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Building and Blocking: The Two Faces of Technology Acquisition

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Non-technical summary

Gaining access to technological assets and patents, in particular, has long been a major motive and objective for firm acquisitions. Firms acquiring the patents underlying a technology may, however, do so for different reasons. On the one hand, firms might be interested in the technological value of a patent. By employing technology from external sources, acquiring firms aim to develop innovative products or services that lead to higher firm value. On the other hand, patents can also be used strategically. Their strategic use may result in "patent fences" that could block competitors in their innovation activities. Technological assets in mergers and acquisitions (M&As) hence exhibit two faces: portfolio building and/or (un-)blocking in technology markets. As a consequence, both aspects should therefore drive the acquirer's willingness to pay for a target firm. Drawing on transaction costs theory and the resource-based view of the firm, this paper is intended to increase our understanding of the motivation and objectives of acquiring firms with regard to technology. The main argument is that firms drawing upon a concentrated pool of technology can safeguard their research and development (R&D) investment more effectively if they can take control over key patents in a technology field. We pay particular attention to the value of technology as a blocking instrument and contribute to the literature on patent indicators by proposing a new measure to assess the blocking potential of patents. Our results are based on a sample of 657 European firms that were subject to horizontal acquisitions in the period from 1996 to 2003. With respect to technology we find a positive effect of the volume and the value of a target's patents. Focusing on the strategic dimension of technology acquisitions, our results indicate that acquirers also deliberately strive to get access to patents with a blocking potential, especially if these are related to the acquirer's own technology portfolio. This may suggest that firm acquisitions are used to unblock ongoing R&D activities. Our results have implications for policy makers, in that M&A transactions may considerably decrease competition in technology markets. Merger control authorities should ideally take this into account. Moreover, managers need to pay close attention to the market for corporate control and monitor the technological assets transferred from target to acquirer and vice versa as this might lead to the establishment of a patent fence.

Das Wichtigste in Kürze

Ein wichtiges Ziel von Fusionen und Übernahmen („mergers and acquisitions“, M&A) ist es, Zugang zu technologischem Wissen zu erlangen. Einerseits dienen Patente, die solcher Technologie zugrunde liegen, im Wesentlichen der Ergänzung des Technologieportfolios des Käuferunternehmens. Mit Hilfe extern verfügbarer Technologie streben Käuferunternehmen danach, innovative Produkte und Dienstleistungen zu entwickeln, die wiederum den Unternehmenswert steigern. Andererseits können Patente jedoch auch strategisch eingesetzt werden. Solch ein strategischer Nutzen kann in so genannten „patent fences“ („Patentzäunen“) liegen, die Innovationsaktivitäten von Wettbewerbern blockieren. Die Akquisition von Patenten im Zuge von M&A-Aktivitäten hat somit zwei Gesichter: Sie dienen einmal der Ergänzung des Patentportfolis, zum zweiten aber auch der Blockierung bzw. Auflösung von „patent fences“ in Technologiemärkten. Von beiden Aspekten kann daher ein Einfluss auf die Zahlungsbereitschaft des Käuferunternehmens für das Ziel erwartet werden. Der vorliegende Aufsatz trägt zu einem besseren Verständnis der Motivation und der Ziele von erwerbenden Unternehmen im Hinblick auf technologisches Wissen bei. Durch die besondere Berücksichtigung von Technologie als ein Blockadeinstrument leisten wir einen Beitrag zur Literatur über Patentindikatoren, indem wir ein neues Maß zur Bestimmung des Blockadepotenzials von Patenten vorschlagen. Unsere Ergebnisse basieren auf einer Stichprobe von 657 europäischen M&A-Transaktionen im Zeitraum von 1996 bis 2003. Sie zeigen einen positiven Effekt von Technologien auf den Transaktionswert. Darüber hinaus zeigen wir, dass Käuferunternehmen in der Lage sind, sowohl die Patentqualität als auch das Blockadepotenzial der Technologien einzuschätzen und zu bewerten. Käufer sind dabei insbesondere an solchen Technologien interessiert, die ein hohes Blockadepotenzial wie auch eine hohe Verwandtschaft zu den bereits vom Käufer genutzten Technologien aufweisen. Unsere Ergebnisse zeigen, dass M&A-Transaktionen den Wettbewerb in Technologiemärkten bedeutend verringern können, was auch von Fusionskontrollbehörden beachtet werden sollte. Darüber hinaus sollte das Management von Unternehmen M&A-Aktivitäten genau beobachten, um ein Entstehen von „patent fences“ möglichst frühzeitig zu verhindern.

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Abstract

Gaining access to technological assets and patents, in particular, has long been a major motive and objective for firm acquisitions. On the one hand, patents are used as a building instrument for the acquirer's technology portfolio. On the other hand, patents can be attractive because of their strategic value as a bargaining chip, e.g. in licensing negotiations. This is especially the case if patents have the potential to block competitors. Drawing on transaction cost economics and the resource-based view of the firm, we analyze the importance of these two faces of technology acquisition for the valuation of a target firm. Empirical evidence for European firm acquisitions in the period from 1996 to 2003 indicates that the price paid by an acquirer for a target increases with the building and blocking potential of the target's patents, especially if building and blocking patents are in technology fields related to the acquiring firm's patent portfolio. Our results have implications for the technology strategy of the firm, in that M&A transactions may considerably impact technology markets, increasing the concentration of key technologies.

Keywords: Firm acquisitions, technology, building patents, blocking patents

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1 Introduction

The acquisition of external technologies as a complement to in-house research and technology development has frequently been shown to be vital to firm performance and economic growth (Kogut & Zander, 1992). Along with technology alliances (Teece, 1992, Hagedoorn, 1993, Mowery, Oxley, & Silverman, 1996) and licensing agreements (Teece, 1986), the acquisition of innovative firms has, for a number of years, been a major tool for accessing externally developed technologies (Capron, Dussauge, & Mitchell, 1998, Graebner, 2004). By employing technology from external sources, firms aim to develop innovative products or services that lead to improved firm value (Griliches, 1981; Pakes, 1985). Acquired technologies can also be a decisive factor for post-merger innovation performance in technology motivated acquisitions (Ahuja & Katila, 2001; Cloodt, Hagedoorn, & van Kranenburg, 2006; Colombo, Grilli, & Piva, 2006). A firm's patent portfolio, in particular, can be assumed to have a direct influence on innovative capacities (Mansfield, 1986). Intellectual property rights (IPR) such as patents are hence an important factor for the merger decision (Veugelers, 2006). This implies that firm acquisitions can also be used strategically. Acquirers who gain control over important patents may be able to erect or break down barriers to entry and exert market power in technology markets (Reinganum, 1983; Mukherjee, Kiymaz, & Baker, 2004). From this it follows that a firm's IPR strategy is closely knit with its mergers and acquisitions (M&A) strategy (Cassiman, Colombo, Garrone, & Veugelers, 2005; Lesser, 1998; Graff, Rausser, & Small, 2003, for the biotech industry). While resource-based explanations, focusing on complementarity of resources and synergistic potentials, have received considerable attention in the academic literature (e.g., Harrison, Hitt, Hoskisson, & Ireland, 1991, 2001; Capron et al., 1998), only little is known about the importance of strategic technology acquisition motives.

Given the importance of technologies and patents in M&A we use firm acquisitions as an exemplary channel for assessing technologies to study the value of acquired technologies. In this paper, we argue that technology acquisitions exhibit "two faces": building the acquirer's technology portfolio and blocking competitors in technology markets. The building or resource-based motivation emphasizes the combinatory potential of the merging partners' research and development (R&D) resources, which could enable efficiency gains through the exploitation of scale and scope economies in R&D (Kamien & Schwartz, 1982; Cohen & Levin, 1989a). Additionally, researchers have argued that such transactions can be used to reconfigure the acquirer's or target's business, in order to respond to changes in the competitive environment or to enhance and improve existing operations (e.g., Bowman & Singh, 1993; Capron et al., 1998; Capron & Hulland, 1999). Reconfiguring the business goes along with a redeployment of resources which, in case of R&D, may involve IPR, personnel, laboratories and technical instruments being physically transferred to new locations or used in different R&D projects. Moreover, the combination of two product or technology portfolios provides an opportunity to exploit complementarities (Ahuja et al., 2001; Colombo et al., 2006) that result from a skilled unbundling and bundling of resources with the objective of enhancing (technological) core competencies of the merged entity (Cassiman et al., 2005; Sorescu, Chandy, & Prahbu, 2007). In other words, technology acquisitions allow extra returns to be appropriated from innovation activities through an enhanced, more valuable resource base (Barney, 1991).

Alternatively, technology acquisitions can be used strategically, as a means of taking control over IPR and especially patents. As patents grant the holder the right to exclude third parties from using the protected technology, ownership of IPR can be used to block competitors' innovation activities (Cohen, Nelson, & Walsh, 2000; Ziedonis, 2004; Scotchmer, 2004; Blind, Edler, Frietsch, & Schmooch, 2006; Heeley, Matusik, & Jain, 2007). Accordingly, control over key IPR can be an essential factor to maintain or enhance a firm's position in technology markets. Against the background of a surge in patenting over the past decades at the world's major patent offices, the patent landscape nowadays is characterized by marginal inventions, overlapping claims and multiple patent ownerships for complementary technologies (Heller & Eisenberg, 1998), as well as by patent fences of substitute technologies owned by a single firm or a group of firms (Cohen et al., 2000). Successfully navigating through these "patent thickets" (Shapiro, 2001) and dealing with patent fences (Schneider, 2008) can be a decisive factor in a firms' strategic planning. In response to this development, acquisitions of IPR and their enforcement have increased which led to "overfencing" in IP markets (David, 2001). As a consequence, some firms would "underinvest" in R&D if it meant having to license technology from multiple owners (Heller et al., 1998) or if a technology fence hinders further research. Other firms aim to access "blocking patents" through M&A (Graff et al., 2003) or engage in collaborative agreements such as licensing and patent pools (Merges, 2001).

Little is known from empirical research about the strategic value of patents. Using the example of M&A activities, this paper contributes to the understanding of the value of strategic technology acquisition. Acquiring firms striving for key technologies might either want to block competitors in technology markets or to "unlock" an existing patent fence which – as a consequence – would enable the acquirer to continue or expand ongoing R&D work (O'Donoghue, Scotchmer, & Thisse, 1998; Lerner, Tirole, & Strojwas, 2003; Graff et al., 2003). An example for an acquisition that was motivated by gaining access to a "blocked" technology is the case of the German optical instrument manufacturer Carl Zeiss that acquired the laser division of the British company BioRad (Competition Commission (UK), 2004). The merger followed a number of patent disputes between Carl Zeiss and BioRad and its most important competitors, among them Leica and Cornell. Cornell invented and patented an outstanding multiphoton technology, which was the leading technology in the field and exclusively licensed out to BioRad. Hence, the acquisition of BioRad granted Carl Zeiss access to a highly valuable, before-hand "blocked" technology.

Drawing from the resource-based view of the firm, transaction cost economics and recent advances in research on IPR, we argue that patents are of special interest for the acquiring firm if they exhibit particular technological features, such as being related to the acquiring firm's technology fields or having a high technological value. Moreover, firms commercializing technologies that draw upon a concentrated pool of valuable patents should be able to safeguard their investment more effectively than others. This should especially be the case for patents with a blocking potential, as they are most threatening to rent appropriation from R&D investments. This strategic value as well as the technological value of patents should both be reflected in the acquirer's willingness to pay for the target firm. While there is some evidence on the importance of the blocking potential of patents (Blind et al., 2007; Grimpe and Hussinger, 2008), to the best of our knowledge, no comparative evidence has yet been gathered on these "two faces" of technology acquisition. This paper is hence intended to contribute to our understanding of the motivation and objectives of acquiring firms with regard to technology and technology acquisition in general.

In that we pay particular attention to the value of patented technologies as building and blocking instruments, we contribute to the literature on patent indicators (Trajtenberg, 1990; Trajtenberg, Henderson, & Jaffe, 1997; Trajtenberg, Jaffe, & Hall, 2000; Harhoff, Scherer, & Vopel, 2003; Harhoff, Hoisl, & Webb, 2005b, 2005a). We suggest two measures, one to assess the blocking potential of patents and a second one mapping the building potential of patents. Both measures are based on detailed information about patent applications at the European Patent Office (EPO). We test the importance of the "two faces" of patents based on a sample of 657 European firms that were subject to horizontal acquisitions in the period from 1996 to 2003. Our findings confirm the importance of building and blocking potential of intellectual property rights. They suggest a positive effect of existing building and blocking patents on the deal value when the patent portfolios of acquirer and target are related. While the positive effect from building patents holds for unrelated patent portfolios, there is no effect from unrelated blocking patents. Acquirers hence deliberately strive to get access to patents with a blocking potential in related technology markets. This suggests that firm acquisitions are used to leverage control over key technologies that can create a competitive advantage by unlocking in-house R&D activities or by blocking competitors' R&D. Based on our findings, we derive important implications for management.

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 our model, data and measures. The empirical test of our hypotheses is provided in section 4. The last section concludes with managerial implications of our study, provides a critical evaluation and points out potential areas for further research.

2 Theoretical Framework and Hypothesis Development

Although the acquisition of innovative firms has frequently been shown to be a major tool for accessing externally developed technologies (e.g., Capron et al., 1998, Graebner, 2004), we cannot always assume that M&As are an attractive means of accessing valuable technological resources. As opposed to arm's-length technology licensing contracts, M&As typically result – at least to some degree – in the integration of the merging firms, which comes at the price of high coordination costs. From a transaction cost perspective, M&As should hence only occur if the benefits of an internal exploitation of technologies – for building and blocking purposes – exceed the costs of coordinating assets within one company (Klein, Crawford, & Alchian, 1978; Williamson, 1979).

In general, this cost of governance argument suggests that licensing contracts are preferable to M&As. Focusing on IPR in acquisitions might, however, change the picture. The coordination of intangible assets is in several ways more challenging than the coordination of "traditional", tangible assets (Arora, Fosfuri, & Gambardella, 2001). Although patents (and other IPR) facilitate bargaining in technology markets tremendously by granting temporary monopoly rights, i.e. ownership rights, on technological inventions to the inventors, patents are still difficult to value, their boundaries are often blurry and difficult to define, and parties owning related, previously patented technologies are often unknown in advance (Merges & Nelson, 1990).[1] Furthermore, markets for technology are increasingly characterized by fragmentation, multiple ownership, overlapping claims, patent thickets and patent fences, leaving patenting firms in an opaque and uncertain environment (Ziedonis, 2004). This leads to several problems for trading IPR at arm's length (Arora, Fosfuri, & Gambardella, 1999; Heller et al., 1998; Somaya & Teece, 2000; Graff et al., 2003). First, fragmented technology markets and blurry IPR boundaries lead to diffuse entitlement problems (Heller et al., 1998). Second, the difficulty of valuing IPR leads to value allocation problems between the technology owner and the licensee (Graff et al., 2003). Third, the dynamic and uncertain environment of technology markets causes difficulties setting up and enforcing the contract, due to monitoring and metering problems (Ziedonis, 2004). Lastly, there are strategic problems that can arise if IPR are traded at arm's length. For example, rent-dissipation effects can result when technologies are licensed out to other firms, because the licensees become new competitors in product markets (Graff et al., 2003). All the problems associated with arm's-length contracts increase their transaction costs in absolute and relative terms as compared to more integrative solutions such as M&As.

[1] There is an ongoing debate on the optimal design of patents (their optimal length and breadth) in the theoretical literature in order to maximize incentives to innovate in the economy (Scotchmer, 1991; Scotchmer & Green, 1990; Scotchmer, 2004).

In a scenario as described above, transaction cost theory shows that simple contracts cannot prevent hold-up problems in the market for IPR because IPR cannot be transferred without a significant loss in value (Klein et al., 1978; Williamson, 1985; Ziedonis, 2004). As a consequence, we observe that some firms underinvest in R&D while others internalize transactions involving IPR. For the latter firms, the degree of integration depends on the trade-off between the expected gains and losses of the different means of accessing a technology, from non-exclusive licensing to firm acquisitions. The fact that previous studies found a strong technology-based motivation behind M&As shows that the expected costs of coordination are often lower than the transaction costs of licensing in dynamic and uncertain technology markets.

Previous empirical literature has shown that technological assets contribute significantly to the value of a firm acquisition (see Veugelers, 2006, for a survey). Hence, M&As exhibit a good example to study the value and nature of different dimensions of technology acquisition. In the following, we will draw from the literature on the resource-based view of the firm (e.g., Wernerfelt, 1984; Barney, 1991) as well as on transaction cost economics (Klein et al., 1978; Williamson, 1979) to hypothesize that the technological and the strategic values of patents are important in firm acquisitions.

2.1 Portfolio building and the technological value of patents

In the previous section we argued that M&As are an attractive tool to access technological assets and especially patents as has been found in the previous empirical literature (Veugelers, 2006). In this section we summarize the main technology-related merger objectives that have been described from a resource-based perspective on M&As and technologies. Previous studies have shown that the value that can be created through technology acquisitions is higher if the merged entity succeeds in exploiting the combinatory potential of resources and, in particular, potential complementarities (Singh & Montgomery, 1987; Barney, 1988; Harrison et al., 1991, 2001; Hitt, Harrison, & Ireland, 2001). In order to realize complementarity effects by combining two technology portfolios, acquiring firms presumably screen technology markets carefully, as they should be interested in those acquisition targets that will most effectively complement their technology portfolio (Frey & Hussinger, 2006). They are hence interested in acquisition targets with a particular technology and IPR profile. 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 the process of resource redeployment (Capron et al., 1998; Capron et al., 1999) a merged entity may thus create a new or improved set of capabilities, providing the basis for superior firm performance and competitive advantage (Penrose, 1959; Eisenhardt & Martin, 2000; Priem & Butler, 2001; Sorescu et al., 2007).

The value of an external technology portfolio as presumably sensed by the acquiring firm can then be split up into different dimensions: the size of the acquired knowledge base (Ahuja et al., 2001; Cloodt et al., 2006), the quality of each technology (Reitzig, 2003; Grimpe & Hussinger, 2008) and the relatedness to the acquiring firm's technology portfolio (Harrison et al., 1991, 2001; Ahuja et al., 2001; Cloodt et al., 2006). A patent portfolio, first of all, acts as a signal as it shows that the prospective target firm has proven its technological expertise and capabilities and that it has a well-functioning laboratory and inventor team (Ndofor & Levitas, 2004; Levitas & McFadyen, 2006; Heeley et al., 2007). The larger the patent stock, the higher the acquisition target's technological productivity. Furthermore, the knowledge base of the then merged firm increases through the acquisition. Significant gains from the combination and joint exploitation of both patent portfolios can be expected. The increase in the firm's internal knowledge base can lead to a higher innovation output or "better quality" inventions. Finally, the enhanced knowledge base increases the absorptive capacity of the merged firm. Absorptive capacity is generally developed as a by-product of a firm's own R&D activities (Cohen & Levinthal, 1989b, 1990). 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 capacity hence increases awareness of market and technology trends, which can be translated into pre-emptive actions (Bowman & Hurry, 1993). As a result, it enables firms to predict future developments more accurately (Cohen & Levinthal, 1994). These benefits should be reflected in a higher willingness to pay for the target firm.

The size of the patent portfolio alone, however, should not be a sufficient reason to acquire the target. The distribution of patent values has been shown to be highly skewed, with most of the patents having a very low value (Harhoff, Narin, Scherer, &

Vopel, 1999; Harhoff et al., 2003). While some patents are important stepping stones in a certain technology line that define the state of the art for follow-up inventions, other patents are never commercialized or used for further technology development. Hence, particularly this "building potential" of the acquired patents with regard to future technologies is thought to be an important driver of the acquisition decision.

Patents with a high building potential are, however, supposed have a different value for different acquirers depending on the fit with the acquiring firm's technology profile. Previous studies identified technological relatedness of the merging partners' technology portfolios as an important factor in M&As (Ahuja et al., 2001; Cassiman et al., 2005; Cloodt et al., 2006). Analogously to product market relatedness, technological relatedness involves economies of scale and scope in R&D. Drawing from the concept of absorptive capacity, firms with related technological skills can presumably learn more from each other than firms active in completely different technology areas. Previous literature suggests, however, that the gains from a merger with a firm holding a technology portfolio that is too similar might be relatively small, as there might be little to learn from a partner with the same technology profile (Harrison et al., 1991, 2001; Ahuja et al., 2001; Cloodt et al., 2006).

We argue that the building potential of the target's patent portfolio will presumably increase with the quality of the target's innovation activities, especially if the patent portfolio of the acquisition target is related to the acquirer's patent portfolio. As a consequence, the price paid for an acquisition target should increase.

Hypothesis 1a: The price paid for an acquisition target increases with the building potential of the target's patents.

Hypothesis 1b: The price paid for an acquisition target with building patents that are closely related to the acquirer's technology is higher than for a target without these patents.

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

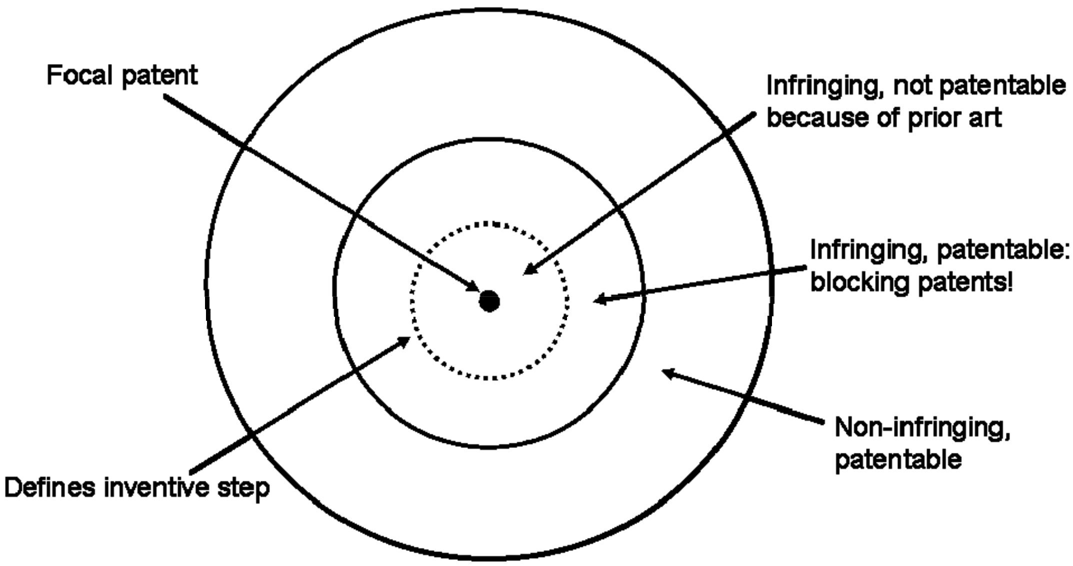
2.2 Competitor blocking and the strategic value of patents

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 – enhancing 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 or to break down existing patent fences. In other words, patents can be used to block competitors from developing a competing alternative technology (Heeley et al., 2007) or to remove existing patent fences. Besides the exploitation-related characteristics of patents, existing patents can block successive patent applications by threatening their novelty requirements (Scotchmer, 1991; Shapiro, 2001; Jaffe & Lerner, 2004; Ziedonis, 2004). This section shifts the emphasis to this second face of technology acquisition.

In fact, there has been a surge in patent applications worldwide over the past decade. This surge has not been accompanied by a proportional increase in R&D investment but instead by an increase in the number of legal disputes over patent rights (Lanjouw & Schankerman, 1997). Against this background, survey evidence for the US and Europe has shown that the protection of intellectual property, i.e. the original conception of patents as a means of providing incentives to innovate by granting the inventor a temporary monopoly on her invention, is often not the most attractive feature of patents (Arundel, van de Paal, & Soete, 1995; Cohen et al., 2000). Instead, the value of patents is determined by their importance as bargaining chips in the market for technologies, e.g. in licensing and M&A negotiations, and by their potential 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, Cremers, & Müller, 2009). Blind et al. (2009) 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. Such a strategic use of patents can lead to patent fences, i.e. where one or a few firms own a number of substitute patents (Cohen et al., 2000; Schneider, 2008), or to overlapping complementary intellectual property rights, i.e. if many different inventors patent marginal inventions and/or if the granted patents are defined too broadly in terms of the protected technology.

In other words, we are interested in identifying those patents that are closely enough related to a focal patent to block its exploitation, but still protect technologies that are different enough to qualify for patent protection. Figure 1 shows a stylized picture of the patentable inventions' sphere around a focal patent (see Scotchmer, 2004, for a similar illustration). In the inner circle around the focal patent we find inventions that are too similar to qualify for patent protection. They are not patentable because the inventive step between the new technology and the focal patent is not big enough. The second circle presents inventions that can be patented as the inventive step is big enough. If the new patent cannot be exploited without the right to use the focal patent, the focal patent has effectively become a blocking patent. Conversely, it is also possible that the new patent could block the focal patent in the same way. An example would be the invention of the laser, which was based on the invention of the maser. The laser is an enhancement of maser technology. Both technologies use the same principle to create coherent electromagnetic waves, but the maser was for microwaves and the laser was for light. As the maser was protected by a broad patent, the first laser patent infringed the maser patent. Nevertheless, the laser was granted a patent of its own – much later – as it solved some technical problems of the maser (see Scotchmer, 1991, for an in-depth discussion of this example). Finally, the outer circle of Figure 1 marks the area of technologies which are patentable and do not infringe the focal patent.

Figure 1: Blocking patents



Obviously, acquiring firms will have a strong interest in technologies that have a blocking potential. Acquirers 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 the further development of a particular technology or when firms want to diversify into a promising product market. Conversely, acquirers might want to build up their own blocking potential against undesired competition. Transaction cost theory suggests that simple market contracts do not safeguard technology investments properly as IPRs are specific assets that cannot be redeployed to the next best use without significant loss due to the transaction costs incurred. Therefore, it is especially beneficial for firms to take control over potentially blocking technologies in order to safeguard their own R&D investment.

Moreover, acquiring firms 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, on the one hand, acquirers might want to "un-block" their own R&D activities or that, on the other hand, acquirers might want to create a particularly strong patent fence. From a transaction cost perspective, we can argue that blocking patents in particular can be better exploited if they are owned by one firm rather than by multiple firms. If two (or more) patents hinder each other's exploitation, the benefits that would be expected due to decentralization will no longer be possible. This means that if patent owners act independently without taking into account the positive effects their inventions might have if combined with other firms' patents, the total potential value of exploiting the patents may not be realized. Since firms strive for higher margins from their technological assets, we would expect them to prefer to acquire patent portfolios with the potential to block their own R&D activities. The higher value of such patents should be reflected in the acquisition price. As a result, our second hypothesis reads:

Hypothesis 2a: The price paid for an acquisition target increases with the blocking potential of the target's patents.

Hypothesis 2b: The price paid 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. In the next section we present our empirical model to test our theoretical considerations.

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, on the basis of the target firm's assets and characteristics. As outlined above, our main focus is on the contribution the two functions of patents make to the deal value paid by the acquiring firm. 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)* would equal the price at which the target firm's assets are traded. In practice, M&As involve a premium above the market value of the target's assets. This reflects that the acquiring firm assumes a higher value for certain assets than the market does. Our empirical model then shows how the deal value is decomposed with respect to the target firm's characteristics and assets:

$$V(X) = f(X) + u \qquad (1)$$

where u is the error term of the empirical model which can be estimated using ordinary least squares (OLS). The target's bundle of characteristics *X* is defined as its technology and non-technology assets. Moreover, industry and year dummies are included to control for the different economic conditions and stock market levels during the period from 1996 to 2003.

3.2 Sample and Data

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 a majority acquisition by a corporate investor in the five-year period from 1996 to 2003. We only focus on mergers between firms in the same 2-digit NACE industry to exclude M&As between firms that serve completely different product markets as the value of patents in those acquisitions is not straightforward. Moreover, only targets from the manufacturing sector were included, as patents should typically be of minor importance for services.

Our sample consists of 657 target firms for which ZEPHYR provides information on the deal value, i.e. on the price paid by the acquiring firm. 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 acquiring and target firm to their patent history as patent applicants at the European Patent Office (EPO). Based on a computer-supported, text-based search algorithm, 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.

3.3 Measures

Technological assets

In order to describe the acquired technology portfolio we first introduce three measures capturing the characteristics of the technological assets of the target firm. All our 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).[2] This variable is used to account for the importance of the quantity of patents held by the target company for the acquirer.

The second variable is the citation rate, which describes the value of the acquired firm's patent portfolio proxied by the sum of citations the patents received in a five-year window after the patent publication date. Patent citations have frequently been shown to be a reliable measure of patent quality and value (Trajtenberg, 1990; Harhoff et al., 2003; Harhoff et al., 2005a). 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. The citations are called forward citations because they occur after the patent has been granted. 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

[2] 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.

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.

To account for the importance of technological proximity of the patent portfolios of acquiring and target firm we calculate a binary variable that indicates whether there is some overlap between the patent portfolios of the merging partners. The measure is based on the proximity measure introduced to the patent literature by Jaffe (1986). In order to calculate this measure we determine 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:

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

where zero represents no overlap of the firms' patent portfolios and a value higher than zero indicates some overlap.

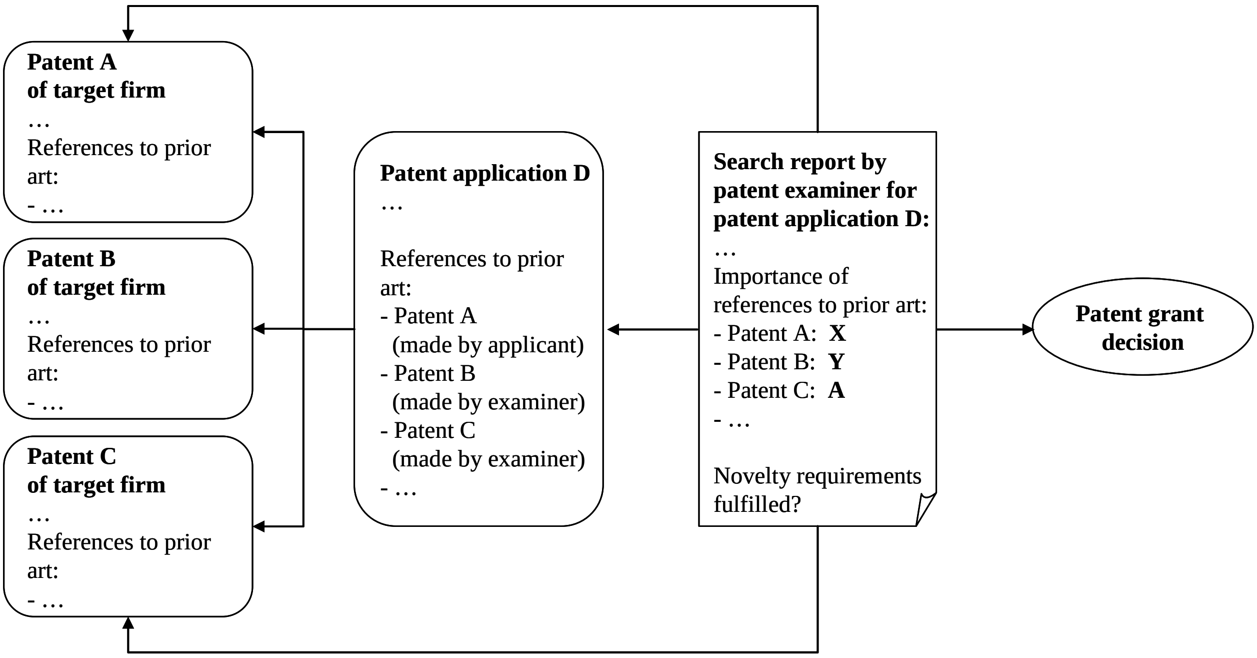
The building and blocking potential of patent portfolios

The measures for the building and blocking potential we propose for the empirical implementation are based on forward citations, making particular use of a unique feature of the citation system at EPO. For each EPO patent application, 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 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 "A" if prior art is cited that defines the state of the art in a technology field but does not threaten the novelty of a patent application itself. These patents are key contributions in a certain technology field and constitute the basis for future innovation (Harhoff & Reitzig, 2001; Harhoff et al., 2005b, 2005a). We use the sum of “A” citations a patent receives in a five-year window to proxy its building potential (H1a). A claim in the patent application is 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., 2001; Harhoff et al., 2005b, 2005a). A patent can still be granted (although this is less likely) if it has some references classified with X or Y. This can be the case for patent applications with several 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. We use the sum of X and Y citations received by the patents of the target firm in a five-year window to proxy their value as blocking patents (H2a).

Figure 2 gives a highly simplified overview of this procedure. We assume that patents A, B and C are held by a potential target firm. All three patents are cited by an incoming patent application D as prior art. In the example, the reference to patent A was made by the applicant while the references to patents B and C were added by the patent examiner. In contrast to the procedure at the United States Patent and Trade Mark Office (USPTO), most references for EPO patent applications are added by the patent examiner (about 95 percent) rather than by the applicant. In the search report, the patent examiner evaluates the importance of prior art for a particular claim by assigning a code letter X, Y or A (for a full description see Harhoff et al., 2005b, 2005a). The sum of X and Y or A citations received by the patents of the target firm are then taken as our measures for building and blocking patents, respectively.

Figure 2: Patent application procedure at the EPO



To account for the high correlation between citations received and the subset of X, Y and A citations received we normalize both measures by the total number of forward citations. In our estimated model the coefficients depict the premium that acquiring firms pay for the building and 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.[3]

Moreover, we distinguish between target firms with a related and an unrelated technology portfolio. In each case, we use separate measures for the building and blocking potential (H1b and H2b). These variables are used to account for the particular importance that related building and blocking patent portfolios have for the acquirer and the expected impact on future innovation activities. Again, in the model the coefficients show the premium paid by acquiring firms on top of what they pay for other target characteristics.

[3] Note that 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., 2005a).

Control variables

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 total liabilities of the target over total assets; and the age of the target, measured in years. 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 their skewed distributions.

4 Results

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for the sample of target firms, divided into patent holders and non-patent holders. First of all, the descriptive statistics show that, on average, firms with EPO patents are significantly larger than those without patents. Significant differences can also be found for the totals assets, the return on assets and the liabilities over assets while no significant differences can be found for the age of the firm. In this respect, it is particularly remarkable that patent holding firms are less profitable on average than firms without patents.

Regarding the technological assets of the target, Table 1 shows that acquisition targets have a patent stock of almost 40 patents. Every patent receives about one citation on average within a five-year window after publication. Further, the descriptive statistics show that 26 percent of all citations are blocking citations (i.e., X and Y forward citations), while 30 percent of the citations are building citations (i.e., A forward citations) according to our definition. About one third of the building patents belong to acquired firms with a related technology portfolio. The share of blocking patents held by acquired firms active in related technological areas is smaller. Finally, 28 percent of the acquisitions occur between firms with a related technology portfolio.

To further explore the relationships between the variables, Table 3 in the appendix reports bivariate correlations of our variables. It turns out that both the technological and the non-technological assets are positively correlated with the deal value.[4] With regard to the building and blocking patents, both turn out to be positively correlated with the deal value. The relationships will be further explored in the following section.

Table 1: Descriptive statistics

	Target Firms with EPO patents		Target Firms without EPO patents		T-Tests	
	104 observations		553 observations		H0: means are significantly different	
	Mean	St. dev.	Mean	St. dev.	Mean difference	
deal value	285.04	577.40	68.85	224.46	-216.19	***
total assets	316.51	597.99	174.42	479.00	-97.36	***
return on assets	-3.24	23.69	3.19	16.54	5.91	***
liabilities/assets	0.53	0.24	0.58	0.23	0.07	***
age of firm (years)	22.06	25.12	21.34	23.63	-0.46	
patent stock	37.92	107.34				
patent stock/assets	0.85	2.69				
# citations /# patents	0.96	0.80				
# blocking citations /# citations (all target firms)	0.26	0.26				
# blocking citations /# citations of target firms with related patent portfolios	0.07	0.16				
# blocking citations /# citations of target firms with unrelated patent portfolios	0.19	0.27				
# building citations /# citations (all target firms)	0.30	0.24				
# building citations /# citations of target firms with related patent portfolios	0.09	0.19				
# building citations /# citations of target firms with unrelated patent portfolios	0.21	0.24				
Technological relatedness	0.28	0.45				

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

4.2 Multivariate analysis

Table 2 shows the results from the OLS estimation in three different model specifications. The first specification serves as a benchmark model to show the effects of the firm characteristics and technology measures if the building and blocking potential is not controlled for. It turns out that the inclusion of these measures in specification 2 and 3 does not impact the effects of the control variables significantly. Focusing on the first specification, which includes the volume and value of

[4] Note that there is a high correlation between A citations for all firms and the subgroups (A citations for firms with related and unrelated patent portfolios) by definition. The same holds true for X and Y citations. These variables will therefore not be used together in one specification later on.

technological assets, the results suggest that both volume, defined as the patent stock over assets, and value, defined as forward citations, drive the deal value. Apparently, patents have a technological value that can be exploited in the merged company or through selling the patents after the acquisition. Moreover, patents might work as a signal for the technological fitness of a potential target company. In addition, the acquiring firm will have the opportunity to redeploy resources and realize the benefits of technology complementarities.

Model 2, which distinguishes between the building and blocking potential of the patent portfolios, shows that acquiring firms are highly interested in securing or enhancing their position in technology markets through firm acquisitions. The estimated quality premium, which was captured by total forward citations in the first specification, becomes insignificant and absorbed by the blocking and building measure. H1a and H2a hence receive support. Building patents show a higher impact on the deal value than blocking patents. A t-test shows, however, that the coefficients for the building and blocking potential of the target's patent portfolio do not differ significantly from each other at any convenient level of statistical significance.

Our third model distinguishes between building and blocking patents of firms being active in related technology fields and firms in unrelated technology fields. The results show that the major value of a patent portfolio stems from firms with a related technology competence, which means that acquiring firms are highly interested in patent portfolios that have a blocking and building potential related to their own technology base. Hence, H1b and H2b receive support. The coefficient for the building potential of a firm with a technologically related patent portfolio exceeds the coefficient for the blocking potential by 0.2. This difference is, however, not different from zero at any convenient level of statistical significance as a t-test suggests. Hence, building and blocking patents in related technology portfolio have the same value to acquiring firms.

The estimated value of building and blocking patents of firms with unrelated patent portfolios shows an interesting difference. While building patents have a value to the acquiring firm, even if they protect an unrelated patent portfolio, this is not the case for blocking patents. The blocking potential of an acquired patent portfolio is only valued by the acquiring firm if it is related to own technological activities.

Moving away from the variables used to test the hypotheses, we can see that the results provide some interesting insights regarding the remaining variables that refer to the target's non-technological characteristics and assets. Focusing on total assets, the coefficient is positive and significant across all three models. Return on assets has a rather small positive effect on the deal value. Apparently, the higher the profitability of the target the higher the deal value will be. This makes intuitive sense, as more profitable targets provide more opportunities to recover the acquisition price. Further, the value of an acquisition target increases in firm age, while the liabilities of the target firm turn out to be insignificant. Finally, year dummies are jointly significantly different from zero as LR-Chi^2 -tests show. Industry dummies appear only to be jointly significantly different from zero for the first specification (Table 2).

Table 2: Ordinary least squares regression for the logarithm of the deal value

	(1) Coefficient (standard error)	(2) Coefficient (standard error)	(3) Coefficient (standard error)
patent stock/assets	0.20 ***	0.16 **	0.16 **
	(0.07)	(0.07)	(0.07)
# citations /# patents	0.12 ***	0.05	0.06
	(0.04)	(0.04)	(0.04)
# blocking citations /# citations		0.76 **	
		(0.38)	
# blocking citations /# citations of firms in related technology fields			1.46 *** (0.71)
# blocking citations /# citations of firms in unrelated technology fields			0.58 (0.41)
# building citations/# citations		1.09 ***	
		(0.35)	
# building citations /# citations of firms in related technology fields			1.66 *** (0.67)
# building citations /# citations of firms in unrelated technology fields			0.87 *** (0.38)
log(total assets)	0.50 ***	0.47 ***	0.46 ***
	(0.04)	(0.04)	(0.04)
return on assets	0.01 ***	0.01 ***	0.01 ***
	(0.00)	(0.00)	(0.00)
liabilities/assets	-0.05	0.02	0.03
	(0.22)	(0.22)	(0.22)
log(age of firm)	0.15 ***	0.15 ***	0.15 ***
	(0.06)	(0.06)	(0.06)
constant	4.51 ***	4.67 ***	4.73 ***
	(0.53)	(0.51)	(0.51)
8 industry dummies	LR-Chi^2 = 18.96**	LR-Chi^2 = 12.35	LR-Chi^2 = 12.15
6 year dummies	LR-Chi^2 = 19.79***	LR-Chi^2 = 21.56***	LR-Chi^2 = 21.48***
R^2	0.31	0.33	0.33
F-Statistic	14.20	15.31	12.73
Number of observations	657	657	657

***, **, * indicate statistical significance at the 1%, 5%, 10% level.
We use heteroscedasticity-consistent Huber/White standard errors, which are clustered to account for multiple acquisitions by the same acquirer.

5 Discussion

Our results have shown that technology acquisitions clearly exhibit two faces: one directed at acquiring valuable technology that can be used in combination with existing technology to build the acquirer's technology portfolio; and another that is directed at improving the position of the acquiring firm in technology markets through accumulating technologies that have the potential to block competitor technologies or to unlock blocked technologies. Acquirers 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). Moreover, acquiring firms obviously succeed in identifying the technology employed by a target company. They are found to pay higher prices for targets with valuable technological assets. In other words, acquirers seem to have developed the necessary absorptive capacity for identifying valuable technologies (Cohen et al., 1989b, 1990).

First, value can be ascribed to the building potential of the target's patent portfolio. Building patents are valued by the acquiring firm independent of whether they protect a related patent portfolio or whether they protect completely unrelated technologies. A reason for this might be our definition of building patents as patents defining the state of the art in a technology field. As they are key contributions in a certain technology field they might exhibit a substantial value in licensing negotiations even if they should be far from an immediate application and exploitation in the merged entity.

Second, patents with a blocking potential are particularly interesting for acquirers. This is in particular important when blocking patents are related to the acquirer's technology. Blocking patents exhibit no additional value for an acquirer if they protect an unrelated patent portfolio. Having control over patents with blocking potential, hence, safeguards R&D investments of the acquiring firm.

In summary, acquiring firms deliberately select targets with patents that could, on the one hand, be used to extend their present R&D activities into areas and, on the other hand, to protect and secure the firm's own technology domains against technology competitors. Patents in acquisitions therefore always serve not only a technological but also a strategic objective in technology markets.

This research contributes to work in the field in several ways. First, our results extend existing knowledge on the motivation for firm acquisitions. For the first time, the two key functions of patents – as building and as blocking instruments – are shown to be reflected in the market for corporate control. In particular, the deliberate acquisition of patents with a blocking potential by acquiring firms has a significant impact on the allocation of technological assets in the market. This may hint at a concentration of key technologies through acquisitions if the acquiring firm accumulates patents to block others. Conversely, it may show that firms acquire blocked technologies and that M&As hence lead to less concentration in technology markets.

Our study has some important implications for the technology strategy of firms. Firms need to keep a careful eye on the key technologies in their industry and identify the underlying IPR. In this respect, it seems also sensible to move beyond and to distinguish between building and blocking as two dimensions of intellectual property rights. Reorganization in the industry through M&A transactions could be directed at a concentration of either building or blocking technologies or both. As acquiring firms do not only aim at the acquisition of valuable patents, but also pay a significant premium for patents with a blocking potential (if closely related), the redeployment of technologies through M&As may result in a powerful basis to threaten the other firms' future R&D activities. As a consequence, firms should shape their M&A strategy in close connection to their IPR strategy. Moreover, the M&A strategy could be complemented by forward-looking efforts to identify technologies to be licensed-in, to avoid being deterred from continuing R&D activities.

In case of an M&A between large firms, outsider firms can be assumed to have some appraisal of the technological capacity of the newly merged entity, thanks to their own absorptive capacity. However, if smaller firms are involved in acquisitions or if acquisitions occur across industries the future technological capacity of the merged entity in technology markets is much more difficult to assess. In such cases, a closer look at the acquired firms' patent portfolio might provide further insights. Based on the measures for the building and blocking potential of firms' patent portfolios suggested here, outsider firms are in a position to evaluate potential threats of entry barriers in technology markets through M&As with less well-known partners.

In a similar vein, particularly the measure for the blocking potential can be used by managers and researchers beyond M&As to assess the blocking potential of actors in technology markets. This study focused on M&As as an example to study the two faces of technology. Our approach is, however, much broader and can be used to analyze technologies in many different scenarios. It may provide managers and researchers with an overview of "who competes with whom" in technology markets. Compared to alternative measures of competition and infringement in technology markets such as litigations and oppositions[5] (only at the EPO), blocking citations occur at a much earlier stage of the patenting procedure, i.e. after patent application. Significant opposition costs, consisting largely of lawyers' salaries, and much higher litigation costs (Harhoff et al., 2004) lead to a low opposition rate and an even lower litigation rate in the US (Lanjouw & Schankerman, 2001) and in Europe (Cremers, 2009, for Germany). In fact, it has been shown that oppositions are only a good measure for competition in some industries (Hall et al., 2004). Citations at EPO, however, are added in the patent examination process and hence potentially infringing patents can be identified at a very early stage of the patent application procedure, without incurring any additional costs for the patent holder or potential infringer.[6] Hence, we argue that blocking citations are a powerful patent-based competition measure.

In order to determine the effects on competition in technology markets one has to be careful though. It is often argued that M&A transactions are carried out with the intention of creating barriers to entry in specific technology markets and, hence, decreasing competition. It should however be distinguished between accumulations of complementary and substitutive patents with a blocking potential. In case of complementary patents, joint control over the technology portfolios can be beneficial. From a transaction cost perspective, a merger in such cases can lead to benefits when using the joint patent portfolio as it puts an end to mutual blocking and obviates the transaction costs of potential licensing contracts. In line with predictions from transaction cost theory, decentralized control over such patents can lead to suboptimal individual exploitation of the two separate technology portfolios. Although this result holds for complementary goods in general, it is more pronounced in technology markets due to the sometimes blurry definition of patents, the fact that they often overlap and hence block each other, and that technology markets are characterized by a high degree of fragmentation and many uncertainties. Because of these specific features of technology markets, standard contracts are complicated by hold-up problems and thus often difficult to realize, which makes centralization of

[5] Oppositions constitute patent validity claims before court (see Harhoff & Reitzig, 2004, for details). They are supposed to make the European patent system more efficient than the US patent system as they are not as costly for the opponents as litigations (Hall & Harhoff, 2004).

[6] Hall and Harhoff (2004) have shown that patents with more patent references to prior art threatening their novelty are more likely to be opposed after granting.

technologies under one controlling party an attractive alternative to arm's-length contracts for firms.

6 Conclusion

This paper has developed a way of looking beyond the broad technology acquisition motive behind M&As. Drawing on transaction cost literature and the resource-based view of the firm, we have argued that there are two faces of technology acquisition. The first focuses on the resource-based, i.e. building, motivations for technology acquisitions. The building motive behind technology acquisitions is important independent of the technological relatedness of acquiring and target firm. The second is a purely strategic dimension that maps the blocking potential of the target firm's patent portfolio. Empirical evidence from a sample of 657 European M&As has shown that firms are paying a significant premium for a patent portfolio with building potential, but only in related areas. Patent portfolios with a blocking potential are associated with a higher value, but only if they are related to the acquiring firm's technology portfolio. Such a technology acquisition can be useful or even necessary to the acquirer for two reasons. On the one hand, the acquiring firm can acquire patents which are blocking its own ongoing R&D, or remove an existing patent fence. On the other hand, the acquiring firm might strive to own patents with blocking potential, in order to enhance its position in technology markets by creating patent fences and entry barriers into the technology market itself. In line with predictions from transaction cost theory, our results suggest that firms strive for central control over a portfolio of important and potentially blocking patents in order to safeguard their R&D investments.

The measures for the building and blocking potential of patents exploit an institutional feature of the EPO, the search report, which is taken out by the patent examiners for each particular patent application. In contrast, patent applicants at the USPTO have the "duty of candor", which means that the applicant herself has to deliver a list of relevant prior art. The search report at EPO, financed by higher application fees for EPO patents than for USPTO patents, does not only increase the quality of European patent grants though a more careful validity check, but also increases transparency in technology markets for actors in technology markets.

Our findings are not without limitations. First, our study might not reveal the full importance of building and blocking patents in M&As. This is because M&As that would have created very significant market power in technology markets might have been blocked by competition authorities. The implication for our analysis is that the predicted importance of both types of patents we found has to be understood as the lower bound of the importance of these patents.[7] Second, like any other patent based measure, our citation measures are subject to industry differences in the likelihood of patenting. In some industries we observe a higher fraction of unpatented inventions than in other industries (Mansfield, 1986). Also, so far, the measures can be only applied to EPO patents as the EPO publishes an examination report indicating the importance of references to patented prior art. Third, in this study we cannot distinguish between the motive of acquiring blocked technologies, i.e. overcoming existing patent fences, and the motive of acquiring patent portfolios with a blocking potential to erect barriers to entry into technology markets. This would be an important distinction to make. However, we are convinced that this distinction can be best analyzed through case studies rather than through large sample studies, as it requires an in-depth knowledge of the technologies involved.

[7] We are grateful to Ambarish Chandra and Andrea Günster for pointing this out.

References

Ahuja, G. & Katila, R. 2001. Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. Strategic Management Journal, 22(3): 197-220.

Arora, A., Fosfuri, A., & Gambardella, A. 1999. Markets for technology (Why do we see them, why we don't see more of them, and why we should care), Universidad Carlos III, Working Paper. Madrid.

Arora, A., Fosfuri, A., & Gambardella, A. 2001. Markets for technology: the economics of innovation and corporate strategy. Cambridge, MA: MIT Press.

Arundel, A., van de Paal, G., & Soete, L. 1995. Innovation strategies of Europe's largest industrial firms, MERIT. Maastricht.

Barney, J. B. 1988. Returns to bidding firms in mergers and acquisitions: Reconsidering the relatedness hypothesis. Strategic Management Journal, 9: 71-78.

Barney, J. B. 1991. Firm resources and sustained competitive advantage. Journal of Management, 17(1): 99-120.

Blind, K., Edler, J., Frietsch, R., & Schmooch, U. 2006. Motives to patent: Empirical evidence from Germany. Research Policy, 35: 655-672.

Blind, K., Cremers, K., & Müller, E. 2009. The influence of strategic patenting on companies' patent portfolios. Research Policy, forthcoming.

Bowman, E. H. & Hurry, D. 1993. Strategy through the option lens: An integrated view of resource investments and the incremental-choice process. Academy of Management Review, 18(4): 760-782.

Bowman, E. H. & Singh, H. 1993. Corporate restructuring: reconfiguring the firm. Strategic Management Journal, 14: 5-14.

Capron, L., Dussauge, P., & Mitchell, W. 1998. Resource redeployment following horizontal acquisitions in Europe and North America. Strategic Management Journal, 19: 631-661.

Capron, L. & Hulland, J. 1999. Redeployment of brands, sales forces, and general marketing management expertise following horizontal acquisitions: a resource-based view. Journal of Marketing, 63(2): 41-54.

Cassiman, B., Colombo, M. G., Garrone, P., & Veugelers, R. 2005. The impact of M&A on the R&D process. An empirical analysis of the role of technological- and market-relatedness. Research Policy, 34: 195-220.

Cloodt, M., Hagedoorn, J., & van Kranenburg, H. 2006. Mergers and acquisitions: Their effect on the innovative performance of companies in high-tech industries. Research Policy, 35: 642-654.

Cohen, W. M. & Levin, R. 1989a. Empirical studies of innovation and market structure. In R. Schmalensee & R. Willig (Eds.), Handbook of Industrial Organisation: 1060-1107. Amsterdam: North Holland.

Cohen, W. M. & Levinthal, D. A. 1989b. Innovation and learning: the two faces of R&D. The Economic Journal, 99(397): 569-596.

Cohen, W. M. & Levinthal, D. A. 1990. Absorptive Capacity: a new perspective on learning and innovation. Administrative Science Quarterly, 35(1): 128-152.

Cohen, W. M. & Levinthal, D. A. 1994. Fortune Favors the Prepared Firm. Management Science, 40(2): 227-251.

Cohen, W. M., Nelson, R. R., & Walsh, J. P. 2000. Protecting their intellectual assets: Appropriability conditions and why U.S. manufacturing firms patent (or not), NBER Working Paper. Cambridge, MA.

Colombo, M. G., Grilli, L., & Piva, E. 2006. In search of complementary assets: The determinants of alliance formation of high-tech start-ups. Research Policy, 35: 1166-1199.

Competition Commission (UK). 2004. Carl Zeiss Jena GmbH and Bio-Rad Laboratories Inc, A Report on the Proposed Acquisition of the Microscope Business of Bio-Rad Laboratories Inc. London.

Conner, K. R. 1991. A historical comparison of resource-based theory and five schools of thought within industrial organization economics. Do we have a new theory of the firm? Journal of Management, 17(1): 121-154.

Cremers, K. 2009. Settlement during patent litigation trials. An empirical analysis for Germany. Journal of Technology Transfer, 34(2): 182-195.

David, P. 2001. Will building “good fences” really make “good neighbours” in science?, Stanford University, Department of Economics Working Paper. Standford, CA.

Eisenhardt, K. M. & Martin, J. A. 2000. Dynamic capabilities: What are they? Strategic Management Journal, 21(10/11): 1105-1121.

Frey, R. & Hussinger, K. 2006. The role of technologies in M&As: a firm-level comparison of cross-border and domestic deals, ZEW Discussion Paper. Mannheim.

Gompers, P. & Lerner, J. 2000. Money chasing deals? The impact of fund inflows on private equity valuations. Journal of Financial Economics, 55: 281-325.

Graebner, M. 2004. Momentum and serendipity: How acquired leaders create value in the integration of technology firms. Strategic Management Journal, 25: 751-777.

Graff, G. D., Rausser, G. C., & Small, A. A. 2003. Agricultural biotechnology's complementary intellectual assets. The Review of Economics and Statistics, 85(2): 349-363.

Griliches, Z. 1981. Market value, R&D and patents. Economics Letters, 7: 183-187.

Grimpe, C. & Hussinger, K. 2008. Pre-empting technology competition through firm acquisitions. Economics Letters, 100(2): 189-191.

Hagedoorn, J. 1993. Understanding the rationale of strategic technology partnering: inter-organizational modes of cooperation and sectoral differences. Strategic Management Journal, 14: 371-385.

Hall, B. H. 1990. The manufacturing sector master file: 1959-1987, NBER Working Paper. Cambridge, MA.

Hall, B. H. & Harhoff, D. 2004. Post-Grant Reviews in the U.S. Patent System: Design Choices and Expected Impact. Berkeley Technology Law Journal, 19(3): 989-1015.

Harhoff, D., Narin, F., Scherer, F. M., & Vopel, K. 1999. Citation Frequency and the Value of Patented Inventions. The Review of Economics and Statistics, 81(3): 511-515.

Harhoff, D. & Reitzig, M. 2001. Strategien der Gewinnmaximierung bei der Anmeldung von Patenten. Zeitschrift für Betriebswirtschaft, 71(5): 509-529.

Harhoff, D., Scherer, F. M., & Vopel, K. 2003. Citations, family size, opposition and the value of patent rights. Research Policy, 32: 1343-1363.

Harhoff, D. & Reitzig, M. 2004. Determinants of Opposition against EPO Patent Grants - The Case of Biotechnology and Pharmaceuticals. International Journal of Industrial Organization, 22(4): 443-480.

Harhoff, D., Hoisl, K., & Webb, C. 2005a. European patent citations. How to count and how to interpret them, LMU Discussion Papers. Munich.

Harhoff, D., Hoisl, K., & Webb, C. 2005b. Analysing European and international patent citations: A set of EPO patent database building blocks, OECD STI Working Paper 2005/9. Paris.

Harrison, J. S., Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. 1991. Synergies and post-acquisition performance: differences versus similarities in resource allocations. Journal of Management, 17(1): 173-190.

Harrison, J. S., Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. 2001. Resource complementarity in business combinations: Extending the logic to organizational alliances. Journal of Management, 27: 679-690.

Heeley, M. B., Matusik, S. F., & Jain, N. 2007. Innovation, appropriability, and the underpricing of initial public offerings. Academy of Management Journal, 50(1): 209-225.

Heller, M. A. & Eisenberg, R. S. 1998. Can Patents Deter Innovation? The Anticommons in Biomedical Research Science, 280(5364): 698-701.

Hitt, M. A., Harrison, J. S., & Ireland, R. D. 2001. Mergers and acquisitions: A guide to creating value for shareholders. New York: Oxford University Press.

Hussinger, K. 2005. Did concentration on core competencies drive merger and acquisition activities in the 1990s?, ZEW Discussion Paper, Vol. No. 5-41. Mannheim.

Jaffe, A. & Lerner, J. 2004. Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it. Princeton, NJ.

Jaffe, A. B. 1986. Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Values. American Economic Review, 76(5): 984-1001.

Kamien, M. I. & Schwartz, N. L. 1982. Market structure and innovation. Cambridge: Cambridge University Press.

Klein, B., Crawford, R. G., & Alchian, A. A. 1978. Vertical integration, appropriable rents, and the competitive contracting process. Journal of Law and Economics, 21: 297-326.

Kogut, B. & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. Organization Science, 3(3): 383-397.

Lanjouw, J. O. & Schankerman, M. 1997. Stylized Facts of Patent Litigation: Value, Scope and Ownership, NBER Working Paper. Cambridge (MA).

Lanjouw, J. O. & Schankerman, M. 2001. Characteristics of patent litigation: a window on competition. RAND Journal of Economics, 32(1): 129-151.

Lerner, J., Tirole, J., & Strojwas, M. 2003. Cooperative marketing agreements between competitors: Evidence from patent pools, NBER Working Paper. Cambridge, MA.

Lesser, W. 1998. Intellectual property rights and concentration in agricultural biotechnology. AgBioForum, 1:2 (Fall 1998): 56-61.

Levitas, E. & McFadyen, M. A. 2006. Managing liquidity in research-intensive firms: Signaling effects of patents & managerial ownership. Academy of Management Proceedings: G1-G6.

Mansfield, E. 1986. Patents and innovation. An empirical study. Management Science, 32(2): 173-181.

Merges, R. P. & Nelson, R. R. 1990. On the complex economics of patent scope. Columbia Law Review, 90(4): 839-916.

Merges, R. P. 2001. Institutions for intellectual property transactions: the case of patent pools. In R. Dreyfuss & D. Zimmerman & H. First (Eds.), Expanding the boundaries of intellectual property: innovation policy for the knowledge society. Oxford: Oxford University Press.

Mowery, D. E., Oxley, J. E., & Silverman, B. S. 1996. Strategic alliances and inter-firm knowledge transfer. Strategic Management Journal, 17: 77-91.

Mukherjee, T. K., Kiymaz, H., & Baker, H. K. 2004. Merger motives and target valuation. A survey of evidence from CEOs. Journal of Applied Finance, 14(2): 7-24.

Ndofor, H. A. & Levitas, E. 2004. Signaling the strategic value of knowledge. Journal of Management, 30(5): 685-702.

O'Donoghue, T., Scotchmer, S., & Thisse, J.-F. 1998. Patent breadth, patent life and the pace of technological progress. Journal of Economics and Management Strategy, 7: 1-32.

Pakes, A. 1985. On patents, R&D, and the stock market rate of return. Journal of Political Economy, 93: 390-409.

Penrose, E. T. 1959. The theory of the growth of the firm. Oxford.

Peteraf, M. A. 1993. The Cornerstones of Competitive Advantage: A Resource-Based View. Strategic Management Journal, 14(3): 179-191.

Priem, R. L. & Butler, J. E. 2001. Is the resource-based "view" a useful perspective for strategic management research? Academy of Management Review, 26(1): 22-40.

Reinganum, J. F. 1983. Uncertain Innovation and the Persistence of Monopoly. American Economic Review, 73: 741-748.

Reitzig, M. 2003. What determines patent value? Insights from the semiconductor industry Research Policy, 32(1): 13-26.

Schneider, C. 2008. Fences and competition in patent races. International Journal of Industrial Organization, 26(6): 1348-1364.

Scotchmer, S. & Green, J. 1990. Novelty and Disclosure in Patent Law. RAND Journal of Economics, 21: 131-146.

Scotchmer, S. 1991. Standing on the shoulders of giants: Cumulative research and the patent law. Journal of Economic Perspectives, 5(1): 29-41.

Scotchmer, S. 2004. Innovation and incentives. Cambridge, MA: MIT Press.

Shapiro, C. 2001. Navigating the patent thicket: Cross licenses, patent pools, and standard setting. In A. Jaffe & J. Lerner & S. Stern (Eds.), Innovation Policy and the Economy, Vol. 1: 119-150. Cambridge, MA.

Singh, H. & Montgomery, C. A. 1987. Corporate acquisition strategies and economic performance. Strategic Management Journal, 8(4): 377-386.

Somaya, D. & Teece, D. J. 2000. Combining incentives in Multi-innovation products: organizational choices, patents and public policy, Haas School of Business Working Paper, University of California. Berkeley.

Sorescu, A. B., Chandy, R. K., & Prahbu, J. C. 2007. Why Some Acquisitions Do Better Than Others: Product Capital as a Driver of Long-Term Stock Returns. Journal of Marketing Research, 44: 57-72.

Teece, D. J. 1986. Profiting from technological innovation. Implications for integration, collaboration, licensing and public policy. Research Policy, 15: 285-305.

Teece, D. J. 1992. Competition, cooperation, and innovation: organizational arrangements for regimes of rapid technological progress. Journal of Economic Behavior & Organization, 18: 1-25.

Trajtenberg, M. 1990. A Penny for your Quotes: Patent Citations and the Value of Innovation. RAND Journal of Economics, 21(1): 172-187.

Trajtenberg, M., Henderson, R., & Jaffe, A. 1997. University versus corporate patents: A window on the basicness of inventions. Economics of Innovation and New Technologies, 5: 19-50.

Trajtenberg, M., Jaffe, A., & Hall, B. H. 2000. The NBER patent citations data file: Lessons, insights, and methodological tools, NBER Working Paper. Cambridge, MA.

Veugelers, R. 2006. Literature Review on M&A and R&D. In B. Cassiman & M. G. Colombo (Eds.), Merger and acquisitions - The innovation impact: 79-118: Edward Elgar.

Wernerfelt, B. 1984. A resource-based view of the firm. Strategic Management Journal, 5(2): 171-180.

Williamson, O. E. 1979. Transaction-cost economics: the governance of contractual relations. Journal of Law and Economics, 22(2): 233-261.

Williamson, O. E. 1985. The economic institutions of capitalism: Firms, markets, relational contracting. New York.

Ziedonis, R. H. 2004. Don't fence me in: Fragmented markets for technology and the patent acquisition strategies of firms. Management Science, 50(6): 804-820.

Appendix

Table 3: Bivariate correlations

	1.	2.	3.	4.	5.	6.	7.
1. log(deal value)	1.00						
2. log(total assets)	0.47 ***	1.00					
3. return on assets	0.05	-0.14 ***	1.00				
4. liabilities/ assets	-0.05	0.03	-0.12 ***	1.00			
5. log(age of firm)	0.09 **	-0.03	0.12 ***	-0.04	1.00		
6. patent stock/ assets	0.11 ***	-0.09 **	0.09 **	-0.04	0.04	1.00	
7. # citations/# patents	0.16 ***	0.09 **	0.00	-0.02	0.05	0.04	1.00
8. #blocking citations/# citations	0.22 ***	0.18 ***	-0.08 **	-0.09 **	0.03	0.20 ***	0.24 ***
9. #blocking citations/# citations of firms with related portfolios	0.18 ***	0.17 ***	-0.09 **	-0.06	0.00	0.02	0.06
10. #blocking citations/# citations of firms with unrelated portfolios	0.15 ***	0.11 ***	-0.04	-0.06 *	0.03	0.21 ***	0.24 ***
11. #building citations/# citations	0.26 ***	0.20 ***	-0.05	-0.09 **	0.01	0.12 ***	0.38 ***
12. #building citations/# citations of firms with related portfolios	0.18 ***	0.13 ***	-0.05	-0.09 **	-0.02	0.02	0.10 ***
13. #building citations/# citations of firms with unrelated portfolios	0.18 ***	0.15 ***	-0.03	-0.05	0.02	0.12 ***	0.37 ***
14. technological relatedness	0.23 ***	0.18 ***	-0.05	-0.04	0.03	0.01	0.14 ***

	8.	9.	10.	11.	12.	13.	14.
1. log(deal value)							
2. log(total assets)							
3. return on assets							
4. liabilities/ assets							
5. log(age of firm)							
6. patent stock/ assets							
7. # citations/# patents							
8. #blocking citations/# citations	1.00						
9. #blocking citations/# citations of firms with related portfolios	0.41 ***	1.00					
10. #blocking citations/# citations of firms with unrelated portfolios	0.89 ***	-0.06	1.00				
11. #building citations/# citations	0.33 ***	0.21 ***	0.25 ***	1.00			
12. #building citations/# citations of firms with related portfolios	0.45 ***	0.54 ***	-0.07 *	0.45 ***	1.00		
13. #building citations/# citations of firms with unrelated portfolios	0.26 ***	-0.07 *	0.32 ***	0.86 ***	-0.08 **	1.00	
14. technological relatedness	0.21 ***	0.63 ***	-0.09 **	0.27 ***	0.72 ***	-0.11 ***	1.00

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