Firm acquisitions, resource complementarity and the access to localized knowledge

**Christoph Grimpe**  
Copenhagen Business School  
Strategy and Innovation  
cg.si@cbs.dk

**Katrin Hussinger**  
University of Luxembourg  
CREA  
katrin.hussinger@uni.lu

**Wolfgang Sofka**  
Copenhagen Business School  
Strategy and Innovation  
ws.si@cbs.dk

**Abstract**

How do firms gain access to localized knowledge? In this research, we investigate firm acquisitions as a channel through which acquiring firms obtain exposure to knowledge spillovers in a target firm’s region. Based on a comprehensive dataset of 851 technology-oriented mergers and acquisitions in Europe from 2001 to 2010 combined with data on regional patent stocks, our results show that the price of a target firm paid by the acquirer increases not only with regard to the target’s knowledge base but also with the amount of knowledge localized in the target’s region. We show that localized knowledge is most valuable to the acquirer when it is closely related to the target’s knowledge base. Conversely, we do not find a significant effect of the relatedness between the acquirer’s knowledge base and the localized knowledge on the acquisition price. In that sense, target firms serve as a conduit for knowledge spillovers for the acquirer.
FIRM ACQUISITIONS, RESOURCE COMPLEMENTARITY, 
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ABSTRACT

How do firms gain access to localized knowledge? In this research, we investigate firm acquisitions as a channel through which acquiring firms obtain exposure to knowledge spillovers in a target firm’s region. Based on a comprehensive dataset of 851 technology-oriented mergers and acquisitions in Europe from 2001 to 2010 combined with data on regional patent stocks, our results show that the price of a target firm paid by the acquirer increases not only with regard to the target’s knowledge base but also with the amount of knowledge localized in the target’s region. We show that localized knowledge is most valuable to the acquirer when it is closely related to the target’s knowledge base. Conversely, we do not find a significant effect of the relatedness between the acquirer’s knowledge base and the localized knowledge on the acquisition price. In that sense, target firms serve as a conduit for knowledge spillovers for the acquirer.

Keywords: firm acquisitions, localized knowledge, patents, resource complementarity, strategic factor market theory
INTRODUCTION

In August 2014, the Swiss pharmaceutical giant Roche decided to acquire Santaris Pharma, a Copenhagen-based biotechnology company that is based on a novel technology developed at the University of Southern Denmark. Instead of integrating Santaris Pharma’s research in the activities in Basel, Switzerland, Roche converted the company into one of its now seven global innovation centers and kept the company’s employees in Copenhagen. Calling himself a big fan of the Danish life science industry, Christoph Franz, chairman of the board of Roche, explains: “Why do we have a Roche Innovation Centre in Copenhagen? The answer is obvious; because that’s where the talent is. We go where there are talented people and solid science. In this case it happened to be Denmark, and it then becomes the basis for increasing our effort in the country – and we are happy to do so.” Franz goes on: “We felt there was high performance and a team with very innovative ideas here, and that was the reason why we decided to keep this unit with scientific entrepreneurship and spirit in Denmark. Viewed in isolation, an acquisition doesn’t add much value in itself. In buying a company, you can attract the talented individuals who are a part of that company. While it’s relatively easy to move equipment and documents, it’s a lot more difficult to move people and their families.”

Gaining access to technological knowledge through firm acquisitions is a central theme in strategy research (Hitt et al., 1996; Ahuja and Katila, 2001; Graebner, 2004; Makri, Hitt, and Lane, 2010; Grimpe and Hussinger, 2014). Much of prior literature has been focused on understanding the conditions under which these acquisitions improve an acquirer’s innovation performance and hence create value (Barney, 1988; Hitt, Harrison, and Ireland, 2001). Yet, the literature on the localization of knowledge (e.g., Jaffe, Trajtenberg, and Henderson, 1993; Audretsch and Feldman, 1996; Alcácer and Chung, 2007, 2014) would lead us to believe that acquiring firms may not only be motivated by a target’s knowledge and technology base in isolation but also by gaining access to a particular location that offers opportunities to benefit from knowledge flows. In fact, knowledge flows are typically geographically confined in scope (Audretsch and

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1 This vignette, developed by the authors, is based on an interview published in MedWatch (https://med-watch.dk/Top_picks_in_english/article9186308.ece) as well as newspaper and database research.
and the availability of spillovers may therefore attract firms to a particular location. Geographic proximity allows interpersonal interactions and spurs labor mobility enabling a transfer of tacit knowledge. In that sense, knowledge transfer is facilitated by proximity, leading co-located firms to enjoy higher benefits from knowledge spillovers (Jaffe et al., 1993).

In this research, we argue that location resources, such as localized knowledge, are an important, yet overlooked source of value that acquiring firms are willing to pay for. Our theoretical models rest on strategic factor market (SFM) theory which has frequently explained firm acquisitions as a means to acquire resources on the market for corporate control (Barney, 1986, 1988; Lippman and Rumelt, 2003) but typically focused on the resources held by the target firm. We challenge existing research which treats location resources as generic and available to any firm in a given place, leaving them out as a basis for firm-specific advantage (e.g., Zaheer and Nachum, 2011). Firms are differentially endowed with resources, and the combination of firm resources with location resources leads to heterogeneous resource complementarity (Barney, 1986, 1988; Adegbesan, 2009), that is, a “surplus” over and above the value that the acquirer’s and locational resources could create independently (Conner, 1991). By integrating theoretical mechanisms from the literature on geographically localized knowledge into SFM theory, we hypothesize a positive relationship between the location resources in the target’s region, specifically the localized knowledge, and the price paid for the target firm, while controlling for the knowledge base and other characteristics of the target.

Moreover, we probe deeper into the mechanisms of heterogeneous resource complementarity that drive the value of location resources for the acquiring firm. Focusing on the acquiring firm, extant SFM theory posits that the acquisition of technology creates value when such re-
sources are complementary, i.e. sufficiently similar to provide learning opportunities, but different enough to offer new and diverse knowledge (Ahuja and Katila, 2001; Cassiman et al., 2005; Cloodt, Hagedoorn, and van Kranenburg, 2006). Hence, we expect a curvilinear relationship between the relatedness of the acquirer’s knowledge base and localized knowledge and the price paid for the target. Focusing on the target firm, the literature on the benefits of co-location stresses the importance of geographical proximity as a prerequisite to accessing localized knowledge spillovers (Almeida and Kogut, 1999; Chung and Alcácer, 2002). Localized knowledge that is useful for innovation may originate from different sources and represent a wide range of elements on which to build and to recombine (Leiponen and Helfat, 2011). As a result, we expect an acquiring firm to pay a higher price for the target if it is particularly effective in absorbing local knowledge spillovers. In other words, we suggest the price to increase the more related the target’s knowledge base is to the localized knowledge. In that sense, we seek to uncover the mechanisms behind the complementarity effects between acquirer and target resources as well as the localized resources, respectively.

Our research is based on a sample of 851 technology-oriented mergers and acquisitions in Europe in the ten-year period from 2001 to 2010. We complement the transaction data with patent information on the acquirer and target firm from the European Patent Office (EPO) and regional patent data from the OECD to construct measures of knowledge bases and localized knowledge. Following prior research (Grimpe and Hussinger, 2014), we seek to explain the price paid for the target firm, an indicator of an acquiring firm’s expected future value creation and capture (Barney, 1988; Brandenburger and Stuart, 1996). If multiple firms compete for resources on the market for corporate control, the acquisition price can be assumed to take differences in
the firms’ ability to achieve gains from trade in strategic factor markets into account (Adegbesan, 2009).

We contribute to the literature in two ways. First, by focusing on the value of location resources vis-à-vis the value of the target’s knowledge base, our research documents an additional source of value unaccounted for in prior literature on technology-motivated firm acquisitions. While the importance of location for innovation has frequently been acknowledged in the international business literature (e.g., Cantwell, 2017), the consideration of location has largely been absent in the literature on firm acquisitions and strategic factor markets although multinational enterprises (MNEs) in particular have been ascribed a “sense of place” in their location decisions (Zaheer and Nachum, 2011). Similarly, the value of knowledge spillovers is well understood. Jaffe (1986), for example, shows that a firm’s patents, profits, and Tobin’s q increase with the size of the knowledge spillover pool. Moreover, Jaffe (1989) finds firms to benefit from knowledge spillovers if they are located close to a university. However, acquisition strategies to access such knowledge spillovers have not been documented in extant literature. Consequently, existing research likely overestimates the value of the target firm’s knowledge base to the acquirer.

Second, extant SFM theory holds that firms create value when they can combine complementary resources because resource complementarity implies the creation of a surplus over and above the value of the resources in isolation. Our theoretical reasoning provides deeper insight into the sources of value based on heterogeneous resource complementarity. In particular, we argue that the target firm acts as a conduit for knowledge spillovers, highlighting the accessibility of location resources for the target that underlie the acquirer’s expected value creation. More
generally, we show that heterogeneous resource complementarity is not strictly limited to the direct relationship between the buyer and supplier of a resource but extends to advantages in which the acquisition of resources provides access to additional resources. Future research can use our theoretical model and theorize about other advantages from resource acquisitions such as the access to strategic human capital.

THEORY AND HYPOTHESES

Firm valuation with heterogeneous resource complementarity

Resource-based theory posits that superior firm performance depends on utilizing valuable resources which are rare, difficult to imitate, and non-substitutable (Barney, 1991; Peteraf, 1993). While the resource-based view typically focuses on the development of such resources internally, they are oftentimes also acquired externally, for example by means of mergers and acquisitions, alliances, and other types of collaborative activities, in order to combine those external with internal resources (e.g., Lippman and Rumelt, 2003; Grimpe and Kaiser, 2010; Grimpe and Hussinger, 2014). The external acquisition of resources comes at a cost: assuming an efficient market for corporate control, SFM theory argues that the cost of acquiring a target firm corresponds to the value of the target to the acquirer (Barney, 1986, 1988). Barney (1988) maintains that the cost of a target will only be lower than its value to the acquirer if the acquirer (1) possesses information about the future value of the target unavailable to other firms, (2) exhibits superior complementarity to a target firm’s resources, or (3) is just lucky. Otherwise, bidding firms that sense an opportunity to acquire valuable resources would bid up the price of the target firm.

SFM theory has particularly been concerned with the condition of superior resource complementarity. Because firms have different endowments with resources, certain combinations of acquirer and target resources are likely more valuable than others. As a consequence, bidding firms
that expect such superior complementarity to occur can afford to acquire the target at a price which exceeds the value of the resources in isolation (Conner, 1991; Lippman and Rumelt, 2003). Some firms can therefore outbid other firms with less resource complementarity, even though all firms are aware ex-ante about the value that can be created (Adegbesan, 2009). Put differently, heterogeneous resource complementarity implies that the combined value of the acquiring firm’s resources $v(A)$ and the target firm’s resources $v(T)$ is $v(A \cup T) = v(A) + v(T) + S_{A,T}$, where $S_{A,T} > 0$. The surplus $S_{A,T}$ hence reflects the level of complementarity between the firms’ resources. In this model, gains from trade in SFM can be realized by the acquirer even if it has to pay $p(T) = v(T)$ for the target firm because $p(T) \leq v(T) + S_{A,T}$ (Grimpe and Hussinger, 2014).

While the implications of combining acquirer and target resources have been well documented in the theoretical and empirical literature on SFM, we suggest that the location resources in the target’s region constitute an additional source of value which prior research has yet failed to account for. In that sense, we argue that the acquirer can expect to create value from a combination of acquirer, target, and location resources, i.e., $v(A \cup T \cup L) = v(A) + v(T) + v(L) + S_{A,T} + S_{A,L} + S_{T,L}$, where $S_{A,L}$ and $S_{T,L}$ reflect the value which can be created by combining firm with location resources. Similarly, we expect heterogeneous resource complementarity between the two firms’ and location resources to determine the amount of value that can be created, and that certain acquiring firms with superior resource complementarity can outbid other bidding firms (Adegbesan, 2009). In other words, we expect the price paid for a target firm to reflect the total value that the acquirer expects to create not only through acquiring the target’s resources but also through getting access to the location resources in the target’s region. Based on these arguments,
the following hypotheses will elaborate on the mechanisms that explain the link between the location resources in a target’s region and the price paid by the acquirer for the target.

**Hypotheses**

Our notion of localized knowledge in a region follows a broad stream of literature that has highlighted how technology creation and innovation are much more concentrated in some geographical areas than in others (Marshall, 1920; Audretsch and Feldman, 1996). Regions with a particularly high concentration of technological activity in an industry are typically referred to as technological clusters (Alcácer and Zhao, 2012). Saxenian (1996) describes how the firms located in a cluster have access to unique knowledge pools which originate from dense networks of universities and firms. Literature provides three main mechanisms by which these localized pools of knowledge emerge. First, technological clusters provide attractive local labor markets. The latter increase the likelihood that scientists and engineers can move to other firms (Almeida and Kogut, 1999) or start-ups (Glaeser and Kerr, 2009) without large relocation costs. These increased levels of job mobility become conduits for the transfer of knowledge which can be tacit or uncodified in nature (Rosenkopf and Almeida, 2003). Second, the colocation of firms increases the likelihood for direct interaction of firms and their employees which enables common knowledge (Jaffe *et al.*, 1993; Powell, Koput, and Smith-Doerr, 1996). Sofka, de Faria, and Shehu (2018) describe for example how colocation in technological clusters makes the investments of firms in R&D and innovation increasingly visible and credible to other firms. Finally, the regional collocation of firms implies that they have common suppliers and buyers. These value chain links create a shared pool of knowledge by facilitating indirect interaction between competitors (Alcácer and Chung, 2007; Fabrizio and Thomas, 2012).
Within our framework, the presence of regionally localized knowledge resources has two implications. First, regional pools of knowledge exist separately and independently from any individual firms in those regions. Second, access to knowledge pools in a region requires a geographical presence since all of the positive mechanisms within technological clusters rely on geographical proximity. Logically, acquiring a target firm within a technological cluster would give an acquirer not just access to the target firm’s resources but also to localized knowledge of the target’s region. This insight has consequences for the degree of complementarity that an acquirer can expect from a particular target firm and the price that it is subsequently willing to pay for the acquisition (Adegbesan, 2009). Taking the localized knowledge in a target firm’s region into account, an acquirer can expect that it will (a) create superior complementarities directly between its own knowledge stock and the target region ($S_{A,L}$) and (b) that the target’s knowledge stock carries additional, indirect opportunities for complementarities based on its access to localized knowledge resources of its region ($S_{T,L}$). For example, an acquirer considering buying an IT firm located in Silicon Valley would determine the acquisition price based not just on the potential for complementarities with this IT firm itself but also based on the complementarities that can emerge from the direct access to broader Silicon Valley knowledge pools as well as the particular value that the target firm can create from its regional access. Conversely, the acquisition price for a target firm in a technologically lagging region should be limited to the expected value from complementarities between acquirer and target firm resources since the region does not provide additional potentials for value creation. In sum, we hypothesize:

**Hypothesis 1:** There is a positive relationship between the localized knowledge in a target’s region and the price paid by the acquirer.
Following our baseline hypothesis 1, we explore heterogeneous resource complementarity effects (Barney, 1986, 1988; Adegbesan, 2009) of regionally localized knowledge with two separate reference points, i.e. with the acquirer’s existing knowledge stock as well as the target firm’s knowledge stock. We start by focusing on complementary effects between an acquirer’s knowledge stock and localized knowledge in the region of its target firm. Complementarity effects between different knowledge stocks are typically explained based on opportunities for creating novel technologies, products or processes based on knowledge combinations (Fleming, 2001; Cassiman and Veugelers, 2006). The knowledge endowment of a given firm constrains its possibilities for knowledge combinations. These possibilities increase significantly once a firm has access to external knowledge which is different from its existing stock since many more combinations become feasible (Rosenkopf and Almeida, 2003). Gaining access to localized knowledge in a region by acquiring a target firm there provides such an opportunity for knowledge recombinations.

A central dimension for the opportunities that an acquirer can expect from knowledge recombinations with localized knowledge in a region is the degree to which the latter is related to its own knowledge stock. While the potentials for novel knowledge recombinations increase with the degree to which both knowledge pools differ (i.e. are technologically distant from one another), there are also substantial costs involved when combining increasingly distant knowledge. These costs originate from extensive needs to create interfaces for integrating increasingly unrelated knowledge as well as a decrease in the reliability of innovation results as the outcomes of increasingly unrelated knowledge combinations become harder to predict ex ante (Katila and Ahuja, 2002).
We reason that this tradeoff in the relatedness of knowledge between the acquirer’s as well as the target firm’s regional knowledge is reflected in the expected value of complementarities and therefore the acquisition price. We conclude that expectations for valuable complementarities reach their maximum at intermediate levels of relatedness between an acquirer’s knowledge stock and the localized knowledge in the target firm’s region. At such intermediate levels, acquirers can expect to benefit from a certain degree of novelty from recombined knowledge, which is somewhat distant while this knowledge is related enough so that knowledge integration can be efficiently and effectively achieved. Put differently, if the localized knowledge in a target firm’s region overlaps completely with the acquirer’s existing knowledge stock, it will be largely redundant. If the regional knowledge is completely unrelated to the acquirer’s knowledge stock, it remains uncertain whether meaningful recombinations can be realized or only under exorbitant integration costs. We propose:

_Hypothesis 2: There is an inverse U-shaped relationship between the relatedness of the acquirer’s knowledge and the localized knowledge in a target’s region and the price paid for the target by the acquirer._

Next, we focus on the potential complementarities that acquiring firms can expect based on the relationship between a target firm’s knowledge stock and the localized knowledge in the target’s region. If these expectations for complementarities are high, acquirers are likely to pay comparatively higher acquisition prices. Considerations for novel knowledge recombinations are also relevant for assessing potential complementarity effects between a target firm and the localized knowledge and its region but the assessment is likely to differ since the target firm will serve as the interface by which the regional knowledge can be absorbed. It is important to note for this
purpose that regional knowledge can be traced back to knowledge sources in the region, i.e. scientists, engineers, universities, suppliers or customers in a region. Target firms can create complementarities based on relational advantages with these knowledge sources.

Cohen and Levinthal (1989, 1990) describe the absorption of external knowledge as a process encompassing the identification, assimilation and exploitation of external knowledge. This process is costly since it requires the continuous screening of potential knowledge sources as well as the development of stable channels and shared language with the most promising ones (Laursen and Salter, 2006). Apart from organizing knowledge transfers efficiently, regional knowledge flows can be limited if firms lack legitimacy. Sofka et al. (2018) show how firms in technological clusters are particularly secretive since any knowledge that they reveal can be effectively exploited by competitors in the same cluster. Hence, firms will be more effective in accessing regional knowledge when they are considered as legitimate, i.e. they are perceived as acting properly and appropriately within a socially constructed system of norms or beliefs (Suchman, 1995). Monteiro and Birkinshaw (2017) document for the Silicon Valley how time consuming the process of legitimacy development is for establishing knowledge channels.

Cohen and Levinthal (1989) tie a firm’s capacity to absorb external knowledge to its own R&D investments. Knowledge flows are more likely to occur between organizations with similar R&D activities (Lane and Lubatkin, 1998). Shared skills, languages, and cognitive structures make it easier for one firm to learn from another (Kogut and Zander, 1992; Makri et al., 2010). Hence, target firms are more likely to benefit from knowledge flows with knowledge sources in their region when their own knowledge stock is closely related to the localized knowledge in the region. Besides, firms become more appropriate and desirable collaboration partners when their knowledge is potentially useful to external partners (Alexy, George, and Salter, 2013). Hence,
the relatedness between knowledge of a target firm and its region makes it more likely to be an attractive and legitimate collaboration partner in a region.

Taken together, we conclude that target firms with knowledge that is highly related to the knowledge of the region in which they are located will be particularly likely to absorb this localized knowledge effectively and efficiently. Accordingly, an acquirer can expect to benefit from particularly high complementarities that originate not just from the target firms’ knowledge but also from its capacity to absorb localized knowledge in its region. Given these expectations, acquirers should pay comparatively higher acquisition prices for such target firms. Hence, our last hypothesis reads:

_Hypothesis 3: There is a positive relationship between the relatedness of the target’s knowledge and the localized knowledge in a target’s region and the price paid for the target by the acquirer._

**METHODS**

**Data**

Our database is retrieved from the M&A database ZEPHYR, which is published by Bureau van Dijk. ZEPHYR covers more than 900,000 worldwide transactions that have been reported since 1996. For the purpose of our study, we selected M&A deals based on the following criteria: First, we only consider majority acquisitions in the ten-year period from 2001 to 2010. Minority acquisitions are excluded as they may be motivated by risk diversification and may not imply taking control of the target’s assets and know-how. Second, we only focus on deals among European firms. This restriction follows from our choice to use patent data from the European Patent Office (EPO). A sample that also covers firms in the US and Japan would need to correct for the so-called home bias of patenting, which describes that firms are more likely to file for patents at
the patent office in their home country (Dernis and Khan, 2004). Finally, we exclude transactions for which either multiple acquirers or targets were listed due to potentially confounding effects for our measurements.

The M&A data is linked to balance sheet data for the acquirer and target firms from Bureau van Dijk’s AMADEUS database and with firms’ patent records at the EPO using the PATSTAT database and the OECD patent citation database. The match between firms and patents was carried out based on firm names and addresses in both databases. We employed a computer-supported, text-based search algorithm to support the matching and manually checked each suggested match. The sample is restricted to those transactions with patents involved, i.e. in which either the acquirer or the target have a patent, which results in a final sample of 851 transactions.

Finally, we added data on the characteristics of the target’s region, which we define at the NUTS-3 level.2 This involves both statistical data from Eurostat, the statistical office of the European Union, as well as regional patent information from the OECD’s REGPAT database. The choice of the NUTS-3 level follows a number of considerations about the appropriate delimitation of regions for the purpose of our study, including the availability to data. In that sense, the notion of spatial proximity facilitating knowledge spillovers seems to be best reflected in the rather small-scale NUTS-3 regions which is in line with prior literature (Grimpe and Patuelli, 2009).

2 The Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard for referencing the subdivisions of countries for statistical purposes. There are 1342 NUTS-3 regions in Europe, which typically refer to the county or district level.
Measures

Dependent variable.
Our dependent variable is the price paid by the acquirer for the target firm. The price approximates the value of the target when it is combined with the bidding firm (Barney, 1988; Grimpe and Hussinger, 2014) and hence reflects the acquiring firm’s expectations of resource complementarity with the target firm and the target firm’s region. Due to the skewness of the price distribution, we take its natural logarithm.

Explanatory variables.
We use the normalized regional patent stock as our measure for localized knowledge in order to test hypothesis 1. The patent stock of region \( r \) in year \( t \) is measured as follows:

\[
\text{PATSTOCK}_{rt} = \left( 1 - \delta \right) \text{PATSTOCK}_{rt-1} + \text{PAT}_{rt}
\]

(1),

where \( \text{PAT}_{rt} \) describes the number of patents in region \( r \) and year \( t \) and \( \delta \) a depreciation rate which we set to 15% as is common practice in the literature (Griliches and Mairesse, 1984; Hall, Jaffe, and Trajtenberg, 2005). To reduce collinearity problems, the regional patent stock is normalized by the number of highly-skilled workers in a region, i.e. the potential inventors of patented technology. In that sense, the measure is similar to a regional patent productivity.

To test hypotheses 2 and 3, we calculate two relatedness measures which are based on the firms’ and the region’s patent portfolios. For hypothesis 2, we calculate the technological relatedness of the acquirer’s patents with the target region’s patents; for hypothesis 3, we calculate the relatedness of the target’s patents with the target region’s patents. For both measures, we use the proximity measure proposed by Jaffe (1986). It captures the extent to which the acquiring or target firm and all entities in the target firm’s region (including firms, universities and other entities, but excluding the focal target firm) develop technology in the same technology classes as
defined by the International Patent Classification (IPC). Following recent literature, we use the three-digit IPC level (Makri et al., 2010). We then calculate separate patent stock measures per three-digit IPC class on the basis of equation (1).

Equation (2) below provides the definition of the technology relatedness measure which is defined as the angular separation of the patent class distribution vectors $F$ of the acquiring or target firm $i$ and the target’s region $r$. The technology vectors $F$ for each acquiring or target firm $i$ and region $r$ can be interpreted as their respective technology portfolio. We use these vectors as a percentage of the total patent stock in order to eliminate patent portfolio size differences between the acquiring or target firm and the target region’s patent portfolios. In technical terms, the relatedness measure $T$ equals the scalar product of these vectors normalized by their scalar products with themselves, so that the measure takes the value of one for any two identical technology vectors:

$$T_{ir} = \frac{F_i F_r}{\sqrt{(F_i^t F_i)(F_r^t F_r)}} \cdot 100$$

where $T_{ir} = 0$ indicates no overlap of the acquiring or target firms’ patent portfolios and the patent portfolio of the other entities in the target’s region. A value higher than zero indicates some overlap. To test hypothesis 2, we employ the relatedness measure between the acquiring firm’s patents and the target region’s patents in a linear and a squared term; for hypothesis 3, we use the relatedness measure between the target firm’s patents and the target region’s patents in a linear term. We perform several specification checks in order to confirm the functional form of the relatedness variables.

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3 See the classification published by the World Intellectual Property Organization (WIPO), http://www.wipo.int/classifications/ipc/en/
Control variables.

We control for a number of factors on the firm and the regional level that may affect the price paid for the target firm. Following Grimpe and Hussinger (2014), we use the patent stock of the target firm, calculated on the basis of equation (1), normalized by the target’s total assets (in millions of Euros) to control for the knowledge base of the acquisition target. We further control for the value of the target’s patents by including the stock of forward citations that the target’s patents received in a five-year window after the grant. Patent citations are commonly used as an indicator of patent value (e.g., Trajtenberg, 1990). Since there is a high correlation between the number of citations a firm receives and the patent stock, we divide the citation stock by the target’s patent stock. Moreover, we include a measure of the target patent’s pre-emptive power, which is defined as the so-called XY-citation stock divided by the citation stock (Grimpe and Hussinger, 2014). To control for the relatedness between the acquirer and target firm knowledge bases, we include the relatedness measure as defined above based on the acquirer and target firm patent portfolios, both in a linear and a squared term.

We also control for the most important non-technological assets. Total assets of the target (in millions of Euros) are used to control for firm size. The target’s return on assets as defined as the sum of profits earned by the firm and the capital gains of assets over total assets controls for its profitability. Financial leverage of the target is controlled for by liabilities over total assets.\footnote{As the variable for liabilities is missing in some cases, we include a dummy variable that takes a value of one in the case of missing liabilities and zero otherwise. Liabilities are set to zero if missing.} Further, we include the target firm’s age measured in years.

Moreover, we include three variables that control for characteristics of the transaction. Here, we include a dummy variable that takes the value of one if both the acquirer and the target are in
the same two-digit NACE industry class to capture horizontal acquisitions. To control for differences between domestic and international transactions we include a dummy variable that takes a value of one in the case of a cross-border deal. We also control for whether the acquirer and target are located in the same NUTS-3 region.

Next, we include control variables for the target’s region. We include the size of the region as measured by regional employment and the share of highly skilled workers in the region. We use a Hirschman-Herfindahl Index (HHI) to control for the concentration in regional technology portfolios. The HHI is defined as the sum of the squared shares of patents of all entities in the region. A value of the HHI closer to its maximum indicates that the patent ownership in the region is highly concentrated. A value closer to zero indicates rather distributed regional patent ownership.

Finally, we control for time effects by including a set of year dummies for the years from 2001 to 2009, with 2010 being the reference category. Five industry dummies indicate the target firm’s industry affiliation. They are defined based on the Eurostat industry aggregation that distinguishes high-tech, medium high-tech, medium low-tech, and low-tech manufacturing, as well as knowledge-intensive and low knowledge-intensive services. High-tech manufacturing is the reference category in our estimations.5

Model

Our empirical model follows Hall et al. (2005) who estimate a market value function that allows to separate the components of the total value. In that sense, the value of a target firm is a function of its technological and non-technological assets as well as the characteristics of the region in

which it is located. Since our dependent variable only takes values larger than zero, our model can be estimated by ordinary least squares (OLS).

RESULTS

Descriptive statistics

Table 1 presents summary statistics. The average acquisition price equals 60 million Euros while the average total assets of the target are 115 million Euros. Target firms have an average patent stock of 1.72 patents (or 0.01 if divided by total assets). On average, the targets’ patent stock receives 0.27 citations within a five-year window after grant. Of the citation stock, 0.04 citations can be characterized as pre-emptive. With regard to the relatedness variables, we find that the relatedness of the acquirer’s patents with the target region’s patents is higher than the relatedness between the target firm’s patents and the patents in its region.

Moreover, it turns out that 40 percent of the transactions are cross-border transactions and 35 percent of the transactions occur in the same industry. In 12 percent of the transactions, acquirer and target firm are located in the same region. Target firms are on average 26 years old, indicating that our sample is not dominated by young companies that get acquired soon after inception. Target firms on average exhibit a low return on assets. The liabilities over assets equal on average 0.39.

The regions in which the target firms are located have an average employment force of 262,000 individuals, which suggests that most M&A transactions take place in larger regions. Almost every second individual is a highly-skilled worker indicating that the regions are knowledge and technology intensive. With respect to our main explanatory variable, it turns out that the regions have a patent stock per highly-skilled worker of 2.79, again indicating that the regions are knowledge and technology intensive.
Table 2 shows pairwise correlations. There are no indications for collinearity problems in our data as evidenced by the rather low correlations among the explanatory variables.

[Insert Table 2 about here]

**Multivariate analysis**

Table 3 shows the results of OLS estimations to test our hypotheses. The first specification serves as a benchmark model (Model 1) to show the effects of the control variables on the acquisition price. The estimated coefficients largely show the expected signs. With regard to the technology-related control variables, it turns out that the target patent stock over assets and the citation stock over the patent stock have positive, yet insignificant effects. The pre-emptive power of the target’s patents is positively and significantly related to the acquisition price. Moreover, the relatedness between the acquirer’s and the target’s knowledge bases shows a significant inverse U-shaped relationship, as expected (Ahuja and Katila, 2001; Grimpe and Hussinger, 2014).

Regarding the non-technology-related variables, we find a positive and significant relationship between the target’s total assets, return on assets, and the acquisition price. This suggests that more profitable targets provide more opportunities to recover the acquisition price. The acquisition price is also significantly higher for targets in the same industry and when acquirer and target firm are located in different regions. Moreover, the coefficient of the Herfindahl index is positive and significant, indicating that acquiring firms pay a higher price for a target if patent ownership in the region is more concentrated. There is no significant effect of target age, financial leverage and whether the acquisition is cross-border. The effects of the control variables are largely consistent across all specifications.

[Insert Table 3 about here]
Model 2 includes the region-specific variables and the measure of the localized knowledge, i.e. the regional patent stock over the number of highly-skilled workers, which tests hypothesis 1. It turns out that acquirers are willing to pay a higher price for a target that is located in a smaller, yet highly knowledge and technology intensive region, as evidenced by the significant coefficient of the share of highly-skilled workers in the total workforce. Localized knowledge is positively and significantly related with the acquisition price, providing support for hypothesis 1. The economic effects are sizable. A unit change in scientists over employment leads to a 57% change in the deal value, i.e. at the mean the deal value increases from 60 million EUR to 94 million EUR. A more realistic change of one standard deviation (i.e. 0.35) leads to an about 12 percent change in the deal value, i.e. at the mean the deal value increases from 60 million EUR to 72 million EUR.

Models 3 and 4 serve to test hypothesis 2 which suggested an inverse U-shaped relationship between the relatedness of the acquirer’s and the region’s patents and the acquisition price. While Model 3 includes the linear term only, Model 4 includes both the linear and the squared term. In both models, the measures turn out to be statistically insignificant. As a consequence, hypothesis 2 has to be rejected.

Next, Models 5 and 6 add a linear and subsequently a squared term of the relatedness between the target’s and the region’s patents in order to test hypothesis 3 which suggested a linear positive relationship between the relatedness measure and the acquisition price. As expected, we only find the linear term to be significant which provides support for hypothesis 3.\(^6\) A unit change in target relatedness leads to an increase between 80 and 90 percent in the deal value, i.e.

\(^6\) Note that the turning point for the relatedness measure lies within the 99% percentile of the distribution of the dependent variable indicating that the relationship between relatedness and deal value is increasing for the vast majority of the observations.
at the mean the deal value increases from 60 million EUR to 108 to 114 million EUR. A change of one standard deviation (i.e. 0.38) leads to an about 30 to 34 percent change in the deal value, i.e. at the mean the deal value increases from 60 million EUR to 78 to 80 million EUR. Finally, Model 7 includes all variables and shows consistent findings.

**DISCUSSION**

In this research, we investigate the role of localized knowledge in firm acquisitions, which we argue to be a neglected source of value. Based on a comprehensive dataset of 851 technology-oriented mergers and acquisitions in Europe from 2001 to 2010 combined with data on regional patent stocks, our results show that the price of a target firm paid by the acquirer increases not only with regard to the target’s knowledge base but also with the amount of knowledge localized in the target’s region. We show that localized knowledge is most valuable to the acquirer when it is closely related to the target’s knowledge base. Acquiring firms pay a higher price for the target if it is particularly effective in absorbing local knowledge spillovers. We attribute this effect to the ability of the target to benefit as much as possible from incoming knowledge spillovers because of the target’s own absorptive capacity. Conversely, we do not find a significant effect of the relatedness between the acquirer’s knowledge base and the localized knowledge on the acquisition price. In that sense, target firms serve as a conduit for knowledge spillovers for the acquirer.

Our reasoning is based on an integration of SFM theory with the literature on the localization of knowledge which allows us to challenge existing research treating location resources as generic and available to any firm in a given place, leaving them out as a basis for firm-specific advantage (e.g., Zaheer and Nachum, 2011). Since firms are differentially endowed with re-
sources, heterogeneous resource complementarity emerges from the combination of firm resources with location resources (Barney, 1986, 1988; Adegbesan, 2009), that is, a “surplus” over and above the value that the acquirer’s and locational resources could create independently (Conner, 1991).

**Implications for theory**

In that regard, we outline two implications for research on technology-oriented firm acquisitions. First, our research documents an additional source of value unaccounted for in prior literature on technology-motivated firm acquisitions by focusing on the value of location resources vis-à-vis the value of the target’s knowledge base. Although not a new theme and acknowledged in related literature such as international business theory (e.g., Cantwell, 2017), the consideration of location has largely been absent in the literature on firm acquisitions and strategic factor markets.

Our findings are reminiscent of a “sense of place” that multinational enterprises (MNEs) have been ascribed in their location decisions (Zaheer and Nachum, 2011). Similarly, although the value of knowledge spillovers has been extensively discussed (Jaffe, 1989; Jaffe, 1986), acquisition strategies to access such knowledge spillovers have not been documented in extant literature. Consequently, existing research likely overestimates the value of the target firm’s knowledge base to the acquirer.

Second, the notion that resource complementarity creates a surplus over and above the value of the resources in isolation has been a cornerstone of extant SFM theory. Our findings offer deeper insight into the sources of value which are based on heterogeneous resource complementarity. We find that it is the target firm which acts as a conduit for knowledge spillovers. This mechanism highlights the importance of accessing location resources for the target that in turn
underlie the acquirer’s expected value creation. In that sense, heterogeneous resource complementarity is not limited to the direct relationship between the buyer and supplier of a resource but extends to advantages in which the acquisition of resources provides access to additional resources. In other words, our findings shed light on the context in which resources are acquired which opens novel avenues for future research to theorize about additional advantages from resource acquisitions such as the access to strategic human capital.

**Implications for management**

Our findings are also important for management practice. While we show that firm managers are aware of the value that localized knowledge offers, we clarify the mechanism under which firms perceive localized knowledge to be most valuable and can expect to create most value. This is the case when firms select targets, which exhibit high absorptive capacity for the knowledge localized in the target’s region. In other words, acquiring firms should observe the relatedness of a target’s knowledge base with the localized knowledge. Since knowledge flows are more likely to occur between organizations with similar R&D activities (Lane and Lubatkin, 1998), shared skills, languages, and cognitive structures make it easier for one firm to learn from another (Kogut and Zander, 1992; Makri et al., 2010).

Moreover, selecting target firms with high relatedness to localized knowledge also offers acquiring firms access to target firms that are likely to be perceived as legitimate actors within a technological cluster. They may be well embedded in the local innovation system and possess ties to valuable knowledge sources in that region. In this case, knowledge spillovers can likely be maximized and channeled back to the acquiring firm. Relatedly, target firms become more appropriate and desirable collaboration partners when their knowledge is potentially useful to ex-
ternal partners (Alexy et al., 2013). Therefore, a target firm likely becomes an attractive and legitimate collaboration partner in a region when the relatedness between the target’s knowledge base and the localized knowledge is high.

CONCLUSION

While we are able to leverage a comprehensive dataset, our research is not without limitations, which in turn offer avenues for future research. First, patent-based measures are subject to industry differences in the likelihood of patenting. Some industries exhibit a higher fraction of unpatented inventions than other industries (Mansfield, 1986), although the importance of patenting has been growing rapidly in many industries over the recent years, including industries outside the manufacturing sector (Makri et al., 2010). Second, the measures to identify localized knowledge may considerably underestimate the availability of location resources. In that regard, it would be particularly interesting to take the access to other resources such as university research into account. Moreover, our data do not allow to actually observe a target’s legitimacy and embeddedness in a region which we assume to play an important role for benefitting from knowledge spillovers. Finally, while we control for the regional concentration of patent ownership, we have not in detail looked into competition aspects that may gain relevance if various actors compete for access to localized knowledge.

In that sense, future research could provide more granular evidence on the processes by which acquiring firms leverage targets to access localized knowledge. It would be particularly interesting to map a target’s collaborative ties with actors in a local innovation system and how these ties influence an acquirer’s value creation. This also calls for longitudinal research that observes an acquirer’s actual value creation over time, as well as the processes by which acquirers do achieve and not only expect value creation.
REFERENCES


# Tables

Table 1: Summary statistics

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<td>Coef. (std. err.)</td>
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<td>Coef. (std. err.)</td>
<td>Coef. (std. err.)</td>
<td>Coef. (std. err.)</td>
</tr>
<tr>
<td>Total assets</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
<td>0.00*** (0.00)</td>
</tr>
<tr>
<td>Patent/assets</td>
<td>1.84 (1.27)</td>
<td>1.73 (1.42)</td>
<td>1.67 (1.43)</td>
<td>1.67 (1.43)</td>
<td>1.67 (1.40)</td>
<td>2.09 (1.38)</td>
<td>2.11 (1.40)</td>
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<tr>
<td>Citation/patents</td>
<td>0.04 (0.17)</td>
<td>-0.01 (0.17)</td>
<td>-0.01 (0.17)</td>
<td>-0.01 (0.17)</td>
<td>-0.01 (0.18)</td>
<td>-0.21 (0.18)</td>
<td>-0.21 (0.18)</td>
</tr>
<tr>
<td>Crossborder acquisition (d)</td>
<td>-0.32* (0.17)</td>
<td>-0.43*** (0.16)</td>
<td>-0.44*** (0.16)</td>
<td>-0.44*** (0.16)</td>
<td>-0.44*** (0.16)</td>
<td>-0.39*** (0.18)</td>
<td>-0.41*** (0.18)</td>
</tr>
<tr>
<td>Horizontal acquisition (d)</td>
<td>0.53*** (0.13)</td>
<td>0.60*** (0.13)</td>
<td>0.58*** (0.13)</td>
<td>0.58*** (0.13)</td>
<td>0.57*** (0.13)</td>
<td>0.52*** (0.13)</td>
<td>0.52*** (0.13)</td>
</tr>
<tr>
<td>Age</td>
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<td>-0.00 (0.00)</td>
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<td>-0.00 (0.00)</td>
<td>-0.00 (0.00)</td>
<td>-0.00 (0.00)</td>
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<tr>
<td>ROA</td>
<td>0.88** (0.40)</td>
<td>0.75** (0.32)</td>
<td>0.74** (0.31)</td>
<td>0.74** (0.31)</td>
<td>0.63* (0.33)</td>
<td>0.65** (0.32)</td>
<td>0.64** (0.31)</td>
</tr>
<tr>
<td>Liabilities/assets</td>
<td>-0.52 (0.32)</td>
<td>-0.61** (0.31)</td>
<td>-0.60* (0.31)</td>
<td>-0.60* (0.31)</td>
<td>-0.64** (0.31)</td>
<td>-0.56* (0.32)</td>
<td>-0.56* (0.32)</td>
</tr>
<tr>
<td>Different regions</td>
<td>0.90*** (0.23)</td>
<td>1.00*** (0.23)</td>
<td>1.00*** (0.23)</td>
<td>1.00*** (0.23)</td>
<td>0.99*** (0.23)</td>
<td>0.97*** (0.23)</td>
<td>0.97*** (0.23)</td>
</tr>
<tr>
<td>Regional HHI</td>
<td>0.25*** (0.08)</td>
<td>0.14 (0.09)</td>
<td>0.15* (0.09)</td>
<td>0.15* (0.09)</td>
<td>0.14 (0.09)</td>
<td>0.14* (0.09)</td>
<td>0.15* (0.09)</td>
</tr>
<tr>
<td>Regional log(employment)</td>
<td>-0.24*** (0.09)</td>
<td>-0.22** (0.09)</td>
<td>-0.22** (0.09)</td>
<td>-0.22** (0.09)</td>
<td>-0.21** (0.08)</td>
<td>-0.21** (0.08)</td>
<td>-0.20** (0.08)</td>
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<tr>
<td>Scientists/employment</td>
<td>0.57*** (0.22)</td>
<td>0.59*** (0.22)</td>
<td>0.59*** (0.22)</td>
<td>0.47** (0.22)</td>
<td>0.42* (0.22)</td>
<td>0.44* (0.23)</td>
<td>0.44* (0.23)</td>
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<tr>
<td>Regional patents/scientists</td>
<td>0.15*** (0.04)</td>
<td>0.15*** (0.04)</td>
<td>0.15*** (0.04)</td>
<td>0.15*** (0.04)</td>
<td>0.15*** (0.04)</td>
<td>0.15*** (0.04)</td>
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</tr>
<tr>
<td>Acquirer regional relatedness</td>
<td>0.04 (0.09)</td>
<td>0.05 (0.03)</td>
<td>0.05 (0.03)</td>
<td>0.05 (0.03)</td>
<td>0.04 (0.04)</td>
<td>0.04 (0.04)</td>
<td>0.04 (0.04)</td>
</tr>
<tr>
<td>Target regional relatedness squared</td>
<td>-1.28 (38.23)</td>
<td>0.63 (0.08)</td>
<td>0.63 (0.08)</td>
<td>0.63 (0.08)</td>
<td>0.63 (0.08)</td>
<td>0.63 (0.08)</td>
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<tr>
<td>Target regional relatedness squared</td>
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<td></td>
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<td></td>
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<tr>
<td>Blocking citations/citations</td>
<td>2.30** (1.15)</td>
<td>2.26** (1.14)</td>
<td>2.35** (1.13)</td>
<td>2.35** (1.14)</td>
<td>0.99 (1.14)</td>
<td>1.49 (1.14)</td>
<td>1.52 (1.14)</td>
</tr>
<tr>
<td>Relatedness target and acquirer</td>
<td>0.26*** (0.09)</td>
<td>0.23** (0.09)</td>
<td>0.22** (0.10)</td>
<td>0.22** (0.10)</td>
<td>0.24** (0.09)</td>
<td>0.23** (0.09)</td>
<td>0.22** (0.09)</td>
</tr>
<tr>
<td>Relatedness target and acquirer squared</td>
<td>-0.01** (0.00)</td>
<td>-0.01** (0.00)</td>
<td>-0.01** (0.00)</td>
<td>-0.01** (0.00)</td>
<td>-0.01** (0.00)</td>
<td>-0.01** (0.00)</td>
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<tr>
<td>Constant</td>
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<td>0.99 (0.76)</td>
<td>0.99 (0.78)</td>
<td>0.99 (0.75)</td>
<td>1.22 (0.76)</td>
<td>1.33* (0.76)</td>
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<tr>
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<tr>
<td>Log-likelihood</td>
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<td>-1524.61</td>
<td>-1523.39</td>
<td>-1523.39</td>
<td>-1518.39</td>
<td>-1517.32</td>
<td>-1516.45</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.10; standard errors in parentheses; (d) dummy variable
All specifications also include industry dummies, year dummies, a dummy for missing liabilities and a dummy for missing regional information. The latter two variables were not significant in any specification and are omitted in the table above.