Firm Acquisitions and Technology Strategy: Corporate versus Private Equity Investors

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Abstract

Over the last years, private equity sponsored firm acquisitions have increased significantly. Although there is an ongoing public debate in Europe about this phenomenon, the antecedents and outcomes of private equity acquisitions have received little attention in research. In this paper we analyze different acquisition motives for corporate and private equity investors. How do their acquisition targets differ? How important are technologies, a major motive behind corporate acquisitions, for private equity investors? Our empirical results for European fir acquisitions in the period from 1997 to 2003 confirm that there is a significant premium that private equity investors pay relative to corporate investors. Furthermore, corporate investors pay a higher price for patented technologies, especially if those patents have the potential to block technology competitors. In contrast, the blocking potential of patents does not matter for private equity investors.

Keywords: M&A, technology, patents, corporate and private equity investors

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1 Introduction

Over the last years, worldwide merger and acquisition (M&A) activity has increased sharply. By the end of 2006, the volume of M&A transactions had increased from 10,700 transactions in 2000 to more than 37,600 while the total deal value had leaped a new record high at 2.85 trillion Euro in 2006 compared with 2.71 trillion Euro in 2000.[1] This development, however, was not only due to a growing number of corporate acquisitions but also to increased investments by financial investors. In fact, the share of worldwide private equity sponsored acquisitions in terms of total deal value has increased from 21.6 percent in 2000 to 33 percent by the end of 2006. The increasing activity of private equity investors has, particularly in Europe, been subject to a public debate on the motivation and objectives of such investors as well as on the effects of their engagement on firm performance, long-term innovativeness and growth. However, research on private equity acquisitions and how they might differ from corporate acquisitions is scarce. This paper is intended to contribute to our understanding of the motivation and objectives of both types of investors. We pay particular attention to the importance of technologies in firm acquisitions as these play a key role for innovativeness and value creation.

In fact, gaining access to technological knowledge has, for a number of years, been one of the major motives for corporate M&A (Graebner, 2004). In acquiring technology from external sources, firms aim at the development of innovative products or services that lead to improved firm value (Griliches, 1981; Pakes, 1985). Under the accelerating pressure of timing in innovation, M&A transactions give access to technology as a firm-specific resource enabling firms to pursue a resource-based strategy (Barney, 1991; Conner, 1991; Peteraf, 1993; Wernerfelt, 1984). This strategy aims at accumulating valuable technological assets combined with an ambitious intellectual property policy. A firm's patent portfolio can be assumed to have a direct influence on innovative capacities (Mansfield, 1986), especially in case of technological complementarities between the target and acquiring firm (Cassiman *et al.*, 2005; Hussinger, 2005).

[1] Source: ZEPHYR database, Bureau van Dijk Electronic Publishing.

These resource-based motivations for acquisitions have gained a lot of attention in the literature (see Veugelers, 2006, for a survey), but it might be questionable if and to what extent they also apply to private equity investors. Obviously, private equity investors do not intend complementing their own patent portfolio. They rather strive at financing the target firm's activities for a limited period while siphoning off the profits (Thomsen & Pedersen, 2000). Nevertheless, technology should be important as private equity investors frequently benefit from disentangling valuable resources and stripping the technological assets. To a large extent, a firm's endowment with technological assets will hence determine the price that is paid by corporate or private equity investors at the market for corporate control. It has remained unexplored so far, however, what particular value both types of investors attach to a target's technological assets, given their different motivational structure.

Financial market efficiency suggests that the market value of a firm reflects the available information that relates to its current and future profitability (Fama, 1970). Jensen and Ruback (1983) have argued that acquisitions typically involve a significant positive control premium over the market value of the target firm. Moreover, Gompers and Lerner (2000) have shown that substantial capital inflows into private equity funds increase the valuation of these funds' investments. We hypothesize that the type of acquirer affects the price and hence also the premium paid for a target's technological assets. On the one hand, we argue that this is due to information asymmetries between the two types of acquirers (Heeley *et al.*, 2007). While corporate investors possess an in-depth knowledge on relevant technologies in an industry, which they might have accumulated through own research and development (R&D) activities, private equity investors should typically lack this knowledge. On the other hand, there are also synergy considerations as the discussion of technological complementarities indicates (Cassiman *et al.*, 2005). Corporate investors should presumably be willing to pay more for a related technology while this should not make any difference for private equity investors that do not have to take existing technologies into account.

Based on a sample of 1,441 European firms that were subject to acquisitions in the period from 1997 to 2003 our results suggest that private equity investors systematically overvalue their targets relative to corporate investors. With respect to the innovative assets we find that corporate investors are more interested in

technologies – represented by the patent stock of the target – than private equity investors. Accounting for patent quality – in terms of citations received by other patents – our findings show that private equity and corporate investors pay the same for valuable patents. Digging deeper into the strategic dimension of technology acquisitions, however, our results indicate that corporate investors have a significant interest in patents with a potential to block competitors' innovation activities, whereas such patents do not matter for private equity investors. We contribute to the literature on patent indicators (Trajtenberg *et al.*, 1997; Trajtenberg *et al.*, 2000) by proposing a new measure to assess the blocking potential of patents, which is based on forward patent citations using detailed information on the patent application process at the European Patent Office (EPO). Our results have implications for policy makers and managers in that M&A transactions may considerably decrease competition in technology markets which needs to be reflected in a firm's M&A strategy.

The remainder of the paper is organized as follows. The next section outlines our theoretical considerations and establishes a set of hypotheses. Section 3 introduces the data set we use and shows descriptive statistics. The empirical test of our hypotheses is provided subsequently. Section 5 discusses our results and provides implications for management. The last section concludes with a critical evaluation of the study and points out potentials for further research.

2 Theory and hypothesis development

2.1 A closer look at corporate and private equity investors

Drawing a broad distinction between corporate and private equity investors seeking acquisition targets at the market for corporate control is somewhat coarse as it does not reflect the variety of possible types of investors, including wealthy individuals, the own management of a firm or bidding consortia that could be composed of a corporate investor and one or more private equity investors. Nevertheless, these categories provide a useful reference to study differences in the valuation and financing of targets.

Corporate investors, on the one hand, typically represent horizontal acquirers active in the same industry as the target company. They engage in technology acquisitions to realize *economies of scale* in R&D (Cassiman *et al.*, 2005). In response to a

technology acquisition R&D fixed costs can be spread over the larger post-acquisition R&D output of the merged entities and costs can be further decreased as duplicated inputs for the same output are eliminated. A second important factor in technology acquisitions are *economies of scope* in R&D (Cassiman *et al.*, 2005). Post-acquisition R&D investments can be jointly optimized using the fact that costs can be spread over different R&D projects. Cost reductions can be realized because personnel, laboratories and technical instruments can – at least partly – be used in different projects. A further important motivation for M&A transactions that has received a lot of attention in the past (see Veugelers, 2006, for a survey) are expected *synergy effects* from the combination of two technology portfolios. The target's technology portfolio often complements the technology stock of the acquiring firm (Ahuja & Katila, 2001) and enhances the technological core competencies of the merged entity (Cassiman *et al.*, 2005; Hussinger, 2005). Through a close collaboration after the acquisition the *level of spillover effects* from R&D investments can increase (Arrow, 1962; D'Aspremont & Jacquemin, 1988). Further, *intellectual property rights* often play an important role for corporate M&A transactions because corporate investors can necessitate the ownership of intellectual property held by the target firm in order to continue or expand ongoing research (O'Donoghue *et al.*, 1998; Lerner *et al.*, 2003). Besides the acquisition of technology, corporate investors aim at gaining market share, getting access to certain markets and products, increasing efficiency as well as eliminating competition (Chakrabarti *et al.*, 1994; Mukherjee *et al.*, 2004).

Private equity investors, on the other hand, are mainly motivated by financial success to be obtained in a relatively short time frame (Thomsen & Pedersen, 2000). They supply private equity to the target firm in order to initiate often broad and widespread reorganization processes as well as to impose tight financial and operational controls with the objective to increase the target's competitiveness and value. Depending on the maturity of the target, private equity can take on the form of venture capital which is typically less risk averse (Gompers & Lerner, 2001; Wright & Robbie, 1998). Venture capital as a subtype of private equity is mainly concentrated on bringing a new and prospective technology to the market. It has been shown to considerably spur innovation (Fenn & Liang, 1998; Kortum & Lerner, 2000). Later stage private equity includes buyouts of undervalued or distressed companies to reap the profits from disentangling resources and stripping the assets (Kucher & Meitner, 2004). Moreover,

private equity can implicate significant benefits for the target, e.g. by mobilizing research and commercial partners (Folta & Janney, 2004) or by providing management advice (Kaplan & Strömberg, 2003). In any case, the acquirer's engagement at the target is limited in time and geared towards a successful exit, e.g. in the form of an initial public offering (IPO) at the stock market, a trade sale to a corporate investor or a secondary purchase of another private equity firm (Brav & Gompers, 1997).

According to the European Private Equity and Venture Capital Association (EVCA, 2006), private equity transactions in Europe, including its subtype venture capital, leaped to a record level of 71.8 billion Euro in 2005, more than two and a half times the amount of 27,5 billion Euro raised the year before. Among the institutions investing into private equity funds, pension funds were the largest contributor, followed by banks. Particularly pension funds increased their investment allocation to private equity funds in the belief that the returns are largely uncorrelated with public markets (Gompers & Lerner, 2001). The assumption here is that firms receiving private equity remain privately held for a number of years. However, there appears to be a clear linkage between the public and private equity market that becomes apparent when the investor prepares its exit, e.g. through an initial public offering (Brav & Gompers, 1997).

Regarding the structure of private equity investments, buyouts represented 68.2 percent of the total amount but only 22 percent of the total number of investments. Seed investments accounted for only 0.2 percent by amount and 4 percent by number while start-up investments represented 5 percent by amount and 29 percent by number. A share of 42 percent by number and 21.8 percent by amount is due to expansion investments. The remainder refers to replacement capital (EVCA, 2006). The majority of private equity deals hence refers to venture capital investments (seed, start-up and expansion) which, however, only correspond to 27 percent of the total amount invested. In the following, we will focus on private equity buyouts and exclude venture capital from our discussion. First, venture capital can be regarded as a very special form of private equity that is brought in when technologies have not been commercialized yet and the firm might not have even be founded (Wright & Robbie, 1998). In contrast to this, private equity buyouts address rather mature firms with an established technology commercialization process which makes them comparable to

corporate acquisitions. Second, venture capital engagements would in most cases not qualify as an M&A transaction which is why they would not show up in M&A databases either.

2.2 Target valuation and deal financing

When it comes to the valuation of a potential target firm by the investor there are a number of aspects related to the financing of the transaction that distinguish corporate from private equity investors. As the literature on company ownership suggests, the type of acquirer might have a considerable impact on objectives, corporate strategy and performance (Thomsen & Pedersen, 2000). This is assumed to be reflected in profit goals, dividends, capital structure and growth rates (Short, 1994). Private equity buyouts are typically structured as leveraged buyouts with a high share of debt. The private equity firm collects funds to set up a new firm as an acquisition vehicle that is equipped with the desired amount of debt and equity. This firm is subsequently used to acquire the selected target and finally merged with it to create a new company with a capital structure different from the initial structure of the target. A major advantage of debt financing is that it can be raised at significantly lower costs than equity, especially when interest rates are low as they have been worldwide for a couple of years now. By employing a share of 70 to 80 percent of debt to finance an acquisition private equity investors thus have the chance to considerably leverage their internal rate of return (Arundale, 2002). To apply such a financing structure to a potential target firm, however, requires the capital structure of the target to be suitable for this. This means that the debt to equity ratio must not exceed a certain threshold where additional debt would overburden the firm after the acquisition. In this case the firm would not be able to afford the interest and repay the debt in the long run.

In contrast to that, corporate investors tend to finance their transactions with a larger share of equity, for example by an exchange of stock. The higher costs of equity have in turn an impact on the evaluation of potential acquisition targets. Hence, the higher the expectations of the shareholders for the profitability of their equity the lower the price will be that the corporate investor can afford to pay for the target. Private equity investors will therefore presumably be able to afford a higher control premium than corporate investors until the net gain from the acquisition turns less favorable.

Moreover, as the EVCA figures indicated, there has been an abundance of funds over the last years that private equity investors almost desperately need to invest into prospective target companies. The abundance of funds might even crowd out corporate investors. For the venture capital market Gompers and Lerner (2000) have argued that increasing capital inflows lead to higher security prices, or colloquially, "too much money chasing too few deals". Their results show a strong positive correlation between the valuation of such investments and capital inflows. In this relationship, a doubling in public market values is associated with a 15-35 percent increase in valuation while a doubling of capital inflows leads to an increase between 7 and 21 percent. As they find inflows into leveraged buyout funds to be a reliable instrumental variable for inflows to venture capital funds we can assume that the abundance of funds available to private equity investors positively affects the acquisition price of private equity deals. Taking the arguments on deal financing and capital inflows together leads to our first hypothesis:

Hypothesis 1: Private equity investors systematically pay a higher price for acquisition targets than corporate investors.

2.3 Information asymmetries and the pricing of technological assets in M&A transactions

2.3.1 Technological content and the value of technology

We have argued that technological assets in acquisitions serve different objectives for the two types of investors. Corporate investors presumably screen technology markets carefully as they are interested in acquisition targets that complement their technology portfolio most effectively (Frey & Hussinger, 2006). Corporate investors are hence interested in technologies and intellectual property with a particular *technological content*. In contrast, private equity investors are typically not interested in specific technologies as long as the technologies employed in a potential target company serve as a basis for revenue generation. Consequently, corporate investors will also be in a better position to judge the potential of externally available technologies.

A firm's capability to achieve this has been summarized in the literature as absorptive capacity (Cohen & Levinthal, 1989, 1990). Absorptive capacity is generally developed as a by-product of own R&D activities. It is made up of three major components: The identification of valuable technological knowledge in the

environment, its assimilation with existing knowledge stocks and the final exploitation for successful innovation. Absorptive capacities hence increase the awareness for market and technology trends, which can be translated into pre-emptive actions (Bowman & Hurry, 1993). As a result, they enable firms to predict future developments more accurately (Cohen & Levinthal, 1994).

Private equity investors, in turn, will presumably possess a rather low ability to identify valuable technological knowledge if at all. They would have to avail themselves to technology experts or cultivate their own specific knowledge, e.g. by hiring staff with special industry knowledge. Moreover, private equity investors will probably choose to diversify the risk of their portfolio by avoiding a concentration on only one industry. This makes it even more difficult to build-up expert knowledge regarding specific technologies. Hence, when it comes to the evaluation of the technological assets of a potential target at the market for corporate control there will be *information asymmetries* between corporate and private equity investors. These are particularly severe because of the uncertainty related to R&D activities in innovative firms. Knowledge about the innovation quality, however, yields important information on the pricing of the technological assets in an acquisition (Heeley *et al.*, 2007).

Determining the innovation quality of a potential target ideally requires detailed information on every single innovation project. Each innovation project has its own specific attributes which are generally kept secret by a firm to ensure the appropriability of the returns from innovation activities. As the corporate and the private equity investor are equally affected by the level of confidentiality, they will presumably use information sources like patent data to assess the quality of a firm's innovation activities (Heeley *et al.*, 2007). In order for a patent to be granted and offered protection, the technological content of the patent needs to be disclosed by the applicant to the patent office. The information disclosed in the patent, however, provides only little, if any, clue on the ability of the patent holder to extract value from commercialization activities. As it is highly technical information providing only those "skilled in the art" with relevant knowledge about the true content there is a substantial information asymmetry between informed and uninformed investors. This difference is even higher when technological complexity increases as it is typically the case in high-technology industries. To sum up, the content of a patent usually does

not provide any usable information for most potential investors who are not skilled in the art.

Hence, for private equity investors patents and the innovation history of the acquisition target in general are supposed to rather serve as *signals* in the first place (Ndofor & Levitas, 2004; Levitas & McFadyen, 2006; Heeley *et al.*, 2007). A patent acts as a positive signal as it shows that the firm in question has already proven its technological expertise and capabilities and that it has a well-functioning laboratory and inventor team. Moreover, patents can be sold individually after the acquisition. The expected resale value of patents in the technology market might be of particular interest for private equity investors in an asset stripping. As for both types of investors patents have a signaling and a potential resale value but, on top of that, for corporate investors also a value from a combination with existing knowledge stocks we hypothesize that private equity investors will pay a relatively lower price for patents than corporate investors.

Hypothesis 2a: The price paid for an acquisition target with a patent is ceteris paribus higher than for a target without a patent.

Hypothesis 2b: Corporate investors pay, on average, more for a target's patent stock than private equity investors.

Recalling the argument that corporate investors have developed absorptive capacities to identify and assess external technological assets, these investors will presumably be much better able to recognize the value of a potential target's technology. Private equity investors, in contrast, will presumably have to employ external industry or technology experts to judge the value of technology. Nevertheless, their ability to assess the value of the technology will be lower as the total R&D capacity of a corporate investor can assumed to provide a much better basis for this purpose. Corporate investors can hence be regarded as technological insiders who successfully reduce information asymmetries about the value of a target's innovation activities (Aboody & Lev, 2000; Heeley *et al.*, 2007).

Hypothesis 3a: The price paid for an acquisition target with more valuable patents is ceteris paribus higher than for a target with less valuable patents.

Hypothesis 3b: Corporate investors pay, on average, more for valuable patents than private equity investors.

Finally, there are also information asymmetries between both types of investors and the vendor of a potential target. Assuming a generally lower level of relevant technological knowledge of the private equity investor the target's vendors might succeed in obtaining a higher price for the firm from private equity investors compared to a sale to a corporate investor who should be able to reduce information asymmetries considerably. This argument provides additional support for our first hypothesis that private equity investors systematically pay a higher price for a target than corporate investors.

2.3.2 Competitor blocking as strategic value of patents

Besides the acquisition of valuable technological assets that might complement the existing technology portfolio or that serve as a basis for revenue creation, another objective for M&A transactions has been identified as to enhance the position of the merged entity in technology competition (Cassiman *et al.*, 2005; Williamson, 1975). Through the pooling of technological assets the merged entity is in a position to create significant barriers to entry into particular technology lines. In other words, patents can be used to block competitors from developing a competing technology alternative (Heeley *et al.*, 2007). This section therefore shifts emphasis on a third function of patents. Besides the knowledge protection character of patents and their signaling effect for potential investors, patents can block successive patent applications by threatening their novelty requirements (Scotchmer, 1991; Shapiro, 2001; Jaffe & Lerner, 2004).[2] In fact, survey evidence for the US and Europe has shown that the protection of intellectual property, i.e. what patents are originally made for in order to stimulate incentives to innovate by granting the inventor a temporary monopoly on her invention, is not what makes them attractive in the first place (Arundel *et al.*, 1995; Cohen *et al.*, 2000). The value of patents is often rather determined by their importance in licensing and M&A negotiations and by their capability to block the inventions of competitors. A recent survey for Germany shows that more than 40 percent of patenting firms apply for patents in order to block competitors (Blind *et al.*, 2007). Especially, Blind et al. (2007) find striking evidence for "defensive blocking"

[2] There is a huge body of theoretical literature on the optimal "patent breadth", i.e. the degree of the patent protection, from a welfare perspective. The more "narrow" a patent is the easier it is to "invent around" the patent. Surveys on this particular literature are provided by Denicoló (1996) and Takalo (2001).

through patenting what they define as a forward-looking protection strategy directed at protecting the firm's position in technology markets.

Again, the identification of patents that can actually be used to block competitors in technology markets (blocking patents) should strongly depend on the ability of an investor to recognize those patents. Private equity investors, however, presumably lack the necessary in-depth knowledge on technology markets and their future development in order to predict which patents might reduce future technology competition. This requires detailed information on the technology development process which usually only firms doing research in a particular field possess as they get immediately confronted with existing patent fences. Nevertheless, blocking patents will generally be valuable for both types of investors as such patents should possess a higher potential resale value. As before, however, corporate investors will be much better able to identify and value the blocking patents.

Hypothesis 4a: The price paid for an acquisition target with blocking patents is ceteris paribus higher than for a target without these patents.

Hypothesis 4b: Corporate investors pay, on average, more for blocking patents than private equity investors.

In conclusion, we argue that technological assets of a potential target firm are a major driver for the price paid at the market for corporate control. However, the two basic types of investors – corporate and private equity investors – are supposed to attach systematically varying values to the target's assets. The valuation stems from different levels of knowledge about the technologies employed by the target which are a result of different absorptive capacities of the acquirer.

3 Methods

3.1 Empirical Model

In our empirical model we explain the deal value of the acquisition, i.e. the price paid by the acquirer, by the target firm's assets and characteristics in order to derive insights on the importance of technologies for different types of acquirers. We define the acquired company in a hedonic way as a bundle of its characteristics and assets X (Gompers & Lerner, 2000). The deal value of the target V is a function of those characteristics X. In the presence of efficient markets and full information $V(X)$ equals

the price at which the target firm's assets are traded. Our empirical model shows how the deal value is decomposed with respect to the target firms characteristics and assets. As outlined above, our main focus is on the contribution of different variables capturing the target's innovative assets. We use a flexible specification that allows deals with private equity investor involvement (*PEI*) to differ from corporate investor acquisitions in their intercept as well as in their slope coefficients:

$$V(X) = c + (1 - PEI) * f(X) + PEI * f(c_{PEI}, X) + u .$$

u is the error term of the empirical model which can be estimated using ordinary least squares (OLS). *c* refers to the intercept of the model and c_{PEI} depicts the expected premium paid by private equity investors. The target's bundle of characteristics is defined as its total assets, return on assets, total liabilities and firm age. To test our hypotheses on the value of technologies for different acquirers we introduce different measures for the target's technological assets: the patent stock, the forward citations that its patents received in a five-year window and a measure for the capability of patents to block other patents into the empirical model. Their definition will be detailed in the following section. Further, industry and year dummies are included to control for the different economic conditions and stock market levels during the period from 1997 to 2003. All continuous variables reflect the target's assets and characteristics in the pre-completion year of the acquisition; they are all measured in logarithms to take account of the skewness of their distributions.

3.2 Data sources and variable definitions

Our main source of data is the merger and acquisition database ZEPHYR of Bureau van Dijk Electronic Publishing. We identified firms located in Europe that were subject to an acquisition by a corporate or private equity investor in the period from 1997 to 2003. To distinguish between corporate and private equity investors we relied on the acquirer industry classification provided in the ZEPHYR database. Moreover, only targets from the manufacturing sector were included as patents are of minor importance for services. Our sample consists of 1,441 target firms with known deal values. Financial information on the firms is taken from the Amadeus database of Bureau van Dijk Electronic Publishing. As our main focus is on innovative assets, we linked the acquisition targets to their patent history as patent applicants at the

European Patent Office (EPO).[3] Based on a computer supported text based search algorithm, target firms and patent applications were linked to each other using firm names and addresses in both databases. Each potential match proposed by the search engine was checked manually.

Focusing on the target's technological assets we use three variables to capture different aspects of the innovative activities of the target companies. In line with many recent papers all measures are based on the EPO patent data. First, we use the patent stock (*PS*) to proxy the number of technologies the firm owns, which is calculated as follows:

$$PS_t = PS_{t-1}(1-\delta) + patent\_applications_t$$

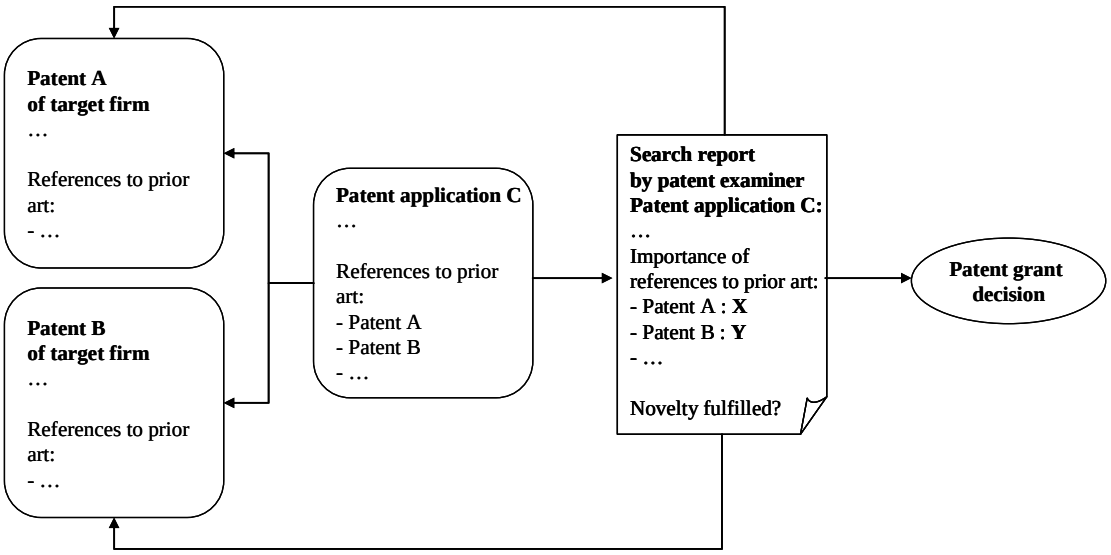
where δ represents the constant knowledge depreciation rate, which is set to 15 percent as is standard in the literature (e.g. Hall, 1990). This variable is used to test the importance of the quantity of patents held by the target company for the acquirer (Hypotheses 2a, 2b). The second variable describes the average patent value which is proxied by the sum of citations the patents received in a five-year window after the patent priority date (Hypotheses 3a, 3b). Patent citations have frequently been shown to be a reliable measure of patent quality and hence value (Harhoff *et al.*, 2003; Harhoff *et al.*, 2005). Patents receive citations when subsequent patents make reference to relevant prior art during the patent application process. The more frequent a patent is cited by other patents the higher its importance in a particular technology field can assumed to be. The citations are hence called "forward citations". As the citations a firm receives are highly correlated with the patent stock of a firm we divide them by the number of patents for our empirical specification. The estimated coefficient can be interpreted as the premium an acquiring firms pays for the value of the target's patents on top of the price he pays for the patented technologies themselves.

The third technology measure we use is a proxy for the potential of patents to block other patents (Hypothesis 4a, 4b). The measure we propose is also based on forward citations, making particular use of the citation system at the EPO. For each EPO

[3] Dating patents according to their application date as opposed to the granting date conforms with common practice (e.g. Griliches, 1981). The application date has the advantage to be closer to the actual completion of the invention.

patent the patent examiner prepares a search report that lists all important documents, which are considered as prior art. Based on the search report it is decided whether a patent application is novel enough to be granted. An interesting feature of the EPO search reports as opposed to search reports at the United States Patent and Trademark Office (USPTO) is that references to prior art are classified according to their importance for the patent filing. Prior art which threatens the novelty requirement of the patent application is made visible in that way. In the search report those references are marked with an "X" if the invention cannot be considered to be novel or cannot be considered to involve an inventive step when the referenced document is taken into consideration alone. References are marked with a "Y" if the invention cannot be considered to involve an inventive step when the referenced document is combined with one or more other documents of the same category, such a combination being obvious to a person skilled in the art (Harhoff *et al.*, 2005). Figure 1 gives an overview of the patent application procedure at the EPO.

Figure 1: Patent application procedure at the EPO



We assume that patent A and patent B are held by a potential target firm. Both patents are cited by an incoming patent application C as prior art. In the search report, the patent examiner evaluates the importance of the references made by assigning a code letter "X" and "Y", respectively (for a full description of all EPO code letters see Harhoff *et al.*, 2005). We use the sum of X and Y citations that patent A and patent B receive in a five-year window to proxy their value as a blocking patent. To account

for the high correlation between citations received and the subset of X or Y citations received we normalize this measure by the total number of forward citations. Hence we use the percentage of X and Y citations in order to depict the threatening power of the patents. Again, the estimated coefficient depicts the premium that acquiring firms pay for the blocking potential of the target company's patents on top of what they pay for the patented technologies and their value as measured by citations.

Finally, to control for technological proximity of the patent portfolios of acquiring and target firm we use the proximity measure introduced by Jaffe (1986). As the technological content of the assets to be acquired is assumingly only important for corporate investors the proximity measure is only calculated for these investors. After all, it would be impossible to calculate the measure for private equity investors as these do not possess a patent portfolio.[4] In order to calculate this measure we determined for each firm patent stocks for each 2-digit technology class according to the International Patent Classification (IPC). This yields a technology vector F for each target i and acquirer j, which can be interpreted as their technology portfolio. Using these vectors (as a percentage of the total patent stock) technological proximity T is now calculated as:

$$T_{ij} = \frac{F_i F_j}{\sqrt{(F_i' F_i)(F_j' F_j)}}; \qquad 0 \le T_{ij} \le 1.$$

Prior literature suggests an inverted U-shaped relationship between the relatedness of the acquirer's and target's technology portfolio and innovation performance (Ahuja & Katila, 2001). On the one hand, new acquired knowledge may provide additional stimuli and information to the acquirer's knowledge base. On the other hand, acquired knowledge that is too closely related to the existing knowledge presumably limits the benefits. This pattern should be reflected in the price that acquiring firm's pay for their purchase as the deal price is supposed to capture the expected value of the assets for the acquiring firm.

[4] An exception might be private equity investors that follow a buy-and-build strategy. In that case the patent portfolios of the firms in the private equity portfolio would have to be taken into account. However, information on the complete portfolios of these firms is not available to us.

4 Results

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for the sample of target firms. All continuous variables except for the deal value refer to the pre-completion year of the acquisition. First of all, the descriptive statistics show that corporate investors pay, on average, a much higher price for their targets than private equity investors. This is related to the average size of the targets as targets of private equity investors are significantly smaller than firms being subject to corporate acquisitions in terms of pre-acquisition total assets. Furthermore, targets of private equity investors are, on average, less profitable as indicated by the returns on assets, defined as the sum of profits earned by the firm and the capital gains of assets over the market value of assets in the year prior to the acquisition. For both types of acquisition targets the average return on assets is negative. Regarding the liabilities of the targets over total assets, i.e. the leverage of the firms, acquisition targets involved in a deal with a corporate investor exceed on average those with a private equity investor which indicates a higher risk associated with such targets. Table 1 further indicates that private equity investors prefer younger firms by showing that targets of private equity investors are on average 10 years younger than those bought by corporate acquirers. The descriptive statistics thus already hint at a considerably different firm profile in which corporate and private equity investors are interested. The findings suggest that private equity investors – in comparison to corporate investors – tend to prefer rather distressed firms or younger firms with potentially unstable revenue and earning flows.

Regarding the technological assets of the target, Table 1 shows that acquisition targets of private equity investors are on average five times as innovative as the targets of corporate investors in terms of their patent stock over total assets. The difference, however, diminishes when the average patent value is considered as proxied by the sum of citations the patents received. However, 79 percent of the patents owned by the targets of corporate and private equity investors receive no citations at all, which indicates a highly skewed distribution of patent value (Harhoff *et al.*, 2003; Harhoff *et al.*, 2005). Interestingly, the descriptive statistics show that the patents of targets involved in deals with a private equity investor have, on average, more blocking

citations (i.e., X and Y citations) than the patents acquired from targets of corporate investors.

Table 1: Descriptive statistics

	Private equity targets	**Corporate targets**	
	# 784	# 657	
	Mean	Mean	Mean difference
	(st.dev.)	(st.dev.)	(std.err.)
deal value (mio EUR)	39.196	103.073	63.876***
	(153.098)	(317.770)	(12.824)
total assets (mio EUR)	67.963	96.000	28.037**
	(170.643)	(258.808)	(11.391)
return on assets (%)	-11.844	-0.291	11.55***
	(25.007)	(18.268)	(1.173)
leverage	0.573	0.587	0.015
	(0.329)	(0.258)	(0.016)
age (years)	10	21	10.453***
	(20)	(24)	(1.14)
patent stock/assets	0.0005	0.0001	-0.0003***
	(0.0020)	(0.0011)	(0.0001)
technological proximity		0.006	
		(0.041)	
citations/patents	0.410	0.481	0.071
	(0.931)	(1.370)	(0.061)
blocking citations/citations	14.95	6.45	-0.075***
	(27.85)	(17.12)	(0.012)
Patenting firms only:	# 198	# 104	
patent stock/assets	0.0019	0.0001	-0.0011***
	(0.0036)	(0.0027)	(0.0004)
technological proximity		0.007	
		(0.040)	
citations/patents	0.786	0.956	0.170
	(0.989)	(0.796)	(0.1122)
blocking citations/citations	0.365	0.262	-0.103***
	(0.024)	(0.026)	(0.038)

***, **, * indicate statistical significance at the 1%, 5%, 10% level.

To further explore the relationships between the variables, Table 4 in the appendix reports the bivariate correlations. The coefficients above the diagonal refer to the corporate investors while the coefficients below the diagonal depict the private equity investors. It turns out that for both corporate and private equity investors total assets are positively correlated with the deal value. Regarding the return on assets, however, there is a positive relationship with the deal value only for the private equity investors. This suggests that private equity investors are much more interested in the financial profitability of the target than corporate investors who might have different priorities. In fact, corporate investors seem to put a much higher emphasis on the technological

assets of the target. The patent stock, the patent value and the blocking potential of the patents are positively correlated with the deal value, whereas only the patent value seems to be of importance for private equity investors. Their interest in blocking patents turns out to be much weaker. Finally, the age of the target firm is positively correlated with the deal value for both types of investors. However, this relationship proves to be stronger for private equity investors.

4.2 Empirical analysis

Table 2 shows the results from the OLS estimation in three different model specifications. Results of F-tests for equality of the coefficients between the two groups are provided in Table 3. Regarding the intercept for private equity firms, the results indicate that private equity investors pay, on average, significantly more than corporate investors confirming our first hypothesis. Given that the deal value consists of the market value of the respective target plus a merger premium, this shows that private equity investors systematically overvalue their targets relative to corporate investors.

Focusing on the value of technologies the first specification, which controls for the volume of technological assets only, suggests that patents are valuable for both types of investors (Hypothesis 2a) and that corporate investors valuate patents much higher than private equity investors (Hypothesis 2b). Part of this can be attributed to the different meaning patents have in acquisitions. On the one hand, patents have a technological value that can be exploited in the merged company or through selling the patents after the acquisition. On the other hand, patents work as a signal for the technological fitness of a potential target company. The signaling function and the technological value of patents is supposed to be the more important feature of patents for private equity acquirers as their acquisitions are supposed to be less content driven in technological acquisitions. Hence, private equity firms cannot realize an additional value trough the combination of the acquired patents and own existing knowledge stocks. When citations as a measure for the value of the technological assets are taken into account (specification 2) it turns out that a significant part of the attractiveness of patents is explained by their value rather than by the patent stocks (Hypothesis 3a). Further, Table 3 shows that there is no significant difference between the coefficients for corporate and private equity investors. Hypothesis 3b is hence rejected. Accounting for the value of blocking patents, specification 3 shows that corporate

investors are highly interested in securing or enhancing their position in technology markets through firm acquisitions, whereas there is no such evidence for private equity investors. Therefore, hypothesis 4a is rejected while hypothesis 4b receives support. This most complete specification shows that a significant part of the difference between private equity and corporate investors in technologies relates to their different valuation of blocking patents. Including this measure into the regression does not alter the coefficients discussed above. In fact, results turn out to be robust across the three specifications. To sum up, the most notable difference in the investors' attitude towards patents lies in their ability to secure a firm's future position in technology markets through the blocking potential of its patents.

Apart from the variables used to test the hypotheses the results show that the relatedness of the target firm's technology portfolio is of high importance for the corporate investors. As expected, the coefficients hint at an inverted U-shaped relationship between the relatedness of the technology portfolios and the deal value. Corporate investors are hence willing to pay for technological assets that provide opportunities for cross-fertilization. However, the deal value is negatively affected when the technology portfolios are too closely related. Similar results for the relationship between technology relatedness and innovation performance (Ahuja & Katila, 2001) can therefore be extended to the market for corporate control. In fact, the price paid for a target should reflect the future innovation potential of the merged entity.

Furthermore, Table 2 and Table 3 show some interesting results regarding the remaining variables that refer to the target's characteristics and assets. Focusing on total assets the coefficients for both types of investors are positive and significant. The magnitude moreover indicates that corporate investors attach a higher importance to the target's assets. Referring to the return on assets there tends to be a rather small positive effect for both types of investors on the deal value. As Table 3 shows, differences between the coefficients for both types of acquirers are significant. The leverage of the target firm turns out to be not important for the deal value. Moreover, we cannot observe a significantly different effect of the target's age on deal value for both corporate and private equity investors. Finally, industry and year dummies were tested for joint significance which can be confirmed.

Table 2: Ordinary least squares regression for the deal value

	Model 1 Coefficient (st. err. [A])		**Model 2** Coefficient (st. err. [A])		**Model 3** Coefficient (st. err. [A])	
Private equity investors						
intercept	2.424	***	2.391	***	2.324	***
	(0.497)		(0.495)		(0.495)	
patent stock/assets	0.065	**	0.060	**	0.055	*
	(0.031)		(0.030)		(0.031)	
citations/patents			0.162	**	0.137	*
			(0.073)		(0.079)	
blocking citations/citations					0.182	
					(0.166)	
log(total assets)	0.223	***	0.216	***	0.214	***
	(0.024)		(0.024)		(0.024)	
return on assets	0.004	**	0.004	**	0.004	**
	(0.002)		(0.002)		(0.002)	
leverage	0.173		0.179		0.184	
	(0.144)		(0.142)		(0.142)	
log(age)	0.135	**	0.125	**	0.126	**
	(0.055)		(0.056)		(0.056)	
Corporate investors						
patent stock/assets	0.212	***	0.204	***	0.176	***
	(0.068)		(0.066)		(0.066)	
tech. proximity	7.907	***	7.086	**	6.138	**
	(3.065)		(3.075)		(3.025)	
tech. proximity-squared	-15.472	***	-14.672	**	-12.657	**
	(6.306)		(6.257)		(6.180)	
citations/patents			0.125	***	0.099	**
			(0.045)		(0.041)	
blocking citations/citations					0.964	***
					(0.388)	
log(total assets)	0.503	***	0.495	***	0.480	***
	(0.037)		(0.038)		(0.038)	
return on assets	0.010	***	0.010	***	0.011	***
	(0.003)		(0.003)		(0.003)	
leverage	-0.118		-0.116		-0.068	
	(0.209)		(0.208)		(0.208)	
log(age)	0.171	***	0.160	***	0.160	***
	(0.058)		(0.057)		(0.057)	
constant	4.268	***	4.275	***	4.391	***
	(0.469)		(0.470)		(0.470)	
8 industry dummies	LR-Chi^2 = 16.23**		LR-Chi^2 = 16.12**		LR-Chi^2 = 14.48**	
6 year dummies	LR-Chi^2 = 32.79***		LR-Chi^2 = 29.86***		LR-Chi^2 = 31.05***	
Number of observations			1,441			
F-statistic	18.53***		17.84***		17.31***	
R-squared	0.27		0.28		0.29	

***, **, * indicate statistical significance at the 1%, 5%, 10% level.

[A] Standard errors are based on the Huber/White estimator to account for heteroscedasticity.

Table 3: F-Tests for equality of coefficients for private equity and corporate investors

	Model 1 F-statistic	**Model 2** F-statistic	**Model 3** F-statistic
log(total assets)	50.03***	49.65***	44.48***
return on assets	2.74*	2.61*	3.12*
leverage	1.19	1.24	0.89
log(age)	0.26	0.25	0.23
patent stock/assets	6.74***	6.51**	4.34**
citations/patents		0.25	0.23
blocking citations/citations			3.83**

***, **, * indicate statistical significance at the 1%, 5%, 10% level.

5 Discussion and conclusions

Our results have shown that technology considerably matters in firm acquisitions – but to a varying extent and depending on the acquirer's identity. First of all, private equity acquirers systematically pay more for a target while controlling for the target's assets and characteristics. This result can be attributed to a number of reasons: First of all, private equity investors are able to pay a higher price than horizontal acquirers as these transactions are typically structured as leveraged buyouts with a high share of debt while horizontal transactions tend to be financed with equity (Arundale, 2002). Debt can be raised at significantly lower costs than equity which is why private equity investors can afford a higher merger premium. Moreover, private equity investors tend to expect higher returns from their investment in a shorter time. To achieve this objective, private equity investors can usually take more rigorous steps in the reorganization of the target than a corporate acquirer as the target is still a legally independent firm and – besides a buy-and-build strategy – there are no plans for integration into the parent. In contrast to that, corporate acquirers have to cope with significant integration efforts when they try to integrate the target's technology portfolio into their own portfolio. This post-merger integration considerably affects the innovation processes of a firm and hence requires a well-planned integration approach (Grimpe, 2007). Apart from the high failure rate of such transactions (Miles & Snow, 1984), it is not clear at the time of the acquisition whether the integration of technology portfolios proves to be beneficial for innovative capacities. Corporate acquirers presumably take this risk into account when they decide on the acquisition

price. Together with the higher cost of equity this could lead to a higher merger premium of private equity acquisitions relative to corporate acquisitions. Our results also support the findings of Gompers and Lerner (2000) for leveraged buyout funds regarding the positive impact of capital inflows on target firm valuation.

Moreover, our results indicate that patents have a high importance in M&A transactions. Patents indeed serve as a signal to exhibit technological capabilities which reduces uncertainties associated with the firm acquisition for the investors (Ndofor & Levitas, 2004; Levitas & McFadyen, 2006). Results of prior work on the importance of patents as signals in initial public offerings (IPO) can hence be transferred to the market for corporate control (Heeley *et al.*, 2007). This seems to be particularly true for private equity investors as they should typically lack the technological expertise to evaluate a potential target's patent portfolio. Although patents disclose technological information that can be taken as an indicator for future innovation performance, this technical information is hardly interpretable for investors not skilled in the art. In this context, corporate investors benefit from having built up absorptive capacities through own R&D activities that enable them to identify and evaluate relevant technological assets in the external environment. What is more, private equity investors should not normally have certain considerations how the acquired technology fits into an existing technology portfolio. Rather, they are supposed to be interested in patents because they provide an indication of potential revenue flows and because of their expected value if sold after the acquisition. The technological content and the possibility to exploit protected knowledge in combination with own knowledge stocks is, however, of great importance for corporate investors as they deliberately strive to complement their own technology portfolio in order to increase own innovative capabilities (Cassiman *et al.*, 2005; Hussinger, 2005). Corporate investors, hence, attach a higher value to patents than private equity investors.

Both types of acquirers are found to pay higher prices for targets with valuable technological assets. Obviously, there seems to be no significant knowledge gap of private equity investors compared to corporate investors. In other words, both types of investors seem to have developed the necessary knowledge for identifying valuable technologies. However, when the blocking potential of acquired patents is taken into consideration there is a clear difference in the valuation between corporate and private

equity investors. Corporate investors deliberately identify targets with such patents that could, on the one hand, be used to extend present R&D activities into areas that were previously blocked by competitors. On the other hand, these patents provide a basis to protect and secure own technology domains. Patents in corporate acquisitions therefore always serve a technological but also a strategic objective in technology markets (Blind *et al.*, 2007). Surprisingly, private equity investors do not show an interest in patents with a blocking potential although these patents should serve as a basis for sustainable rent appropriation from innovation activities. This result may be attributed to a lack of specific knowledge that might be necessary to identify particularly relevant patents for future innovation trajectories. Such knowledge could hence be at the core of the corporate investors' absorptive capacities.

In this respect, our results extend existing knowledge on the motivation for firm acquisitions. For the first time, the two key functions of patents – as monopoly rent devices and as blocking instruments – are shown to be reflected in the market for corporate control. Their importance, however, differs according to the type of acquirer. Especially the deliberate acquisition of patents with a blocking potential by corporate investors has a significant impact on the allocation of technological assets in the market as it hints at a concentration of key technologies in technological markets through acquisitions. This links our results with an important implication for competition policy in that M&A transactions, to a large extent, are meant to create barriers to entry in specific technology markets and, hence, decrease competition. This tendency needs to be reflected in a firm's M&A strategy. Firms need to have a particular eye on the key technologies in their industry and identify the underlying intellectual property. They need to understand that reorganization in the industry through M&A transactions could be directed at a concentration of key technologies and that these might, in a new combination with other technological assets, serve as a basis to threaten the novelty requirements of future patent applications.

This result is also of high relevance for private equity investors who apparently do not attach particular importance to patents with a blocking potential. The value of the acquired firm's technological assets may, however, depreciate substantially if the firm is blocked in its subsequent R&D activities by other firms' patents. Given the rather short investment horizon of private equity investors there is a clear need to make sure that the technological assets are not threatened by other patents. As this would sharply

decrease the price that a private equity investor can obtain upon its exit, it should be a key interest to secure those targets with the necessary patent endowment.

6 Limitations and future research

This paper has shown for a sample of European firm acquisitions with the involvement of corporate and private equity investors that technology matters in firm acquisitions but to a varying extent and in different ways when the acquirer's identity is taken into account. Our results, however, provide no indication whether there is an effect of acquirer identity on innovation performance following the deal. Thomsen and Pedersen (2000) provided evidence that private equity investor ownership leads to higher shareholder value. It is questionable though whether such an effect also holds in the context of technology. Previous studies have indicated that the interpretation of the post-merger developments in R&D is not that straightforward. A decrease in technological engagement after an acquisition might correspond to post-merger integration difficulties (as the integration of two firms' R&D departments) that hinder the exploitation of the joint capacities (Ahuja & Katila, 2001; Grimpe, 2007). However, a post-merger decrease in technology outcome can also be the response to a dominant position of the merged entity in technology markets (market power effect), which reduces the incentives to innovate. In such cases that infer a decrease in technology activities, an independent advancement of the technology portfolio in a firm owned by a private equity investor might lead to a superior technological outcome. This perspective opens the door for future research that should try to generate empirical evidence on the longitudinal performance of firm acquisitions with respect to different acquirer identities.

Moreover, it would be desirable to identify buy-and-build strategies that private equity investors execute to create a new and integrated company. In that case, motivations regarding the acquired technologies should also differ as the acquired firms are expected to fit together technologically. More valuable patents and those with a blocking character should hence also receive more importance for private equity investors.

7 Appendix

Table 4: Bivariate correlations

Corporate investors / **Private equity investors**	**1.**		**2.**		**3.**		**4.**		**5.**		**6.**		**7.**		**8.**	
1. Log(deal value)			0.47	***	0.05		-0.05		0.09	**	0.11	***	0.16	***	0.22	***
2. Log(total assets)	0.35	***			-0.14	***	0.03		-0.03		-0.09	**	0.09	**	0.18	***
3. Return on assets	0.17	***	0.22	***			-0.12	***	0.12	***	0.09	**	0.00		-0.08	**
4. Leverage	0.02		-0.07	**	0.08	**			-0.04		-0.04		-0.02		-0.09	**
5. Log(age)	0.16	***	0.21	***	0.30	***	0.05				0.04		0.05		0.03	
6. Patent stock/total assets	-0.01		-0.26	***	-0.02		0.02		-0.02				0.04		0.20	***
7. Citations/patents	0.16	***	0.13	***	0.03		-0.02		0.09	**	0.05				0.24	***
8. Blocking citations/citations	0.07	**	0.02		-0.11	***	-0.09	***	-0.05		0.24	***	0.39	***		

***, **, * indicate statistical significance at the 1%, 5%, 10% level; n = 1,441

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