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Firm Acquisitions and Technology Strategy: Corporate versus Private Equity Investors

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Non-technical summary

Over the last few years, worldwide mergers and acquisitions (M&A) have increased sharply both in terms of value and volume. This development has not only been driven by corporate acquirers but also to an increasing extent by private equity investors. In fact, the share of worldwide private equity sponsored acquisitions in terms of total deal value increased from 21.6 percent in 2000 to 33 percent by the end of 2006. The increasing activity of private equity investors has been subject to public debate, particularly in Europe, about 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. In this paper, we analyze differences in acquisition motives for corporate and private equity investors. We pay particular attention to the importance of technological assets in M&A transactions and distinguish between the technological value of patents and their potential to block competitors in technology markets. Our empirical results for European firm acquisitions in the period from 1999 to 2003 show that both corporate and private equity investors pay a higher price for target firms with valuable patents. However, patents with a potential to block technology competitors seem to be only of interest to corporate investors, especially if these are closely related to the patent portfolio of the acquirer. Our results have implications for policy makers and managers, in that M&A transactions may considerably decrease competition in technology markets. This needs to be reflected in a firm's M&A strategy.

Firm Acquisitions and Technology Strategy: Corporate versus Private Equity Investors

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Abstract

Over the last few years, worldwide mergers and acquisitions (M&A) have increased sharply both in terms of value and volume. This development has not only been driven by corporate acquirers but also to an increasing extent by private equity investors. In this paper, we analyze differences in acquisition motives for corporate and private equity investors. We pay particular attention to the importance of technological assets in M&A transactions and distinguish between the technological value of patents and their potential to block competitors in technology markets. Our empirical results for European firm acquisitions in the period from 1999 to 2003 show that both corporate and private equity investors pay a higher price for target firms with valuable patents. However, patents with a potential to block technology competitors seem to be only of interest to corporate investors, especially if these are closely related to the patent portfolio of the acquirer.

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

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1 Introduction

Over the last few 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 to a new record high at 2.85 trillion Euros in 2006 compared with 2.71 trillion Euros 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 increased from 21.6 percent in 2000 to 33 percent by the end of 2006. The increasing activity of private equity investors has been subject to public debate, particularly in Europe, about 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.[2] 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 they play a key role for innovativeness and value creation.

Gaining access to technological knowledge has, for a number of years, been one of the major motives for corporate M&A (e.g., Capron *et al.*, 1998; Graebner, 2004). When acquiring technology from external sources, firms aim to develop innovative products or services that lead to improved firm value (Griliches, 1981; Pakes, 1985). Under the 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 (e.g., Wernerfelt, 1984; Barney, 1991; Conner, 1991; Peteraf, 1993). This strategy aims at accumulating valuable technological assets and redeploying these resources between the acquiring and target firm (Capron *et al.*, 1998; Capron and Hulland, 1999). The redeployment subsequently allows firms to improve existing operations, respond to changes in the competitive environment and to grow as a result

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

[2] In the following, we will use the terms "corporate investor" and "private equity investor" to distinguish between the two dominant types of acquirers. Frequently, the corresponding terms "strategic investor" and "financial investor" can be found in the literature which would – in our understanding – however implicitly assume that private equity investors might not have a strategic interest in an acquisition.

of new business applications (Teece, 1982; Dierickx and Cool, 1989; Sorescu et al., 2007).

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. Private equity investors might redeploy managerial skills and financial resources but usually they should not be interested in complementing a technology portfolio, as no such portfolio exists in their case. Private equity investors rather strive to finance the target firm’s activities for a limited period while siphoning off the profits (Thomsen and Pedersen, 2000). Nevertheless, technology should be important as private equity investors frequently benefit from disentangling valuable resources and stripping the technological assets. A target firm’s endowment with technological assets will therefore play a large part in determining the price that is paid by corporate or private equity investors in the market for corporate control. However, the question of what particular value both types of investors attach to a target’s technological assets, given their different objectives and motivations, has remained unexplored so far.

Among the technological resources, a firm’s patent portfolio in particular can be assumed to have a direct influence on innovative capacities (Mansfield, 1986). Patents generally serve as a mechanism to appropriate the returns of an innovation but they can also be used strategically. Their strategic use involves establishing “patent fences” that may block competitors in their innovation activities (Blind et al., 2006; Heeley et al., 2007). Technological complementarities between the acquiring and target firm should spur post-acquisition innovation (e.g., Ahuja and Katila, 2001; Cassiman *et al.*, 2005) and corporate investors should hence be willing to pay more for those technological resources than private equity investors who cannot realize such complementarities. Moreover, corporate investors should be able to unlock value if they acquire a target firm that has established a patent fence threatening the innovation activities of the acquirer. Again, this should lead to differences in the valuation of technological resources by corporate and private equity investors.

Previous studies have largely focused on the importance of technology either in corporate acquisitions (e.g., Chakrabarti et al., 1994; Ahuja and Katila, 2001; Graebner, 2004) or on the well-covered subtype of private equity that is venture capital (e.g., Fenn and Liang, 1998; Wright and Robbie, 1998; Kortum and Lerner, 2000; Gompers and Lerner, 2001). Knowledge about private equity sponsored transactions, excluding venture capital, and on the role of technology in such transactions, however, is scarce. Bearing in mind that M&A transactions might involve a bidding situation between corporate and private equity investors, we provide theoretical arguments and empirical evidence for differences in the valuation of a target's technological resources. Moreover, we pay particular attention to the value of technology as a blocking instrument and 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. Our results are based on a sample of 1,204 European firms that were subject to acquisitions in the period from 1999 to 2003. 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 are 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 roughly 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 the potential to block competitors' innovation activities, whereas such patents do not matter to private equity investors. Our results have implications for policy makers and managers, in that M&A transactions may considerably decrease competition in technology markets. This needs to be reflected in a firm's M&A strategy.

The remainder of the paper is organized as follows. The next section provides a brief description of the patterns of M&A activity, differentiated by the type of acquirer. Section 3 outlines our theoretical considerations and establishes a set of hypotheses. Section 4 introduces the data set we use and presents descriptive statistics. The empirical test of our hypotheses is provided subsequently. Section 6 discusses our results and provides implications for management. The last section concludes with a critical evaluation of the study and points out potential areas for further research.

2 A closer look at corporate and private equity investors

Drawing a broad distinction between corporate and private equity investors seeking acquisition targets in the market for corporate control is somewhat rough, as it does not reflect the variety of possible types of investors. These include wealthy individuals, a firm's own management or bidding consortia that may be composed of a corporate investor and one or more private equity investors. Nevertheless, the two overall categories provide a useful reference to study differences in the valuation and financing of targets. As the literature on company ownership suggests, the type of acquirer might have a considerable impact on objectives, corporate strategy and performance (Thomsen and Pedersen, 2000). This is assumed to be reflected in profit goals, dividends, capital structure and growth rates (Short, 1994).

2.1 The characteristics of corporate investors

Corporate investors typically represent horizontal acquirers operating in the same industry as the target company. Industrial organization economics has traditionally put emphasis on market power and efficiency gains as drivers of M&A activity (Scherer and Ross, 1990). On the one hand, horizontal acquisitions may reduce competition and increase market power in product and technology markets (Chakrabarti *et al.*, 1994; Mukherjee *et al.*, 2004). On the other hand, they engage in firm acquisitions to realize *economies of scale* in production as well as in research and development (R&D) (Cassiman *et al.*, 2005). Following a firm acquisition, fixed costs can be spread over the larger post-acquisition output of the merged entities and costs can be further decreased as duplicated inputs for the same output are eliminated in R&D and production processes. A second important factor in firm acquisitions is that of *economies of scope*. Post-acquisition investments can be jointly optimized using the fact that costs can be spread over different projects in production, marketing, R&D etc.

Complementarily to the industrial organization perspective, strategy researchers have argued that M&A transactions can be used to reconfigure the acquirer's or target's business, in order to respond to changes in the competitive environment or enhance and improve existing operations (e.g., Bowman and Singh, 1993; Capron et al., 1998; Capron and Hulland, 1999). Reconfiguring the business goes along with a redeployment of resources which, in case of R&D, may involve personnel, laboratories and technical instruments being physically transferred to new locations or used in different R&D projects, for example. Moreover, the combination of two product or technology portfolios provides an opportunity to exploit complementarities (Ahuja and Katila, 2001; Colombo et al., 2006) that result from a skilled unbundling and bundling of resources with the objective to enhance (technological) core competencies of the merged entity (Cassiman *et al.*, 2005; Sorescu et al., 2007). Finally, *intellectual property rights* protecting technological knowledge through patents often play an important role in M&A transactions because corporate investors may need the rights to 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 this rather defensive action, acquirers might also choose to offensively block competitors in their R&D activities.

2.2 The characteristics of private equity investors

In contrast to corporate investors, private equity investors are mainly motivated by the chance to obtain financial success in a relatively short time frame (Thomsen and Pedersen, 2000; Kaplan and Schoar, 2005). 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 of increasing the target's competitiveness and value. This typically involves the redeployment of managerial skills and financial resources. Depending on whether the target firm is more or less mature, private equity may take on the form of venture capital, which is usually less risk-averse than publicly available equity (Gompers and Lerner, 2001; Wright and Robbie, 1998). Venture capital, a subtype of private equity, is mainly concentrated on bringing new and prospective technologies to the market. It has been shown to spur innovation considerably (Fenn and Liang, 1998; Kortum and Lerner, 2000, for the US; Bottazzi and Da Rin, 2002, for Europe). Later stage private equity includes buyouts of undervalued or distressed companies to reap the profits from disentangling resources and stripping the assets (Kucher and Meitner, 2004). Moreover, private equity can imply significant benefits for the target, e.g. by mobilizing research and commercial partners (Folta and Janney, 2004) or by providing management advice (Kaplan and Strömberg, 2003). In any case, the acquirer's engagement in the target is limited in time and geared towards a successful exit, e.g. in the form of an initial public offering (IPO) in the stock market, a trade sale to a corporate investor or a secondary purchase by another private equity firm (Brav and Gompers, 1997).

According to the European Private Equity and Venture Capital Association (EVCA, 2006), private equity transactions in Europe, including the 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 in private equity funds, pension funds were the largest contributor, followed by banks. Pension funds in particular increased their investment allocation to private equity funds in the belief that the returns are largely uncorrelated with public markets (Gompers and 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 IPO (Brav and Gompers, 1997).

Regarding the structure of private equity investments, buyouts represented 68.2 percent of the total value but only 22 percent of the total number of investments. Seed investments accounted for only 0.2 percent by value and 4 percent by number, while start-up investments represented 5 percent by value and 29 percent by number. A share of 42 percent by number and 21.8 percent by value is due to expansion investments. The remainder is accounted for by replacement capital (EVCA, 2006). The majority of private equity deals are thus venture capital investments (seed, start-up and expansion) which, however, only correspond to 27 percent of the total value 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 been founded (Wright and Robbie, 1998). In contrast to this, private equity buyouts address rather mature firms with an established technology commercialization process. This makes them comparable to corporate acquisitions. Second, venture capital engagements would in most cases not qualify as M&A transactions, which is why they would not appear in M&A databases either.

Private equity buyouts are typically structured as leveraged buyouts with a high share of debt. In contrast, corporate investors tend to finance their transactions with a larger share of equity, for example by an exchange of stock. 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 more than a decade now. By employing a share of 70 to 80 percent of debt to finance an acquisition, private equity investors have the chance to leverage their internal rate of return considerably (Arundale, 2002). To apply such a financing structure to a potential target firm, however, requires the target to have a suitable capital structure. This means that the debt to equity ratio must not exceed a certain threshold, above which additional debt would overburden the firm after the acquisition. In this case the firm would not be able to afford the interest and repayments on the debt in the long run. In the next section of the paper, we turn to our conceptual model outlining our hypotheses on differences in the valuation of a target's technology, depending on the type of acquirer.

3 The pricing of technological assets in M&A transactions

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. We hypothesize that the type of acquirer affects the price and hence also the premium paid for a target's technological assets. This should be dependent on two factors: the *technological content* and the *blocking potential* of a target's technological resources.

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 will complement their technology portfolio the most effectively (Frey and Hussinger, 2006). Corporate investors are hence interested in technologies and intellectual property with a particular *technological content*. Resource-based theory suggests that complementarity effects between acquirer and target result from bundling strategic resources into unique and valuable combinations (Barney, 1991; Conner, 1991; Peteraf, 1993). Through this process of resource redeployment (Capron et al., 1998; Capron and Hulland, 1999), a merged entity may create a new or improved set of capabilities providing the basis for superior firm performance and competitive advantage (Penrose, 1959; Eisenhardt and Martin, 2000; Priem and Butler, 2001;

Sorescu et al., 2007). 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. Their opportunities for resource redeployment are limited and confined to managerial skills or financial resources. Regarding technology, they will not be able to realize value through complementarities.[3] Following this argumentation, corporate investors should be willing to pay a higher price for technology compared with private equity investors.

However, valuable resources of a target firm, which could provide complementarities or generate revenues first need to be identified by the investor. The ability of an investor to judge the potential of externally available technologies and hence to value the innovation activities of a prospective target firm has been discussed from different theoretical perspectives. One of these perspectives has been summarized in the literature as the *absorptive capacity* of a firm (Cohen and Levinthal, 1989, 1990). Absorptive capacity is generally developed as a by-product of a firm's 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 awareness for market and technology trends, which can be translated into pre-emptive actions (Bowman and Hurry, 1993). As a result, they enable firms to predict future developments more accurately (Cohen and Levinthal, 1994).

Corporate investors who wish to realize complementarities have conducted R&D activities of their own, suggesting that they have also developed absorptive capacities in a particular technology field. However, it might not be appropriate to assume that private equity investors do not have such capacities at their disposal. There are basically two channels by which private equity investors may develop absorptive capacities equivalent to those developed through R&D activities. First, private equity investors have typically acquired a large number of firms over time. The dominant players on the market like Kohlberg Kravis Roberts (KKR), Blackstone or the Carlyle Group usually acquire 20 to 50 firms a year. The importance of experience in M&A transactions for post-acquisition performance has been highlighted in several studies

[3] An exception might be private equity investors that follow a buy-and-build strategy, i.e. who acquire several related firms which are merged together to form a new entity.

(e.g., Gerpott, 1995; Birkinshaw et al., 2000; Hagedoorn and Duysters, 2002). Given prior acquisition experience, private equity investors will therefore have a fairly exact idea of what to focus on during the target selection process. Second, private equity investors frequently employ technology experts or cultivate their own specific knowledge, e.g. by hiring staff with special knowledge of an industry or technology. Hence, absorptive capacities alone do not provide a sufficient reason for assuming valuation differences between corporate and private equity investors.

Another theoretical perspective for analyzing the ability of an investor to judge the potential of externally available technologies has emerged from the literature on information asymmetries in investment decisions (e.g., Aboody and Lev, 2000; Cohen and Dean, 2005; Heeley et al., 2007). Generally speaking, investors face the challenge of determining the value of a potential target's innovation activities in the absence of 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 may use publicly available 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. However, Heeley et al. (2007) have argued that the information disclosed in the patent provides only little, if any, clue as to 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 becomes even more pronounced when technological complexity increases, as is typically the case in high-technology industries.

Given the previous discussion on absorptive capacity, corporate investors should be in a favorable position to value technology based on patent data. They are used to dealing with patents in their own R&D activities and they need to consider other patents when they decide to file a patent application. Nevertheless, private equity investors skilled in the art may be able to compensate for this advantage of corporate investors, as discussed above. Hence, we extend the theoretical argument of information asymmetries to the typical investment lifecycle of private equity: While these investors may be adequately skilled to value the technology of a target firm at the time of the acquisition they will be uncertain about the resale value of the target firm at the time of the desired exit, for example through a trade sale to a corporate investor. This uncertainty directly results from risks associated with the technology, which might have become obsolete or have been substituted or shown to be unfeasible. Moreover, the private equity investor will be uncertain about existing resale opportunities, i.e. whether it will be possible to find a corporate investor within a limited timeline who can reasonably use the technology and benefit from complementarities. In contrast to this, corporate investors will be almost immediately aware of potential complementarities at the time of the acquisition. From this it follows that private equity investors will presumably discount the value of acquired technology compared to corporate investors (Hertzel and Smith, 1993). This investor discount can also be found in the acquisition of unlisted target firms (Officer, 2007). Another example is the IPO market, where information asymmetries may lead to a considerable underpricing of a firm's assets (Heeley et al., 2007).

Taking both theoretical arguments together, i.e. the complementarity of technological resources providing benefits for corporate investors and the discounting of acquired technology by private equity investors, leads to the conclusion that corporate investors will presumably pay a higher price for the technology of target firms than private equity investors. The value of technology can then be split up into the number of technologies to be acquired and the quality of each technology. Roughly equating a technology with a patent, a patent acts, first of all, 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 (Ndofor and Levitas, 2004; Levitas and McFadyen, 2006; Heeley *et al.*, 2007). Moreover, patents can be sold individually after the acquisition. As patents have a signaling and a potential resale value for both types of investors but, on top of that, an additional value for corporate investors from a combination with existing knowledge stocks, while considering the private equity discount, we hypothesize that corporate investors will pay a higher price for a stock of patents than private equity investors.

Hypothesis 1a: The price paid for an acquisition target increases with the target's patent stock.

Hypothesis 1b: Corporate investors pay more on average for a target‘s patent stock than private equity investors.

Recalling that both types of investors will have developed absorptive capacities that stem either from their own R&D activities or prior acquisition experience and acquired technological knowledge, we argue that both will also be able to identify valuable technological resources, i.e. high-quality patents. But again, there will presumably be an on-top effect from complementarities for corporate investors as well as a discount for private equity investors with respect to patent quality. Our second hypothesis hence reads:

Hypothesis 2a: The price paid for an acquisition target with more valuable patents is higher than for a target with less valuable patents.

Hypothesis 2b: Corporate investors pay more on average for valuable patents than private equity investors.

In the next section, we turn to the second factor in the valuation of technology which is the blocking potential of acquired technology.

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: to enhance the position of the merged entity in technology competition (Cassiman *et al.*, 2005). By pooling 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 alternative technology (Heeley *et al.*, 2007). This section therefore shifts the emphasis to 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 and Lerner, 2004). In fact, survey evidence for the US and Europe has shown that the protection of intellectual property, i.e. what patents were originally conceived 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 determined instead 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). Blind et al. (2007) find particularly striking evidence of "defensive blocking" through patenting. They define this as a forward-looking protection strategy directed at protecting the firm's position in technology markets.

Obviously, both types of investors will have a substantial interest in acquiring those technologies that have blocking potential. Moreover, as before we assume that both will be equally capable of identifying such patents. The importance of such patents, however, will again differ between corporate and private equity investors. On the one hand, corporate investors might find themselves in a situation where their own R&D activities are hindered as they are confronted with existing patent fences. The strategic importance of being able to continue with these R&D activities will presumably be higher when considerable (sunk) investments have already been made in a particular technology line, when major products or services offered by the firm depend on further development of a particular technology or when firms want to diversify into a promising product market. On the other hand, corporate investors might want to build up their own blocking potential against undesired competition. In contrast to this, private equity investors again face the challenge of uncertainty about the future prospects of a technology with blocking potential. Competitors may be able to "invent around" that technology, quickly making it obsolete. This hence leads to a discount in the valuation process. Although we argue that both types of investors should be willing to pay more for technologies with a blocking potential, we hypothesize that the effect for corporate investors will be higher compared with private equity investors who might discount the patent value. Our third hypothesis hence reads:

Hypothesis 3a: The price paid for an acquisition target with blocking patents is higher than for a target without these patents.

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

Moreover, we hypothesize that corporate investors will have a particular interest in those target patents that have a blocking potential *and* that are closely related to the technology employed by the acquirer. This interaction represents the situation that corporate investors want to "un-block" their own R&D activities, which presumably directly translates into a higher willingness to pay for such patents. This leads to our final hypothesis:

Hypothesis 4: The price paid by corporate investors for an acquisition target with blocking patents that are closely related to the acquirer's technology is higher than for a target without these patents.

In conclusion, we argue that technological assets of a potential target firm are a major driver for the price paid in 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 opportunities to redeploy resources after the acquisition as well as from discounts made by private equity investors due to uncertainty about the expected resale value. In the next section we present our empirical model to test our theoretical considerations.

4 Methods

4.1 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. Our aim in doing so is to derive insights into 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 and 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 $V(X)$ would equal the price at which the target firm's assets are traded. Our empirical model then shows how the deal value is decomposed with respect to the target firm's characteristics and assets. As outlined above, our main focus is on the contribution of different variables that capture the target's innovative assets. We use a flexible specification that allows deals with private equity investor involvement (*PEI*) to differ from corporate investor (*CI*) acquisitions in their intercept as well as in their slope coefficients:

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

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 deviation from the joint intercept *c* for 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 of the patents' capability to block other patents. Moreover, for corporate investors we include a measure of technological relatedness that is subsequently interacted with the measure for blocking patents. Their definitions will be detailed in the following section. Finally, measures for prior acquisition experience as well as industry and year dummies are included to control for the different economic conditions and stock market levels during the period from 1999 to 2003. All continuous variables reflect the target's assets and characteristics in the year prior to the completion of the acquisition; they are all measured in logarithms to take account of the skewness of their distributions.

4.2 Data sources and measures

Our main source of data is the merger and acquisition database ZEPHYR from 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 five-year period from 1999 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 1,204 target firms with known deal values. Financial information on the firms is taken from Bureau van Dijk Electronic Publishing's Amadeus database. 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).[4] 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.

[4] 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 of being closer to the actual completion of the invention.

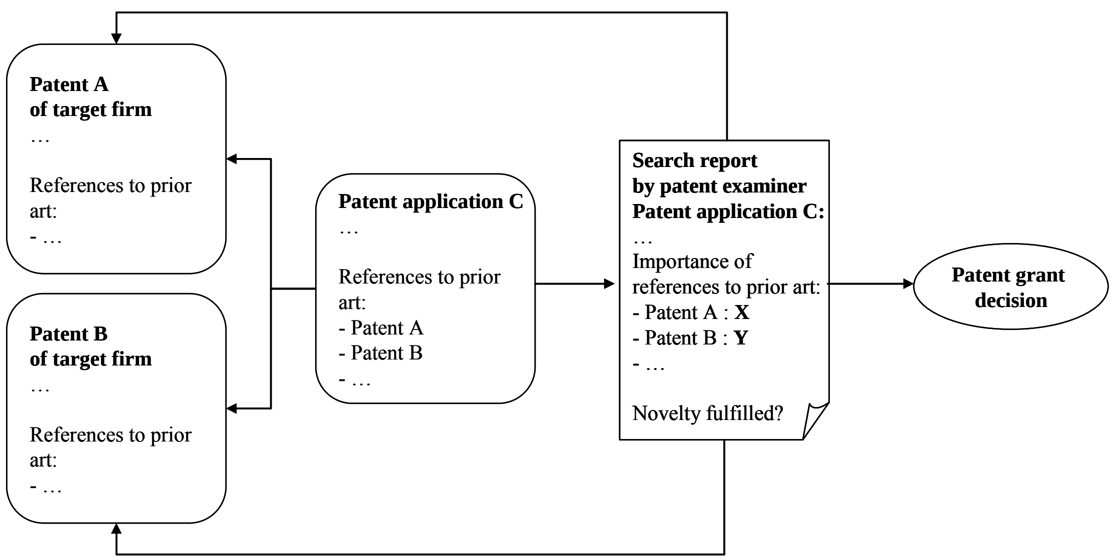
Focusing on the target's technological assets, we use three variables to capture different aspects of the target companies' innovative activities. In line with several recent papers all measures are based on the EPO patent data. First, we use the patent stock (*PS*) to proxy the number of technologies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

$$PS_t = PS_{t-1}(1-\delta) + patent\_applications_t \qquad (2)$$

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 1a, 1b). The second variable is the citation rate, which describes the average patent value proxied by the sum of citations the patents received in a five-year window after the patent publication date (Hypotheses 2a, 2b). 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 frequently a patent is cited by other patents, the higher is its presumable importance in a particular technology field. The citations are hence called "forward citations". As the citations a firm receives are highly correlated with its patent stock, we divide the number of citations by the number of patents for our empirical specification. The estimated coefficient can be interpreted as the premium an acquiring firm pays for the value of the target's patents on top of the price paid for the patented technologies themselves.

The third technology measure we use is a proxy for the potential of patents to block other patents (Hypothesis 3a, 3b). The blocking potential measure we propose is also based on forward citations, making particular use of the citation system at the EPO. For each EPO patent the patent examiner prepares a so-called "search report" that lists all important documents which are considered as prior art. Based on the search report a decision is made as to 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 thus made visible. In the search report, references made for individual claims in the patent application 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 alone is taken into consideration. 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). A patent can still be granted (although this is less likely) if it has many references classified with X or Y. This can be the case for patent applications with many claims. X and Y references may only pertain to single claims and the remaining claims can be strong enough to get a (modified) application granted. All forward citation measures are constructed based on the EPO/OECD patent citation database. Patent equivalents, i.e. if a particular invention is patented at two different patent offices, are taken into account. If patent equivalents were ignored, the number of forward citations a patent receives would be significantly underestimated (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 for a particular claim 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 blocking patents. 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 represent 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.

To control for technological proximity of the patent portfolios of acquiring and target firm we use the proximity measure introduced to the patent literature by Jaffe (1986). As the technological content of the assets to be acquired is assumed only to be 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 they do not possess a patent portfolio. In order to calculate this measure we determined patent stocks for each firm, categorized into 2-digit technology classes 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:

$$T_{ij} = \frac{F_i F_j}{\sqrt{(F_i' F_i)(F_j' F_j)}}; \qquad 0 \leq T_{ij} \leq 1. \qquad (3)$$

Prior literature suggests an inverted U-shaped relationship between the relatedness of the acquirer's and target's technology portfolio and innovation performance (Ahuja and 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 is presumably of limited benefit. This pattern should be reflected in the price that acquiring firms pay for their purchase, as the deal price is supposed to capture the expected value of the innovative assets for the acquiring firm. To allow for such a non-linear relationship between deal value and technological proximity, we also use a squared term of the proximity measure in our empirical model.

Moreover, to test hypothesis 4 we define a binary variable that equals 1 if technological proximity between the M&A partners is larger than zero and the target firm owns patents with a blocking potential. For all other constellations the dummy equals zero. Sticking to a binary variable is necessary in order to avoid multicollinearity in the presence of multiple technology measures. The estimated coefficient of the dummy shows whether blocking patents are more important for acquiring firms which are active in technology areas related to the acquisition target.

Regarding the non-technological assets, we include the following: the total assets; the return 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; the leverage, defined as the total liabilities of the target over total assets; and the age of the target, measured in years. Finally, besides industry and year dummies, our regressions control for prior acquisition experience of corporate and private equity investors. We include a dummy variable that is set to 1 if a corporate or private equity investor acquired at least one firm before the focal transaction. Moreover, we include a dummy variable for private equity investors that is set to 1 if that investor acquired more than five firms prior to the focal transaction, in order to control for very frequent acquirers. It turns out that no corporate investor in our sample has such an acquisition record. Table 4 in the Appendix shows the frequency distribution of acquisitions per acquiring firm in our sample.

5 Results

5.1 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 year prior to completion of the acquisition. First of all, the descriptive statistics show that, on average, corporate investors pay a much higher price for their targets than private equity investors. This is related to the average size of the targets - targets of private equity investors are significantly smaller than firms 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. For both types of acquisition targets the average return on assets is negative. The value for leverage is similar for the targets of the two types of investor, which indicates a rather equal risk associated with these targets. Table 1 further indicates that private equity investors prefer younger firms. Targets of private equity investors are on average 11 years younger than those bought by corporate acquirers. The descriptive statistics thus already hint that corporate and private equity investors are interested in considerably different firm profiles. The findings suggest that private equity investors – in contrast 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 roughly three times as innovative as the targets of corporate investors in terms of their patent stock over total assets. This changes 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. The lower part of Table 1 shows the results for patenting firms only. Generally speaking, the results for the total sample can be reproduced.

Table 1: Descriptive statistics

	Private equity targets # 725 Mean (st.dev.)	**Corporate targets** # 479 Mean (st.dev.)	Mean difference (std.err.)
deal value (mio EUR)	36.713	115.635	78.922***
	(154.087)	(337.385)	(14.371)
total assets (mio EUR)	68.424	110.786	42.362***
	(176.871)	(299.685)	(13.753)
return on assets (%)	-12.416	-0.591	11.825***
	(25.417)	(19.661)	(1.372)
leverage	0.572	0.587	0.015
	(0.337)	(0.265)	(0.018)
age (years)	11.654	22.921	11.267***
	(25.417)	(24.039)	(1.266)
patent stock/assets	0.503	0.179	-0.0003***
	(2.021)	(1.294)	(0.0001)
citation rate	0.355	0.430	0.043
	(0.763)	(1.180)	(0.060)
blocking potential	0.144	0.078	-0.066***
	(0.286)	(0.193)	(0.015)
technological proximity		0.007	
		(0.041)	
interaction proximity/		0.054	
blocking patents		(0.227)	
acquisition experience	0.552	0.203	-0.349***
	(0.498)	(0.402)	(0.027)
acquisition experience (≥ 5)	0.316		
	(0.465)		
Patenting firms only:	# 189	# 90	
patent stock/assets	1.931	0.950	-0.0009**
	(3.600)	(2.874)	(0.0004)
technological proximity		0.021	
		(0.070)	
citation rate	0.705	0.849	0.110
	(0.859)	(0.761)	(0.115)
blocking potential	0.375	0.280	-0.095**
	(0.346)	(0.273)	(0.042)
interaction proximity/		0.222	
blocking patents		(0.418)	

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

To further explore the relationships between the variables, Table 3 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.

5.2 Multivariate analysis

Table 2 shows the results from the OLS estimation in three different model specifications. The intercept for private equity firms indicates that, on average, private equity investors pay significantly more than corporate investors. Given that the deal value consists of the market value of the respective target plus a merger premium, this indicates that after controlling for assets, technologies etc. private equity investors generally pay more than corporate investors. This can be attributed to a number of reasons which will be outlined in more detail in the following section. Focusing on the value of technologies, the first specification, which includes the volume and value of technological assets, suggests that patents are valuable for both types of investors (Hypothesis 1a) and that corporate investors value patents much more highly than private equity investors (Hypothesis 1b).[5] Our first hypothesis can hence be confirmed. 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 resale value of patents are supposed to be the more important features of patents for private equity acquirers as their acquisitions are supposed to be less content-driven. In contrast to this, corporate investors have more opportunities to redeploy resources and realize the benefits from technology complementarities, which is why they also attach a higher value to the

[5] A t-test for equality of the coefficients for the patent stocks of private equity and corporate investors shows that the null hypothesis of equality can be rejected at a 10% level of statistical significance.

technology stock of the target. Citations as a measure for the value of the technological assets show that a significant part of the attractiveness of patents is explained by their value rather than by their volume (Hypothesis 2a). Hypothesis 2b, however, is rejected, as the coefficient for private equity investors turns out not to be different from the coefficient for corporate investors at any convenient level of statistical significance as a t-test suggests.

Model 2, which takes the value of blocking patents into account, 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 3a is rejected while hypothesis 3b receives support. This model 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. Our third model shows a positive and significant interaction term, which means that corporate investors are highly interested in those patents that have a blocking potential and that are closely related to their own technology base. Hypothesis 4 hence receives support. Including this measure in the regression does not alter the coefficients discussed above. In fact, results turn out to be robust across the three model 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 and Katila, 2001; Cloodt et al., 2006) 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 shows 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 indicates that corporate investors attach a higher value to the target's assets.[6] Referring to the return on assets, there is only a rather small positive effect on the deal value for corporate investors.[7] The leverage of the target firm turns out not to be important for the deal value. In contrast to this, the age of the target plays a significant role for private equity investors but is of no importance for corporate investors. The results hence tend to suggest that younger target firms exhibit a higher uncertainty about their actual value (Shen and Reuer, 2005). Furthermore, the measures for prior acquisition experience turn out to be insignificant, except for the frequent acquisition experience which is positively associated with the price that private equity investors pay. Finally, industry and year are jointly significantly different from zero as LR-Chi^2 -tests show (Table 2).

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	2.287	***	2.228	***	2.156	***
	(0.593)		(0.595)		(0.597)	
patent stock/assets	0.060	*	0.056		0.056	
	(0.036)		(0.034)		(0.034)	
citation rate	0.173	**	0.151	*	0.151	*
	(0.083)		(0.093)		(0.093)	
blocking potential			0.155		0.157	
			(0.175)		(0.176)	
log(total assets)	0.202	***	0.200	***	0.200	***
	(0.027)		(0.028)		(0.028)	
return on assets	0.003		0.003		0.003	
	(0.002)		(0.002)		(0.002)	
leverage	0.214		0.218		0.217	
	(0.144)		(0.144)		(0.144)	
log(age)	0.192	***	0.193	***	0.192	***
	(0.062)		(0.062)		(0.062)	
acquisition experience	-0.103		-0.104		-0.103	
	(0.131)		(0.131)		(0.131)	

[6] T-tests show that the difference in the valuation of the target firm's total assets is significant at a 1% level of statistical significance.

[7] The difference in return on assets is, however, statistically significantly different from zero at a 5% level of statistical significance as t-tests suggest.

	Model 1 Coefficient (st. err. A)		Model 2 Coefficient (st. err. A)		Model 3 Coefficient (st. err. A)	
acquisition experience (≥ 5)	0.401	**	0.396	**	0.396	**
	(0.161)		(0.161)		(0.161)	
Corporate investors						
patent stock/assets	0.189	***	0.168	**	0.170	**
	(0.069)		(0.072)		(0.071)	
citation rate	0.159	***	0.137	***	0.142	***
	(0.055)		(0.049)		(0.051)	
blocking potential			0.712	**	0.540	
			(0.389)		(0.402)	
tech. proximity	9.352	***	8.350	***	4.772	
	(2.971)		(2.958)		(3.459)	
tech. proximity^2	-20.980	***	-18.638	***	-12.614	*
	(6.158)		(6.162)		(6.938)	
interaction proximity/					0.608	*
blocking patents					(0.348)	
log(total assets)	0.518	***	0.505	***	0.496	***
	(0.045)		(0.046)		(0.046)	
return on assets	0.012	***	0.012	***	0.012	***
	(0.003)		(0.003)		(0.003)	
leverage	-0.089		-0.051		-0.037	
	(0.259)		(0.259)		(0.258)	
log(age)	0.088		0.089		0.090	
	(0.075)		(0.075)		(0.075)	
acquisition experience	0.150		0.118		0.128	
	(0.188)		(0.185)		(0.186)	
constant	4.572	***	4.658	***	4.740	***
	(0.555)		(0.559)		(0.561)	
8 industry dummies	LR-Chi^2 = 17.27**		LR-Chi^2 = 17.58**		LR-Chi^2 = 17.60**	
6 year dummies	LR-Chi^2 = 22.96***		LR-Chi^2 = 23.89***		LR-Chi^2 = 23.86***	
Number of observations			1,204			
F-statistic	17.64***		16.15***		14.74***	
R^2	0.31		0.32		0.32	

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

[A] We use heteroscedasticity-consistent Huber/White standard errors, which are clustered to account for multiple acquisitions by the same acquirer.

6 Discussion

Our results have shown that technology matters considerably in firm acquisitions – but to a varying extent and depending on the acquirer's identity. Interestingly, private equity acquirers generally seem to pay more for a target, when we control for the target's assets and characteristics. This result can be attributed to a number of factors: First of all, private equity investors may be 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, 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 (Kaplan and Schoar, 2005). 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 put simply, "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 of 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. 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 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 and Levitas, 2004; Levitas and 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). Both types of investors obviously succeed in identifying the technology employed by a target company. They are found to pay higher prices for targets with valuable technological assets. There seems to be no significant knowledge gap between private equity investors and corporate investors. Such a gap could have come about due to prior acquisition experience or personnel skilled in the art. In other words, both types of investors seem to have developed the necessary absorptive capacity for identifying valuable technologies. However, patents with a blocking potential only provide additional value for corporate investors, whereas the patent stock and patent value are important for both. This result becomes more pronounced when the blocking potential is interacted with the technology relatedness of the acquiring and target firms. Corporate investors deliberately identify targets with patents that could, on the one hand, be used to extend their present R&D activities into areas that were previously blocked by competitors and, on the other hand, provide a basis to protect and secure the firm's own technology domains. Patents in corporate acquisitions therefore always serve not only 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 might hint at excessive uncertainty associated with such patents, resulting in a discount with respect to the desired exit date of the investor.

What is more, private equity investors should not normally have to consider 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 opportunity to exploit protected knowledge in combination with one's own knowledge stocks are, however, of great importance for corporate investors. They deliberately strive to complement their own technology portfolio by redeploying technological resources in order to increase their own innovative capabilities (Cassiman *et al.*, 2005; Hussinger, 2005; Sorescu et al., 2007). Corporate investors therefore attach a higher value to patents than private equity investors.

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. In particular, 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. It hints at a concentration of key technologies in technology markets through acquisitions. This links our results with an important implication for competition policy. M&A transactions, to a large extent, are carried out in the intention of creating barriers to entry in specific technology markets and, hence, decreasing competition. This tendency needs to be reflected in a firm's M&A strategy. Firms need to keep a careful 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, through redeployment resulting in a new combination with other technological assets, these technologies might serve as a basis to threaten the novelty requirements of future patent applications.

This result is also of great 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 nonetheless 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 stock of patents.

7 Conclusion and future research

This paper has examined a sample of European firm acquisitions in which corporate and private equity investors were involved and shown that technology matters in firm acquisitions. However the extent to which it matters and the ways it does so depend on the acquirer's identity. Our results, however, provide no indication of 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, however, 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 innovation activity after an acquisition might correspond to post-merger integration difficulties (such as problems in the integration of two firms' R&D departments) that hinder the exploitation of the joint capacities (Ahuja and 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 engender a decrease in innovation 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 this case, motivations regarding the acquired technologies should also differ from those in other private equity transactions 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. A critical prerequisite for that, however, would be the ability to track the post-merger development of the target company, whether it is subsequently integrated and – if so – to what extent and what consequences this has for the once legally independent entity.

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Appendix

Table 3: Bivariate correlations

Private equity investors

Corporate investors	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
1. Log(deal value)		0.34***	0.16***	0.01	0.17***	0.00	0.17***	0.08**			-0.01	0.08**
2. Log(total assets)	0.50***		0.22***	-0.09**	0.23***	-0.26***	0.14***	0.02			-0.05	-0.05
3. Return on assets	0.07	-0.13***		0.07**	0.29***	0.00	0.05	-0.11***			-0.17***	-0.14***
4. Leverage	-0.09*	-0.03	-0.16***		0.04	0.02	-0.01	-0.09**			-0.10***	-0.09**
5. Log(age)	0.09*	0.05	0.11**	-0.07		-0.02	0.08**	-0.05			-0.17***	-0.24***
6. Patent stock/total assets	0.11**	-0.11**	0.10**	-0.05	0.04		0.04	0.24***			0.01	0.01
7. Citation rate	0.19***	0.12***	-0.04	-0.03	0.11**	0.06		0.40***			0.01	0.02
8. Blocking potential	0.21***	0.18***	-0.08*	-0.10**	0.03	0.19***	0.24***				0.11***	0.10**
9. Technological proximity	0.08**	0.08*	-0.11**	-0.09**	-0.01	-0.01	0.18***	0.11**				
10. (Technological proximity) ^{2}	0.04	0.05	-0.08*	-0.08	-0.01	-0.01	0.16***	0.06	0.92***			
11. Acquisition experience	0.01	0.01	-0.12***	0.00	0.00	0.00	-0.04	0.09**	0.05	0.07		0.58***
12. Acquisition experience >5												

**, * indicate statistical significance at the 1%, 5%, 10% level; n = 1,204

Table 4: Frequency distribution of the number of acquisitions over the past three years by type of acquiring firm

Number of acquisitions	Corporate investor	Private equity investor	Total
0	352	263	615
1	56	84	140
2	51	70	121
3	19	48	67
4	1	31	32
5	0	32	32
6	0	13	13
7	0	21	21
8	0	8	8
10	0	31	31
11	0	12	12
13	0	13	13
19	0	13	13
93	0	86	86
Total number of acquisitions	479	725	1,204