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Building and Blocking: The Two Faces of Technology Acquisition

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The Two Faces of Technology Acquisition

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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 1999 to 2003 indicates that the price paid by an acquirer for a target increases with the patent stock, the relatedness, the value and the blocking potential of the target's patents, especially if blocking patents are in technology fields related to the acquiring firm's patent portfolio. Our results have implications for competition authorities, in that M&A transactions may considerably impact technology markets. This would also need to be reflected in the management's technology strategy.

Keywords: Firm acquisitions, technology, patents, blocking patents

JEL: G34, L20, O34

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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 and Zander, 1992). Along with technology alliances (Teece, 1992, Hagedoorn, 1993, Mowery et al., 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 et al., 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 and Katila, 2001; Cloodt et al., 2006; Colombo et al., 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 *et al.*, 2004). From this it follows that a firm's IPR strategy is closely knit with its mergers and acquisitions (M&A) strategy (Cassiman et al., 2005; Lesser, 1998; Graff et al., 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 et al., 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 and Schwartz, 1982; Cohen and Levin, 1989). 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 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 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 and Katila, 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 et al., 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 et al., 2000; Ziedonis, 2004; Scotchmer, 2004; Blind et al., 2006; Heeley et al., 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 and 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 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 "underinvest" in R&D if it would mean having to license technology from multiple owners (Heller and Eisenberg, 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 *et al.*, 1998; Lerner *et al.*, 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 on 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. 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 increase 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 blocking instruments, we contribute to the literature on patent indicators (Trajtenberg, 1990; Trajtenberg *et al.*, 1997; Trajtenberg *et al.*, 2000; Harhoff *et al.*, 2003; Harhoff et al., 2005a2005b). We suggest a measure to assess the blocking potential of patents, which is 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 479 European firms that were subject to horizontal acquisitions in the period from 1999 to 2003. Our findings provide support for both building and blocking. They suggest a positive effect of the volume of technologies a target owns – represented by the patent stock of the target – on the deal value. Accounting for patent quality – in terms of citations received by other patents – our findings show that acquiring firms are paying a premium for high-quality technologies. Focusing on the purely strategic dimension of technology acquisitions, our results indicate that acquirers also deliberately strive to get access to patents with a blocking potential in technology markets. In line with our prediction, the price paid is even higher when such a technology is closely related to the acquirer’s own technology portfolio. This suggests that firm acquisitions are used to leverage control over key technologies that can create a competitive advantage by unlocking ongoing R&D activities or by blocking competitors’ R&D. Based on our findings, we derive important implications for managers and competition authorities.

The remainder of the paper is organized as follows. The next section outlines our theoretical considerations and establishes a set of hypotheses. Section 3 introduces the data set we use and presents descriptive statistics. The empirical test of our hypotheses is provided in section 4. The last section concludes with policy and managerial implications of our study, provides a critical evaluation of the study 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 et al., 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 et al., 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 and 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 et al., 1999; Heller and Eisenberg, 1998; Somaya and Teece, 2000; Graff et al., 2003). First, fragmented technology markets and blurry IPR boundaries lead to diffuse entitlement problems (Heller and Eisenberg, 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.

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;

[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 and Green, 1990; Scotchmer, 2004).

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 and Montgomery, 1987; Barney, 1988; Harrison et al., 1991, 2001; Hitt et al., 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 and 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 and Hulland, 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 and Martin, 2000; Priem and 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 components: the size of the acquired knowledge base (Ahuja and Katila, 2001; Cloodt et al., 2006), the quality of each technology (Reitzig, 2003; Grimpe and Hussinger, 2008) and the relatedness to the acquiring firm's technology portfolio (Harrison et al., 1991, 2001; Ahuja and Katila, 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 and Levitas, 2004; Levitas and 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 and Levinthal, 1989, 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 and Hurry, 1993). As a result, it enables firms to predict future developments more accurately (Cohen and Levinthal, 1994). These benefits should be reflected in a higher willingness to pay for the target firm.

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

In addition to the size of the acquired technology portfolio, the quality of the acquired patents is thought to be an important driver of the acquisition decision. The distribution of patent values has been shown to be highly skewed, with most of the patents having a very low value (Harhoff et al., 1999; Harhoff et al., 2003). The quality of the acquired patent portfolio should matter as well as its size. One reason for this is that patents can be sold individually after the acquisition and valuable patents are associated with a higher price or licensing value. Another reason why patent quality is relevant is that highly valuable patents might have a higher impact on the firm's post-merger innovation outcome and increase the merged entity's absorptive capacity to a larger extent than less valuable patents. Our second hypothesis hence reads:

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

Lastly, technological relatedness has been identified as an important factor in technology M&As (Ahuja and Katila, 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 with too similar a technology portfolio 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 and Katila, 2001; Cloodt et al., 2006). In line with previous literature, we hypothesize that M&A partners can get the maximum out of sharing their knowledge if they are active in technologically related areas which are also different to a certain extent:

Hypothesis 3: The price paid for an acquisition target increases with technological relatedness up to a certain threshold, after which it decreases (inverted U shape).

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]

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[2] It should be mentioned that the acquisition of highly valuable patents and patents in related technology fields can also be viewed as strategic in the sense that a highly valuable patent can generate significant licensing income or that a large pool of patents in a certain technology field can strengthen the firm's position in technology acquisition. In this paper, we subsume patent quality and technological relatedness under resource-based technology acquisition motives to distinguish them from purely strategic motives. It is not our intention to deny strategic motivations in general behind the acquisition of such patents.

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; Grimpe and Hussinger, 2008) 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 and Lerner, 2004; Ziedonis, 2004). This section shifts the emphasis to this second face of technology acquisition.

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 by an increase in the number of legal disputes over patent rights (Lanjouw and 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 thing about patents (Arundel *et al.*, 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 *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. 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.

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. As a result, our fourth hypothesis reads:

Hypothesis 4: The price paid for an acquisition target increases with the blocking potential of the target's patents.

Moreover, we hypothesize that 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 welfare gain 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. This leads to our final hypothesis:

Hypothesis 5: The price 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 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. 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 total assets, return on assets, total liabilities and firm age. To test our hypotheses on the value of technologies 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, we include a measure of technological relatedness that is subsequently interacted with the measure for blocking patents. The definitions of these measures 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 their skewed distributions.

3.2 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 a majority acquisition by a corporate investor in the five-year period from 1999 to 2003. We only focus on mergers between firms in the same NACE 2-digit 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 are of minor importance for services. Our sample consists of 479 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). Based on a computer-supported, text-based search algorithm, target firms and patent applications were linked to each other using firm names and addresses in both databases. Each potential match proposed by the search engine was checked manually.

Focusing on the target's technological assets, we use different 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).[3] This variable is used to test the importance of the quantity of patents held by the target company for the acquirer (Hypothesis 1). 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 (Hypothesis 2). 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., 2005b). 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 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 4). 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

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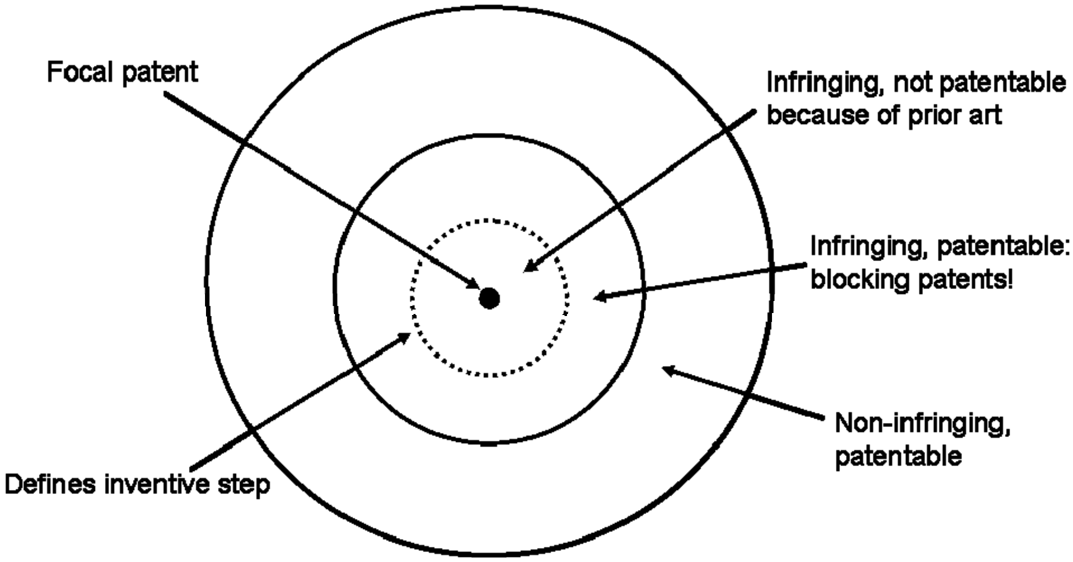
[3] Dating patents according to their application date as opposed to the granting date conforms with common practice (e.g. Griliches, 1981). The application date has the advantage of being closer to the actual completion of the invention.

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

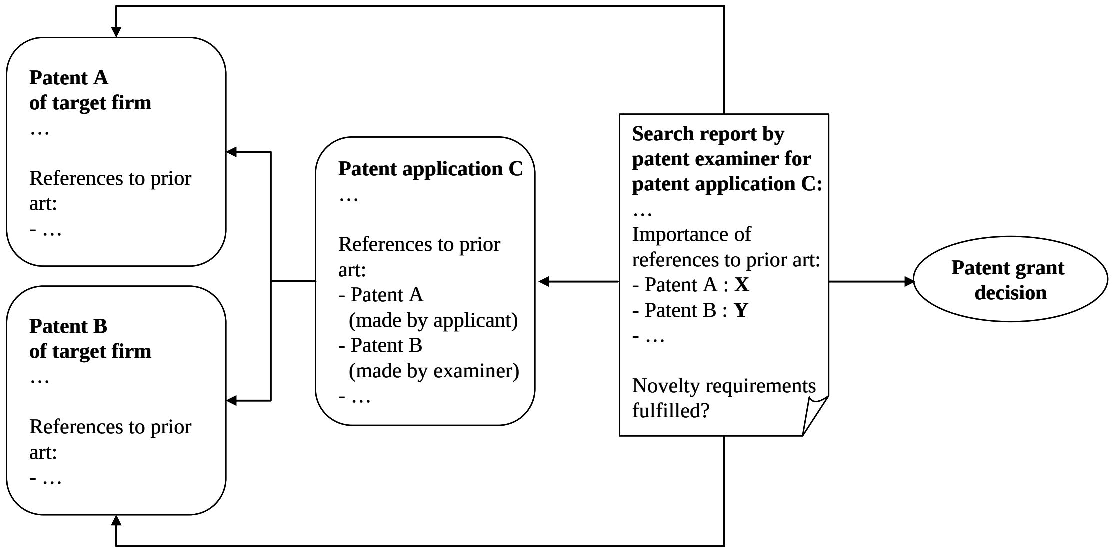


The blocking potential measure we propose for the empirical implementation is based on forward citations, making particular use of the citation system at EPO. For each EPO patent application, the patent examiner prepares a so-called "search report" that lists all important documents which are considered 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 "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 and Reitzig, 2001; Harhoff et al., 2005a2005b). 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.

Figure 2 gives a highly simplified overview of the patent application procedure at 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 example, the reference to patent A was made by the applicant while the reference to patent B was 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” or “Y” (for a full description see Harhoff et al., 2005a2005b). 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, in our estimated model the 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.[4]

[4] 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., 2005b).

Figure 2: Patent application procedure at the EPO



To test for the importance of technological proximity of the patent portfolios of acquiring and target firm (Hypothesis 3) we use 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:

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

where zero represents no overlap of the firms' patent portfolios and a high value indicates a large overlap. To allow for a non-linear relationship between the deal value and technological proximity, we also use a squared term of the proximity measure in our empirical model.

To test hypothesis 5 we define a binary variable that equals one 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 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. We include a dummy variable that is set to one if the acquiring firm acquired at least one firm in the three years before the focal transaction.

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. 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, 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 or the acquisition experience of the acquiring company. 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 42 patents. Every patent receives 0.8 citations on average within a five-year window after publication. 17 percent of the firms with a patent portfolio receive no citations at all. Further, the descriptive statistics show that almost 30 percent of all citations are blocking citations (i.e., X and Y citations). Technological proximity is on average 0.021, which means that the “technology vectors” of the average target and acquiring firm span an angle of 0.021 degree. Table 1 further shows that 30 percent of the acquisitions that involve patenting targets are related to each other in terms of their patent portfolio. Lastly, 22 percent of those acquisitions involve target patents with a blocking potential as measured by a dummy that equals one if the target firm’s patent portfolio has a blocking potential.

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. Besides the total assets driving the deal value, the technology measures are positively and significantly correlated with the deal value. Based on these findings, hypotheses 1, 2 and 4 receive support. 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**	
					H0: means are significantly different	
	90 observations		389 observations			
	Mean	St. dev.	Mean	St. dev.	Mean difference	
deal value	300.748	601.752	72.807	217.68	-216.187	***
total assets	190.533	368.428	92.335	278.731	-97.363	***
return on assets	-6.425	24.672	0.758	18.080	5.909	***
liabilities/assets	0.513	0.265	0.604	0.262	0.073	***
age of firm (years)	23.048	23.904	22.892	24.101	-0.458	
acquisition experience of acquiring firm	0.244	0.432	0.193	0.395	-0.043	
patent stock	41.981	114.729				
patent stock/assets	0.950	2.875				
# citations /# patents	0.849	0.761				
# XY citations /# citations	0.280	0.273				
technological proximity	0.021	0.070				
technological proximity > 0	0.300	0.461				
# XY citations * technological proximity	0.222	0.418				

***, **, * 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. Focusing on the value of technologies, the first specification, which includes the volume and value of technological assets, suggests that both volume and value drive the deal value, which confirms our first and second hypotheses. This result remains robust across the three specifications. 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.

Furthermore, Table 2 shows that the relatedness of the target firm's technology portfolio is of high importance for the acquiring firm. As expected, the coefficients hint at an inverted U-shaped relationship between the relatedness of the technology portfolios and the deal value. Acquiring firms 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.[5]

Model 2, which takes the value of blocking patents into account, shows that acquiring firms are highly interested in securing or enhancing their position in technology markets through firm acquisitions. Firms pay a premium for blocking patents on top of the price of patent portfolio size, quality and technological relatedness. Therefore, hypothesis 4 receives support. Our third model shows a positive and significant interaction term, which means that acquiring firms are highly interested in patents that have a blocking potential and that are closely related to their own technology base. Hypothesis 5 hence receives support. The interaction term captures the separate effects from the blocking citations and technological proximity measures. Those variables turn insignificant. Including the interaction term in the regression does not significantly alter the coefficients discussed above. The results turn out to be robust across the three model specifications.

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 characteristics and assets. Focusing on total assets, the coefficient is positive and significant across all three models. Return on assets has only a rather small positive effect on the deal value. Apparently, the higher the profitability of the target, the higher the deal value. This makes intuitive sense, as more profitable targets provide more opportunities to recover the acquisition price. All other target firm characteristics, as well as the acquisition experience of the acquiring firm, turn out to

[5] It is worth mentioning that the maximum is paid for targets with a proximity between 0.23 (model 1) and 0.19 (model 3). This means that the effect of technological proximity is increasing for about 95% of our observations and that the decreasing part of the curve reflects only about 5% of our sample.

be insignificant. Finally, industry and year dummies are jointly significantly different from zero as LR-Chi^2 -tests show (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	0.174	***	0.152	**	0.155	**
	(0.066)		(0.068)		(0.067)	
# citations /# patents	0.143	***	0.118	**	0.125	**
	(0.054)		(0.049)		(0.050)	
# XY citations /# citations			0.792	**	0.614	
			(0.395)		(0.405)	
technological proximity	8.430	***	7.320	**	3.110	
	(3.015)		(3.046)		(3.740)	
(technological proximity)^2	-18.471	***	-15.657	**	-8.378	
	(6.337)		(6.576)		(8.064)	
dummy (# XY citations &					0.704	**
technological proximity)					(0.338)	
log(total assets)	0.526	***	0.513	***	0.502	***
	(0.045)		(0.045)		(0.046)	
return on assets	0.012	***	0.012	***	0.012	***
	(0.003)		(0.003)		(0.003)	
liabilities/assets	0.016		0.030		0.027	
	(0.280)		(0.279)		(0.278)	
log(age of firm)	0.087		0.088		0.087	
	(0.076)		(0.076)		(0.076)	
acquisition experience of	0.135		0.100		0.109	
the acquiring firm	(0.188)		(0.184)		(0.186)	
Constant	4.680	***	4.792	***	4.914	***
	(0.616)		(0.619)		(0.622)	
8 industry dummies	LR-Chi^2 = 14.13*		LR-Chi^2 = 14.17*		LR-Chi^2 = 15.38**	
4 year dummies	LR-Chi^2 = 16.84***		LR-Chi^2 = 17.89***		LR-Chi^2 = 18.16***	

***, **, * 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.

Our results have shown that technology acquisitions clearly have 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. 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.

Our results have demonstrated that the technological content and the opportunity to exploit protected knowledge in combination with one's own knowledge stocks are of great importance. 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, patents with a blocking potential are particularly interesting for acquirers. This result becomes more pronounced when the blocking potential is interacted with the technology relatedness of the acquiring and target firms. Having control over a concentrated pool of key technologies safeguards R&D investments of the merged firm. Acquiring firms hence deliberately select 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 such acquisitions therefore always serve not only a technological but also a strategic objective in technology markets.

5 Conclusion and future research

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 motivations for technology acquisitions. The second is a purely strategic dimension, which abstracts from the size- and content-dominated dimensions typically used to describe a firm's patent portfolio, and instead maps its blocking potential. Empirical evidence from a sample of 479 European M&As has shown that firms are paying a significant premium for a patent portfolio with blocking potential. 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.

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.

This finding is particularly relevant for competition policy. 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. This would however not necessarily be the case if an acquisition led to a “hole in a patent fence”. Merger control authorities should therefore have an eye on the concentration of key technologies in the market and distinguish between firms with blocking patents and others. In case of a concentration of patents with a blocking potential through a merger the competition authority should consider remedies such as compulsory licensing. An example for this is the merger of Pfizer and Pharmacia that was only allowed under significant conditions and divestures including compulsory licensing of their patented technologies to third parties (Commission of the European Communities, 2003). In case of a resolution of a blocked technology portfolio through a merger, competition authorities might prefer to refrain from taking action if a joint control over the technology portfolios is beneficial. This could be the case if the acquired blocked or blocking technology is related to the technology portfolio of the acquiring firm. From a transaction cost perspective, the merger in such cases can lead to a welfare enhancing use of 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 might 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 technologies under one controlling party an attractive alternative to arm's-length contracts for firms.

In order to distinguish between technology accumulation and the unlocking of a blocked technology through M&As, competition authorities would have to develop a set of criteria defining key technologies and distinguishing them from blocked or blocking technologies. As compared to the identification of entry barriers into product markets created through M&As, the identification of such barriers in technology markets is not straightforward due to the characteristics of technology markets mentioned above. Our study suggests an indicator for the blocking potential of firms involved in M&As. The measure can be calculated based on patent examination reports at the EPO. Nevertheless, it has to be clarified that this indicator can only give an indication to help identify firms with blocking patents. The use of such an indicator cannot replace interviews with industry experts as not all technologies are patented and there might be some noise in patent citation based measures.

Lastly, 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, as reorganization in the industry through M&A transactions could be directed at a concentration of key technologies or blocking technologies. 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, 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 a good 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 across industries occur 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 measure for the blocking potential of firms 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, our measure for 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[6] (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 and Reitzig, 2004) lead to a low opposition rate and an even lower litigation rate in the US (Lanjouw and Schankerman, 2001) and in Europe (Cremers, 2008, for Germany). In fact, it has been shown that oppositions are only a good measure for competition in some industries (Hall and Harhoff, 2004). Citations at the 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.[7] Hence, we argue that blocking citations are potentially the most powerful patent-based competition measure.

The measure for the blocking potential of patents exploits 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

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

[7] 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.

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 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 blocking patents we found has to be understood as the lower bound of the importance of these patents.[8] Second, like any other patent based measure, our citation measure is 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, this measure 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.

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

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Appendix

Table 3: Bivariate correlations

Variables	1.		2.		3.		4.		5.		6.		7.		8.		9.		10.
1. log(deal value)	1.000																		
2. log(total assets)	0.501	***	1.000																
3. return on assets	0.066		-0.128	***	1.000														
4. liabilities/ assets	-0.087	*	-0.026		-0.158	***	1.000												
5. log(age of firm)	0.086	*	0.053		0.111	**	-0.069		1.000										
6. patent stock/ assets	0.111	***	-0.106	**	0.100	**	-0.049		0.044		1.000								
7. # citations/# patents	0.188	***	0.122	***	-0.041		-0.030		0.107	**	0.061		1.000						
8. #XY citations/# citations	0.213	*	0.183	***	-0.085	*	-0.104	**	0.033		0.194	***	0.236	***	1.000				
9. technological proximity	0.084		0.084	*	-0.106	**	-0.089	**	-0.013		-0.010		0.178	***	0.111	***	1.000		
10. (technological proximity)^2	0.036		0.052		-0.077	*	-0.079	*	-0.008		-0.007		0.156	***	0.056		0.922	***	1.000
11. acquisition experience	0.015		0.006		-0.116	***	-0.004		-0.003		0.005		-0.037		0.093	**	0.046		0.069

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