)_{t-n} + \gamma_5 Acquisitions_{t-n} + \gamma_6 Divestitures_{t-n} \\
&+ \gamma_7(Acquisitions_{t-n} * KnowLack_{t-n}) + \gamma_8(Acquisitions_{t-n} * FinLack_{t-n}) \\
&+ \gamma_9(Acquisitions_{t-n} * OtherLack_{t-n}) + \gamma_{10}(Divestitures_{t-n} * KnowLack_{t-n}) \\
&+ \gamma_{11}(Divestitures_{t-n} * FinLack_{t-n}) + \gamma_{12}(Divestitures_{t-n} * OtherLack_{t-n}) \\
&+ \gamma_{13} Sectordummies + \gamma_{14} Timedummies \qquad (2)
\end{aligned}
$$

with: n = 2, 4;

The dependent variable of model (2) shows innovative output performance as a productivity measure, i.e. sales of products that are new to the market per employee. In the CIS questionnaires a distinction is made between sales of products new to the firm and new to the market. Products that are new to the firm but not new to the market are considered as incremental innovations of which a part can be imitations while products that are new to the market are considered as more radical innovations.

The natural logarithm of firm size in employees is the first independent variable. The size of a firm is assumed to affect its sales positively.[3] Export-intensity – exports as a share of total sales – is expected to affect the turnover per employee positively ($\gamma_2 > 0$) as a higher share of sales achieved in foreign markets is a proxy for more exposure to competition, which forces innovating firms to make their innovations a commercial success. The variable $Cooperation_{t-n}$ is a dummy variable with a value 1 if the firm cooperates on reported innovations with other partners and 0 otherwise. We expect cooperation with third parties to be fruitful for commercialization of the innovations and hence a positive sign of $\gamma_3 > 0$. R&D-permanence – a dummy with value 1 if a firm reports to have R&D expenditures continuously and 0 otherwise – is assumed to work out positively on turnover of products new to the market per employee, i.e. $\gamma_4 > 0$.

With the exception of the sector- and time dummies the rest of the independent variables in model (2) relate acquisitions and divestitures to innovation performance. The variables $Acquisitions_{t-n}$ and $Divestitures_{t-n}$ are the impact of acquisitions respectively divestitures of firms that do not report barriers to innovations in the period *t-n*. As we have not formulated hypotheses on these variables, we do not postulate a priori what sign of the coefficients we expect. The variable ($Acquisitions_{t-n}$ * $KnowLack_{t-n}$) is 1 if firms are involved in acquiring activities and report a lack of knowledge as a barrier to innovate. This is considered as a proxy for acquisitions that are motivated by lack of knowledge as an innovation barrier. Hypothesis 3a postulates that the sum of the coefficient γ_5 and γ_7 is expected to be positive. ($Acquisitions_{t-n}$ * $FinLack_{t-n}$) is constructed in the same way as ($Acquisitions_{t-n}$ * $KnowLack_{t-n}$) but now the interpretation refers to acquisitions motivated

[3] The dependent variable has the number of employees as its denominator. Therefore by construction a negative bias of coefficient γ_1 is introduced.

by a lack of finance as an innovation barrier. Acquisitions are hard to realize when lack of finance is a problem and hence we expect a negative sign for $\gamma_5 + \gamma_8$. The variable ($Acquisitions_{t-n}$ * $OtherLack_{t-n}$) is a proxy for acquisitions motivated by "other barriers" against innovations than lack of knowledge or finance. As it is a heterogeneous combination of barriers no a priori expectation of the sign of the coefficients γ_9 and γ_{12} can be formulated. The variable ($Divestitures_{t-n}$ * $KnowLack_{t-n}$) refers to divestitures that are motivated by lack of knowledge as an innovation barrier. We expect $\gamma_6 + \gamma_{10}$ to show a negative sign as lack of knowledge will not be solved by selling assets to other firms in the short term. In the longer term it might be positive as divestitures might free up financial means that can be used for buying required knowledge. ($Divestitures_{t-n}$ * $FinLack_{t-n}$) refers to hypothesis 3b and postulates that $\gamma_6 + \gamma_{11} > 0$.

4. Data

The models are estimated with data from the Community Innovation Survey (CIS) for the Netherlands in the period 1996-2004. The Community Innovation Survey is a survey conducted every four years by EU member states. It resulted from an initiative by the OECD and the European Statistical Office (Eurostat) to formulate guidelines for an internationally comparable questionnaire and methodological design for innovation. In the Netherlands, the survey is conducted *biannually* by Statistics Netherlands.

For the purpose of the present study we were able to access the CIS2 (1994-1996), CIS3 (1998-2000) and CIS4 (2002-2004) data for the Netherlands, but also the 'in-between waves' CIS25 (1996-1998) and CIS35 (2000-2002). In these waves innovations have three characteristics. They should 1) be based on technological new knowledge, 2) be new or significantly improved to the corresponding firm or new to the market, and 3)

be implemented successfully, either in the form of new (or significantly improved) products or services (product innovations) or new processes (process innovations).

Furthermore the CIS2, CIS25 and CIS3 surveys contain information on whether firms have taken over other firms through acquisitions and whether they had divestitures. In order to allow for two year and four year time lags between being an innovator and being involved in acquisition/divestitures (equation (1)), or between acquisitions/divestitures and innovative performance (equation (2)) we merge two consecutive waves of the CIS. To construct a two year time lag we merge CIS2 with CIS25, CIS25 with CIS3, and CIS3 with CIS35.[4] The four year time lag is constructed by merging the following waves: CIS2 with CIS3, CIS25 with CIS35, and CIS3 with CIS4. These merged datasets are pooled and used as input for estimating the models (1) and (2). This means for instance in the case of a two year lag that the dependent variables come from the pooled dataset consisting of CIS35, CIS3 and CIS25 and the independent variable from the pooled dataset consisting of CIS3, CIS25 and CIS2 respectively. As a result, the analyses in this paper have been restricted to firms that are present in two consecutive surveys.

In Table 1 the descriptive statistics of the samples used in the regressions are presented.

INSERT TABLE 1

In equation (1) acquisitions in the period *t-2* are nearly 4.8% of the observations, i.e. nearly 500 firms. This is reduced to 3.5 % or 113 firms when the acquisitions refer to the period *t-4*. For divestitures these percentages are 3.1 respectively 2.7. Both acquisitions

[4] CIS35 & CIS4 is not a viable combination, because in neither wave information on mergers, acquisitions and divestitures is available.

and divestitures in Table 1 are considered as "large", i.e. as those acquisitions (divestitures) that increased (decreased) the sales of the acquiring (divesting) firm with more than 10 %. The natural logarithm of the size measure is 4.321 and 4.462 for the two- and the four year lag samples respectively. The percentage of exporters is 28 % in the two-year lag model and increases to 47 % in the four-year lag model. More than 50 % of the sample consists of innovating firms. The innovation barriers that are perceived most are the knowledge barriers, which are experienced by 14 till 17 % of the firms. Financial barriers are reported by 11-12 % of the firms. The other barriers are a small percentage and constitute a mix of innovation barriers than cannot be registered under knowledge- or financial barriers.

With regard to equation (2) only innovative firms report turnover with new products, which explains why the number of observations is substantially less as in equation (1). Ln$(Size)_{t-n}$ is on average higher in equation (2) as in equation (1), which relates to the positive relation between having positive sales with products new to the market and firm size. More than one third of the innovating firms co-operate on R&D-projects. Their export intensity is some 18 % of total sales. Fifty-seven per cent of the innovating firms report to be involved in R&D at a permanent basis. The percentage of innovating firms that report to be involved in acquisitions or divestitures do not substantially deviate from the percentage of all (innovating and non-innovating) firms that are used in equation (1). Looking closer at the acquisitions and divestitures of firms that also report innovation barriers, it appears that knowledge barrier occur more frequent than financial and other barriers. Some two and a half percent of the innovating firms are involved in acquisitions and also experience knowledge barriers. This percentage is 2.0 (two year lag) and 1.7

(four year lag) in case firms do perform acquisitions and experience financial barriers. The percentage of firms divesting assets is 3.5 % (two year lag) and 2.8 % (four year lag).

5. Empirical results

The empirical results are reported in the tables 2, 3 and 4. In Table 2 the logit estimation results of equation (1) with a two year lag are presented. The results of the four year lag are not reported but will be discussed only when they deviate from the results of the two year lag estimates.[5] The dependent variable in Table 2 is "large" acquisitions and "large" divestitures.

INSERT TABLE 2

A first observation is that the size of the firm affects the probability to acquire or divest (assets of) other firms positively, which is expected a priori. Exports as an indicator of exposure to world competition is also positive although – in case of divestitures – not significant. When the lag increases to four years both size and exports affect the probability to acquire or divest negatively though insignificant. Firms that were an innovator have a higher probability to acquire other firms two years later but a lower probability to divest assets. Innovating firms attempt to gain control over their external environment by acquiring other firms. The negative effect of innovation on divestitures is unexpected. Apparently innovative firms do not use divestitures as a means to refocus their business activities. Hypothesis 1a cannot be rejected but hypothesis 1b should be rejected.

[5] These results are available upon request from the authors.

The independent variables $Divestitures_{t-n}$ in regressions 1 and 2 are distinguished into all (small and large) divestitures (regression 1) and large divestitures (regression 2). Both affect the probability to acquire other firms two years latter significantly positive, which suggests that firms divest assets first as a part of a broader strategy of freeing up financial means or re-structuring the business before they start to acquire other firms.[6]

In regressions 3 and 4 $Acquisitions_{t-n}$ is an independent variable, which affects the probability to divest other firms two years later positively. This is not valid when only large acquisitions are taken into account. Then the sign is negative but not significant, which suggests that firms that take-over other firms with a more than 10 % sales impact, have an insignificant lower probability to divest assets. Large acquisitions require careful planning on strategy and finance and hence lead to less wrong decisions that should be corrected by shedding off assets. When the lag between acquisitions and divestitures as specified in equation (1) are increased to four years, the insignificant negative effect arises also for "all acquisitions" although the effect is very small.[7]

Lack of knowledge in the innovation process increases the probability to acquire other firms two years after. This is expected a priori and points at technology-searching motives of acquisitions. However, the insignificance of the estimate in regressions 1 and 2 means a rejection of hypothesis 2a. Hypothesis 2b cannot be rejected as the coefficients of $Finlack_{t-2}$ are significantly positive in regressions 3 and 4. Divesting assets originates from a lack of finance that impedes innovations as a motive. The lack of knowledge barrier to innovation increases the probability to divest assets. If the innovation process is

[6] An example is the Dutch chemical firm AKZO-Nobel in 2007 that first divested its pharmacy producer Organon for € 11 billion and later acquired British Imperial Chemical Industries (ICI) for € 12 billion.
[7] This corresponds to the observation of Maksimovic (2008) that restructuring takes place in the short term after the acquisition (< 3 years).

impeded by lack of knowledge more divestitures might be a way to free up financial means in order to get access to the relevant knowledge at a later stage. The other "barriers-to-innovation" variables are not significant. After four years none of the barrier variables turn out to be significant.

The pseudo R^2 is between 3.2 and 3.5 %, which indicates that much heterogeneity cannot be explained.

INSERT TABLE 3

In order to test for hypotheses 3a and 3b the causality is reversed and the estimation results of equation (2) are reported in Table 3. As the dependent variable – natural logarithm of turnover achieved with products new to the market per employee – is only defined for innovating firms a sample selection bias might lead to biased estimates if no correction takes place. Therefore the estimates in Table 3 are Heckman sample selection corrected ordinary least square estimates. The probit estimates of the selection equation used are reported in Table 4. This equation identifies the drivers of a positive probability to have output of products new to the market. The independent variables in the selection equation are partly those for equation (2). Some differences have to be noticed. First, instead of the export share, the export dummy has been included in the selection equation. Second, the variables $Cooperation_{t-n}$ and $R\&D\ permanent_{t-n}$ are excluded as these are not defined for not-innovating firms. Third, one additional variable is included – product innovation, which measures whether the firm reports a product innovation (value = 1) or not (value = 0) – as the identifying variable. The *Size*-variable is very small and

not significant in regressions 5 and 6 and slightly significant in regressions 7 and 8. As argued in footnote 3 a negative bias of this estimate exists. Remarkably, the *co-operation* variable is not significant.[8] The share of sales sold abroad (*Export-intensity*$_{t-n}$) affects the innovative performance significantly positive, which is as expected. If an innovating firms reports to invest in R&D permanently it also reports higher sales of new to the market products after two years. When the lag is increased to four years this effect gets more uncertain as witnessed by the loss of significance of this variable in regressions 7 and 8.

The coefficients that relate the acquisition and divestiture variables to the innovative sales new to the market per employee are all insignificant. One interesting observation is that the positive impact of divestitures – though insignificant – arises after four years and the lack of finance of a motive plays a role. The ultimate effect – the sum of the coefficients $\gamma_6 + \gamma_{11}$ – is 0.759. However, the insignificance of the results leads to a rejection of both hypotheses 3a and 3b. Acquisitions and divestitures have no significant effect on innovation performance of innovating firms in the Netherlands in the period 1996-2004.

INSERT TABLE 4

Although the estimate of the parameter ρ is small and not significant and hence the same results can be expected when not correcting for the possible sample selection bias,

[8] It should be noted that the insignificant effect found is an aggregate effect as the variable *Co-operation* includes co-operation with different kind of partners. For example, Wevers et.al (2008) find that co-operation of innovating firms in the Netherlands with public science partners do effect the share of sales with product new to the market significantly positive.

the Heckman correction does provide us with interesting information. In Table 4 the estimation results of the selection equation used to estimate equation (2) are shown. The export- and size variables are positive and significant, as expected. No significant effects of divestitures on the probability of positive sales with innovative products could be found. Acquisitions exert a significant negative effect on the probability of innovative products sales after two years and no effect after four years (regressions 10 and 12). When the innovation barriers are introduced we find that this effect becomes clearer. Acquisitions by firms that report no innovation barriers have a negative impact on having sales with innovative products new to the market. The sample of 14,383 observations consists of both innovating and non-innovating firms. As non-innovative firms have no sales with innovative products this leads to a negative bias of the coefficient. In order to correct for this bias the variable *Product Innovation* has been included, which is also the identifying variable in the select equation. The impact of acquisitions by firms that are motivated by knowledge barriers to innovation processes exerts a positive effect on the probability to have sales with innovative products new to the market, i.e. -0.217 + 0.320 = 0.104. Financial innovation barriers as a motive to acquire affects the probability of a positive innovation performance negatively, i.e. -0.217 + 0.118 = -0.099. The impact of other barriers is also positive i.e., -0.217 + 0.850 = 0.633. These barriers are not of our main interest as they are a rest category of all kinds of innovation barriers. This leads to the conclusion that acquisitions motivated by lack of knowledge as innovation barriers increase the chance of having sales of innovative product new to the market (Table 4). However, these knowledge driven acquisitions do not affect the innovation performance per se as shown in Table 3.

6. Conclusions

This paper deals with two central questions in the theoretical and empirical literature on acquisitions, i.e. 1) the reasons why acquisitions and divestitures occur, and 2) the impact of acquisitions and divestitures on firms' innovation performance.

The first question has been dealt with by investigating two issues. The first one is whether or not an innovating firm shows a higher probability to acquire and/or divest assets than non-innovating firms. This fits in the notion that restructuring activities are provoked by external technological shocks, which leads to additional turbulence in the external environment of innovating firms. Acquisitions and divestitures can be a strategy to access control over the fast changing external environment of innovating firms. Using Community Innovation Survey (CIS) data of the period 1996-2004 for the Netherlands, we investigate whether or not innovative activities in a firm are a driving force for actively purchasing (acquisitions) or selling (divestitures) of or to other firms. The findings show that innovating firms are significantly more involved in acquisition activities two years later than non-innovating firms. This suggests that innovative firms use acquisitions as a strategy to gain access over the external environment. The impact of innovative firms on the probability to divest is negative. This suggests that innovative firms do not use divestitures in order to refocus their business activities.

Another finding is that divestitures affect acquisitions two years latter significantly positive which suggests that firms divest assets as part of a broader strategy of releasing financial means or re-structuring the business before acquiring other firms. Large

acquisitions require careful planning on strategy and finance and hence lead to shedding off assets as a strategy to restructure before acquisitions take place. This is also supported by the negative though insignificant impact of large acquisitions on divestitures two years later, which implies that divestitures are not an instrument to re-focus business activities afterwards.

The second issue deals with the impact of knowledge and financial barriers on acquisitions and/or divestitures. The empirical analysis shows that lack of knowledge as a barrier to innovate affects the probability to acquire assets of other firms positively but not significant. This is weak evidence that lack-of-knowledge barriers to innovation leads to a strategy to acquire (assets of) other firms in order to overcome these barriers. Financial barriers to innovate do not affect the probability to acquire. However, both knowledge and financial barriers to innovate seem to influence positively the chance of divestitures, which suggests that divestitures are a means to free up financial means in order to overcome these barriers.

The second question is examined by investigating the impact of acquisitions and/or divestiture activities on the innovative performance of the firm. The empirical results reveal that firms that experience no barriers to innovate reveal a negative impact on the chance of having turnover with new products. The impact of acquisitions motivated by knowledge barriers in the innovation process affects the probability to have turnover with new products positively. This suggests that acquisitions related to the search for knowledge necessary to remain innovative is important. However, when explaining the level of the innovative performance of innovative firms in the Netherlands in 1996-2004, the effect becomes insignificant.

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Table 1. Descriptive Statistics

	Two year lag			Four year lag		
variable	mean	standard deviation	observations	mean	standard deviation	observations
		Equation (1)				
Acquisitions (large)	0.048	0.214	10389	0.035	0.185	3220
Divestitures (large)	0.031	0.174	10389	0.027	0.162	3164
Ln(Size)	4.321	1.227	10389	4.462	1.062	3220
Exports	0.283	0.450	10389	0.470	0.499	3220
Innovation	0.539	0.498	10389	0.548	0.498	3220
KnowLack	0.142	0.349	10389	0.165	0.371	3220
FinLack	0.108	0.310	10389	0.123	0.329	3220
OtherLack	0.045	0.207	10389	0.043	0.202	3220
		Equation (2)				
Ln(Turn_empl) (new to market)	4.415	2.607	2047	4.479	2.834	1742
Ln(Size)	4.744	1.269	2047	4.895	1.221	1742
Export-intensity	0.179	0.299	2047	0.173	0.297	1742
Co-operation	0.357	0.479	2047	0.363	0.481	1742
R&D-permanent	0.571	0.495	2047	0.576	0.494	1742
Acquistions	0.058	0.234	2047	0.073	0.260	1742
(Acquisitions*KnowLack)	0.024	0.153	2047	0.024	0.152	1742
(Acquisitions*FinLack)	0.020	0.138	2047	0.017	0.130	1742
(Acquisitions*OtherLack)	0.008	0.088	2047	0.006	0.076	1742
Divestitures	0.035	0.183	2047	0.028	0.164	1742
(Divestitures*KnowLack)	0.015	0.120	2047	0.012	0.109	1742
(Divestitures*FinLack)	0.013	0.112	2047	0.008	0.089	1742
(Divestitures*OtherLack)	0.001	0.038	2047	0.003	0.054	1742

Table 2. Determinants of large acquisitions and divestitures: logit regressions with two year lag (l = 2)

Regression	1	2	3	4
Dependent	$Acquisitions_t$	$Acquisitions_t$	$Divestitures_t$	$Divestitures_t$
Constant	-3.133***	-3.140***	-3.629***	-3.717***
	(0.331)	(0.331)	(0.408)	(0.407)
$Ln(Size)_{t-l}$	0.090**	0.094**	0.170***	0.202***
	(0.042)	(0.042)	(0.049)	(0.048)
$Exports_{t-l}$	0.401***	0.402***	0.252	0.256
	(0.133)	(0.133)	(0.158)	(0.159)
$Innovation_{t-l}$	0.298***	0.300***	-0.289**	-0.268**
	(0.107)	(0.107)	(0.136)	(0.136)
$Divestitures_{t-l}$ (all)	0.487***			
	(0.158)			
$Divestitures_{t-l}$ (large)		0.742***		
		(0.205)		
$Acquisitions_{t-l}$ (all)			0.336**	
			(0.159)	
$Acquisitions_{t-l}$ (large)				-0.458
				(0.287)
$KnowLack_{t-l}$	0.105	0.105	0.303*	0.312*
	(0.142)	(0.141)	(0.183)	(0.183)
$FinLack_{t-l}$	-0.060	-0.052	0.614***	0.629***
	(0.155)	(0.155)	(0.177)	(0.178)
$OtherLack_{t-l}$	-0.153	-0.144	0.003	0.010
	(0.232)	(0.205)	(0.330)	(0.332)
Sector dummies	yes	yes	yes	yes
Time dummy	yes	yes	yes	yes
Number of observations	10389	10389	10389	10389
Pseudo R^2	0.035	0.035	0.033	0.032
Log likelihood	-1938.39	-1937.55	-1391.67	-1392.39

Note: Large acquisitions (divestitures) are those that increase (decrease) total sales with more than 10 %. Significance at 10 % (*), 5 % (**) or 1 % (***).

Table 3. Impact of acquisitions and divestitures on the share of sales achieved with innovative products new to the market: ols estimates with Heckman correction for sample selection bias

	Two year lag (l = 2)		Four year lag (l = 4)	
Regression	5	6	7	8
Constant	2.150***	2.148***	3.074***	3.048***
	(0.414)	(0.013)	(0.521)	(0.519)
$Ln(Size)_{t-l}$	-0.013	-0.012	-0.070*	-0.073*
	(0.033)	(0.033)	(0.038)	(0.038)
$Co\text{-}operation_{t-l}$	0.057	0.054	0.079	0.076
	(0.076)	(0.076)	(0.086)	(0.086)
$Export\text{-}intensity_{t-l}$	0.562***	0.560***	0.453***	0.482***
	(0.143)	(0.143)	(0.160)	(0.160)
$R\&D\ permanent_{t-l}$	0.169**	0.171**	0.151	0.158*
	(0.079)	(0.079)	(0.092)	(0.092)
$Acquisition_{t-l}$	-0.047	-0.081	-0.030	0.050
	(0.145)	(0.223)	(0.149)	(0.149)
$(Acquisition_{t-l} * KnowLack_{t-l})$		-0.086		-0.495
		(0.333)		(0.351)
$(Acquisition_{t-l} * FinLack_{t-l})$		0.125		0.033
		(0.340)		(0.383)
$(Acquisition_{t-l} * OtherLack_{t-l})$		0.417		0.844
		(0.452)		(0.538)
$Divestitures_{t-l}$	-0.209	-0.192	0.142	0.217
	(0.186)	(0.275)	(0.235)	(0.357)
$(Divestitures_{t-l} * KnowLack_{t-l})$		0.503		-0.513
		(0.383)		(0.538)
$(Divestitures_{t-l} * FinLack_{t-l})$		-0.619		0.542
		(0.394)		(0.569)
$(Divestitures_{t-l} * OtherLack_{t-l})$		-0.069		-0.160
		(0.930)		(0.794)
Sector dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Uncensored observations	2047	2047	1742	1742
Prob > Chi^2	0.0000	0.0000	0.0000	0.0000
Log likelihood	-8380.70	-8369.14	-7056.89	-7052.03
Select equation	5	6	7	8
ρ	0.046	0.055	-0.080	-0.073
	(0.101)	(0.102)	(0.119)	(0.118)

Table 4. Impact of acquisitions and divestitures on the probability of positive sales with innovative products new to the market: selection equation of Heckman model (probit).

	Two year lag (l = 2)		Four year lag (l = 4)	
Regression	9	10	11	12
Constant	-2.199***	-2.174***	-1.988***	-1.984***
	(0.118)	(0.118)	(0.146)	(0.147)
$Ln(Size)_{t-l}$	0.126***	0.124***	0.113***	0.112***
	(0.013)	(0.013)	(0.015)	(0.015)
$Exports_{t-l}$	0.447***	0.446***	0.377***	0.376***
	(0.065)	(0.065)	(0.075)	(0.075)
$Acquisition_{t-l}$	-0.169	-0.217**	0.073	0.074
	(0.065)	(0.088)	(0.066)	(0.082)
($Acquisition_{t-l}$ * $KnowLack_{t-l}$)		0.321**		-0.011
		(0.164)		(0.172)
($Acquisition_{t-l}$ * $FinLack_{t-l}$)		0.118		0.018
		(0.174)		(0.191)
($Acquisition_{t-l}$ * $OtherLack_{t-l}$)		0.850***		0.043
		(0.241)		(0.256)
$Divestitures_{t-l}$	0.072	0.105	0.005	-0.088
	(0.088)	(0.117)	(0.104)	(0.141)
($Divestitures_{t-l}$ * $KnowLack_{t-l}$)		-0.087		0.360
		(0.210)		(0.256)
($Divestitures_{t-l}$ * $FinLack_{t-l}$)		0.121		-0.139
		(0.220)		(0.279)
($Divestitures_{t-l}$ * $OtherLack_{t-l}$)		-0.500		0.090
		(0.400)		(0.369)
Product $Innovation_{t-l}$	0.649***	0.646***	0.764***	0.763***
	(0.033)	(0.033)	(0.037)	(0.037)
Sector-dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Number of observations	14383	14383	10041	10041

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