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Technological acquisitions: The impact of geography on post-acquisition innovative performance

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ABSTRACT

Our empirical study considers the impact of geography on post-acquisition performance for technological acquisitions. Relying on insights from the transaction costs and international business literatures we suggest that both geographic distance and borders influence post-acquisition innovative performance. Examining the patent portfolios of 3683 high tech acquirers in the period 2000–2012 we support a 'liability of distance' hypothesis and show that every 1000 km between the target and the acquirer costs as much as 19 lost patent applications. We do not find support for a 'liability of foreignness' hypothesis, however, but show in fact, that else equal, cross-border deals result in 3.15 additional patent applications. For high tech acquirers we find that 'foreignness' appears, therefore, to be more of an 'asset' than a 'liability'. We find that the lion's share of this is attributable to cultural differences.

1. Introduction

Technological acquisitions – that is, acquisitions in which a firm is acquired for its technological knowledge or capabilities (Ziedonis, 2004; Hung and Tang, 2008) – are everyday occurrences (see e.g., Sears and Hoetker 2014). The classic example is *Google*'s 2012 acquisition of *Motorola*, and its 17,000 patents, for $12.5bn.[1]

Conceptually, technological acquisitions make sense. Technological acquisitions not only provide a firm with economies of scale and scope (see e.g. Mowery et al., 1996; Desyllas and Hughes, 2010) but also increase the firm's capacity to absorb, develop and recombine knowledge in new ways (Cohen and Levinthal, 1990). This contributes both to the firm's short-term innovative performance (see e.g., Cloodt et al., 2006; Makri et al., 2010), and to the creation of a long-term competitive advantage (see e.g., Barney, 1986; Kogut and Zander, 1992). *Google*, for example, hoped to combine its capabilities in software engineering with *Motorola*'s knowledge of smart-phones, to build a defendable position for itself in the growing smart-phone market.

Empirically, however, many acquisitions are described as failures (e.g., Moeller et al., 2004), and technological acquisitions, in particular, are known to be prone to complication and disappointment (Chaudhuri and Tabrizi, 1999; Kapoor and Lim, 2007; Desyllas and Hughes, 2010; Graebner et al., 2010). Studies looking at the effect of technological acquisitions on the R&D process (Danzon et al., 2007; Hitt et al., 1996), the output (Prabhu et al., 2005; Cefis et al., 2009) as well as the financial performance of the firm (King et al., 2004; Cosh et al., 2008; Cosh and Hughes, 2008) consistently present less than spectacular results. *Google's* acquisition of *Motorola*, for example, resulted in a loss of $10 billion; after failing to use *Motorola* to protect itself from *Apple* and *Microsoft*,

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[1] http://www.chicagobusiness.com/article/20110815/NEWS08/110819934/google-to-buy-motorola-mobility-for-12-5-billion-icahn-praises.

http://dx.doi.org/10.1016/j.respol.2016.05.012
0048-7333/

Google sold *Motorola* in 2014 for $2.9bn. *Forbes* described *Google's* misadventure with *Motorola* as its 'biggest mistake to date'.[2]

A number of explanations have been put forward to explain why technological acquisitions fail. In general terms, the conclusion has been that technological acquisitions are complex events, which require specialist attention if they are to work (Desyllas and Hughes, 2010; Graebner et al., 2010; Colombo and Rabbiosi, 2014).

Surprisingly, the role of geography has been absent from this discussion (Prabhu et al., 2005; Cefis et al., 2009), and it has been assumed, implicitly, that the benefits of a technological acquisition are directly realizable, irrespective of where the firm and its target are located (Howells and Bessant, 2012). Two literatures, however, not only suggest that geography matters but suggest that the hurdles implied by geography will be particularly problematic for in the context of technological acquisitions.

The first – the transaction cost literature – suggests that *geographic distance* between the firm and its target increases transaction, monitoring, agency and asymmetric information costs, while at the same time reduces the benefits of soft information (Böckerman and Lehto, 2006; Grote and Umber, 2006). This, so-called 'liability of distance', means that distant deals are less likely to result in the sorts of information sharing necessary to improve innovation (Cloodt et al., 2006). Distant deals, in other words, are less likely to improve the innovative performance of the acquiring firm.

The second literature – the international business literature – suggests that *geographic borders* imply 'foreignness', not only in terms of cultural and institutional differences (Hofstede, 2001; Hemmert, 2004), which complicate communication (Laurent, 1983; Chevrier, 2003), reduce the quality and the flow of information (Jaffe et al., 1993), create uncertainty (Reus and Lamont, 2009), and lead to situations of 'them and us' (Huntington, 1993), but also in terms of the delays, disruptions, and inevitable bad decisions that come due to the firms "unfamiliarity with and lack of roots in a local environment" (Zaheer, 1995; p.342). This complicates the information flow necessary to spur innovation (Jiang and Li, 2009) and reduces, therefore, the likelihood that a cross-border acquisition will improve the acquiring firm's innovative performance.

We test these propositions using a sample of 3683 high tech acquisitions, announced in the period Jan 2003 to Dec 2008. To consider if the acquisition leads the newly created firm to deviate from its innovation trajectory, we apply a modified version of Brown and Warner's (1985) 'event study' to the patent portfolio of both the target and the acquiring firm. Looking at the patenting behaviour of both firms over the four years prior to the acquisition, we forecast their 'expected' behaviour as two stand-alone firms. We then compare their 'actual' and 'expected' performance in the year after the deal, to consider if the deal added to, or detracted from, what was expected. In other words, we measure acquisition success and failure in terms of the number of new patent application that it brings the firms, above or below the expected number.

We find the net effect of technological acquisitions was an increase in the number of patent application; there were, on average, 15,060 more patent applications, per year, after the acquisitions in our sample than been forecast in their absence. We find, though, that not all firms were equally successful in improving their patenting performance; in fact, we find that only 21% of firms in the sample beat their patenting forecast, and filed more patents in the year after the deal. Or, put another way, a massive 79% saw no improvement in their post-acquisition innovative performance.

Looking at the impact of geography on this equation, we present some interesting results. Firstly, we find strong evidence to support the notion of a 'liability of distance' for technological acquisitions. We report that every 1000 km between the target and the acquirer costs 19 abnormal patents. Given that *Google* paid *Motorola* $400,000 per patent in 2012, and given too that a 1000 km is equivalent to the distance between London and Berlin, this is not a trivial result. Secondly, we not only fail to support our hypothesis on the 'liability of foreignness', but report that foreignness is actually an 'asset' when it comes to technological acquisitions (Nachum, 2010). We find that, all else equal, cross-border deals result in 3.15 additional patent applications. The largest share of this, we find, is due to the insights brought by cultural differences, but a share is also due, simply, to the existence of a border: 'newness', in terms of new markets, increases innovation

Our findings contribute in a number of important ways to the literature on technological acquisitions in general, but especially to our understanding of how geography impacts post-acquisition innovative performance. We introduce, for example, a new measure for post-acquisition innovative performance, which allows us to describe performance not only in terms of what happened to patenting behaviour, but also in how such behaviour differed from what was expected. Our key contribution, however, is in the way we separate out the liabilities of 'distance' and 'foreignness' – two concepts which tend to be lumped together (e.g., Zaheer, 1995; Larsson and Finkelstein, 1999; Qian et al., 2013) – to systemically demonstrate the significance of geography on the innovative performance of a technological acquisition. In doing so, we offer insight on the role of geography in innovative performance, which is lacking (Prabhu et al., 2005; Cefis et al., 2009), and open up avenues for future research on a topic traditionally overlooked by innovation scholars.

2. Background

2.1. The paradox of technological acquisitions

'Technological acquisitions' – that is, acquisitions in which a target firm is acquired for its knowledge or technological capabilities (Ziedonis, 2004; Hung and Tang, 2008) – are everyday occurrences (Makri et al., 2010; Sears and Hoetker, 2014).

Theory suggests that technological acquisitions make sense for a number of reasons. Most importantly, and from a resource-based perspective, technological acquisitions improve the innovative performance of the acquiring firm. This literature suggests that a firm's innovativeness is a function of its knowledge base, and while the knowledge base of the firm can be extended internally through, for instance, an investment in R&D (Huber, 1991), M&A authors argue that grafting a 'knowledge rich' target onto the firms existing base offers a higher benefit for a lower price. Technological acquisitions, they suggest, enhance the firm's asset base and organisational capabilities (Chaudhuri and Tabrizi, 1999; Ahuja and Katila, 2001; Puranam et al., 2006; Kapoor and Lim, 2007), which spurs innovation (Cloodt et al., 2006) while, at the same time, allows the firm to side-step the time-consuming process of internal accumulation (Tsai and Wang, 2008; Desyllas and Hughes, 2010). Perhaps more importantly, however, the literature suggests that by acquiring 'knowledge rich' firms, acquirers not only 'get what they buy' – in terms of the 'explicit knowledge' that motivated the deal – but also the unseen 'tacit knowledge' too. With this the firm can recombine itself to create new syntheses and can explore previously unknown and unimagined opportunities (Puranam et al., 2006; Wry and Lounsbury, 2013). In doing so, and by actively developing the 'perceptiveness' of the firm's knowledge base, the acquirer can not only enhance its current abilities, but can enhance its ability to absorb new knowledge too (Cohen and Levinthal, 1990).

[2] http://www.forbes.com/sites/adamhartung/2011/08/18/googles-big-mistake-buying-motorola-to-save-android/#52274d4e7eef.

Empirically, however, many acquisitions are described as failures (Moeller et al., 2004); acquisitions are usually found to have a neutral (Agrawal and Jaffe, 2000) or negative effect (Agrawal et al., 1992) on the performance of the acquiring firm. And although "only a few studies have evaluated the contribution of external technology acquisition to firm performance" (Tsai and Wang, 2008; p.93), the research that has been done shows that technological acquisitions are particularly prone to post-acquisition complication and disappointment (see e.g., Kapoor and Lim, 2007; Desyllas and Hughes, 2010; Graebner et al., 2010). Jones et al. (2001), for example, show that technological acquisitions are negatively associated with a host of performance measures, and studies looking at the effect of technological acquisitions specifically on the firm's R&D process (Hitt et al., 1996; Danzon et al., 2007; Tsai and Wang, 2008), its output, (Prabhu et al., 2005; Cefis et al., 2009) as well as its financial performance (King et al., 2004; Cosh et al., 2008; Cosh and Hughes, 2008) typically report disappointing results for technological acquisitions.

2.2. Explaining the performance of technological acquisitions

A number of explanations have been put forward to explain why, theoretically, technological acquisitions should succeed, yet empirically tend to be disappointing.

Strategy scholars, for instance, suggest that technological acquisitions are just a particularly sensitive type of acquisition. This literature claims that all acquisitions disrupt the routines of the acquiring firm leading to delays and disruptions (Jemison and Sitkin, 1986; Haspeslagh and Jemison 1991). Because, in a technological acquisition, these sorts of disruptions occur in the set of routines closest to the firm's core, these delays and disruptions are likely to be particularly problematic (Hoskisson and Hitt, 1994; Hitt et al., 1996; Ahuja and Katila 2001). High tech acquisitions fail, this literature suggests, simply because high tech acquisitions are high-risk events.

Organisational scholars argue, however, that because the way in which an acquisition is integrated is the single most important determinant of performance (Zollo and Singh, 2004; Björkman et al., 2007), the level of disruption caused by a technological acquisition can be managed. According to the literature, corporate and cultural differences, and the communication problems that these imply, are significant predictors of post-acquisition performance (Haspeslagh and Jemison, 1991; Kavanagh and Ashkanasy 2006; Stahl and Voigt, 2008). These become all the more significant in the case of high tech acquisitions, which require knowledge to be efficiently understood, shared and transferred between companies if the acquisition is to succeed (Ranft and Lord, 2002; Puranam et al., 2006; Heimeriks et al., 2012). Managers, this literature suggests, can control the level of disruption, and thus the performance of the acquisition, by choosing to invest in the integration (Graebner et al., 2010; Heimeriks et al., 2012; Colombo and Rabbiosi 2014; Cefis and Marsili, 2015). High tech acquisitions fail, in other words, they suggest, because of organisation challenges, and managers that under-invest in ensuring that predicted synergies are realised.

3. Hypotheses

The existing literature assumes, implicitly, that firms exist in an 'aspatial world' (Howells and Bessant, 2012). The majority of studies evaluating the impact of mergers and acquisitions on R&D investment and technology performance tend not, for example, to differentiate between domestic and cross-border deals (Bertrand, 2009), and as a result empirical insights on the role of geography on post-acquisition innovative performance remain scarce (Prabhu et al., 2005; Cefis et al., 2009). Geography is, however, known to play a role in mergers and acquisitions (Böckerman and Lehto, 2006; Ellwanger and Boschma, 2013; Chakrabarti and Mitchell, 2015), and two literatures – transaction cost theory and international business theory – led us to suggest that the impact of geography may even be amplified in the case of technological acquisitions. Geography creates "real" hurdles, both literatures suggest, which interfere with the manager's ability to realise the benefits of the acquisition.

3.1. Transaction cost theory and the liability of distance

The transaction cost literature states that – even in the face of easier travel and extensive telecommunication connections (Sorenson and Baum, 2003) – geographic distance should impact firm performance (see e.g., Green and Cromley, 1984; Hannan and Rhoades, 1987; Schildt and Laamanen, 2006) for a number of reasons.

Firstly, geographic distance increases transaction costs (Grote and Umber, 2006). Integrating an acquisition requires an exchange of goods and workers (Capron et al., 1998). The greater the distance between the target and the acquirer, the more time consuming and costly these exchanges become (Grote and Umber, 2006). As geographic distance increases the cost of integration, it reduces the acquiring firm's willingness to make the sorts of exchanges necessary to maximise the value of the acquisition (Capron et al., 1998). Distance, therefore, decreases performance.

Secondly, geographic distance increases monitoring and agency costs (Böckerman and Lehto, 2006). Agency theory suggests that poorly monitored managers are more likely to act in a self-interested way. Geographic proximity improves monitoring, or at least decreases the costs of monitoring (Green, 1990; Ashcroft et al., 1994; Lerner 1995; Sorenson and Stuart 2001; Zook 2002), and because of this, 'closer' targets are more likely to be monitored and less likely to engage in value-destroying agency.

Finally, geographic distance reduces the benefits of so-called 'soft information' – that is, the sort of information that is difficult to quantify, such as an acquiring party's ...'vision, motivation, goals, expectations, ideas, [and] opinions' (Chakrabarti and Mitchell, 2013, p.1809) – for at least three reasons. Firstly, and in terms of efficient communication, research indicates that distance increases communication difficulties (Jaffe et al., 1993; Maurseth and Verspagen, 2002; Greunz, 2003; Cummings, 2007), as well as the costs of seeking and of integrating relevant knowledge (Borgatti and Cross, 2003; Cummings and Ghosh, 2005). Secondly, and in terms of tacit information – that is, information about moods and feelings, for example – research indicates that tacit information is not easily transferable over distance (Polanyi, 1958; Knoben and Oerlemans 2006) and presumes 'face-to-face' contact and spatial proximity (Von Hippel, 1994; Morgan, 2004). Finally, and in terms of unrequested information, distance matters because by being proximate to the deal investors get information without having to ask for it, just by, for instance, 'bumping into people and chatting with them' (Storper and Venables, 2004). Geographic proximity, in other words, creates 'informational advantages' (Lewis 1999; Strong and Xu 2003; Ahearne et al., 2004; Malloy 2005; Dvořaík, 2005; Chan et al., 2005), meaning that 'closer' acquirers are exposed to more information than distant acquirers, and are more likely, to outperform distant acquirers when it comes to rendering innovative output.

Thus, because geographic distance increases transaction and monitoring costs, while reducing the benefits of soft-information, we argue that the distance between the target and the acquiring firm will impact post-deal innovative performance.

Hypothesis 1. *The geographic distance between the target and the acquirer negatively impacts the post-acquisition innovative performance of the firm.*

3.2. International business theory and the liability of foreignness

The international business literature suggests that – even in the face of globalization and increasing cultural convergence (Jenkins, 2006) – national borders matter.

Borders bring a number of notable costs. Firstly, borders imply institutional differences. Differences between the political, economic and regulatory environments of the home and host country increase the costs of cooperation (Davidson and McFetridge, 1985), and decrease, therefore, the probable success of a cross-border acquisition. Secondly, borders imply cultural differences. Culture shapes the way in which people communicate, make decisions and resolve conflicts (Laurent, 1983; Chevrier, 2003). Culture matters in mergers for three reasons. Firstly, culture impacts the way in which the acquisition negotiation is concluded. Research shows that cultural differences increase negotiation times (Walsh, 1989), increasing uncertainty, which increases the risk of employee exit and decreases both operational and innovative performance (Shane, 1993; Reus and Lamont, 2009). Secondly, culture impacts how and with whom partners interact (Singelis and Brown, 1995; Hofstede, 2001). Research shows that people prefer to communicate with members of the same or a similar culture (Lane et al., 2006), which makes it difficult to integrate cross-border workforces (Reus and Lamont, 2009). Thirdly, culture matters because cultural differences create 'them and us situations' (Huntington, 1993), which not only end up framing the conversation between the two organizations (Luo, 2001), but can make target firm employees feel excluded (Krug and Hegarty, 1997), triggering conflict and mistrust between the target and the acquirer (Cartwright and Cooper, 1992; Datta and Puia, 1995). This leads, at best, to inefficiencies and at worst to employee dysfunction and to the loss of the key talent that motivated the deal. Because the performance of high tech acquisitions depends so much on the efficiently sharing and transfer of information between companies (Ranft and Lord, 2002; Puranam et al., 2006; Heimeriks et al., 2012), cultural differences complicate cross-border acquisitions.

Beyond these cultural and institutional differences, however, borders matter because borders introduce a 'liability of foreignness' (Hymer, 1976). This is the set of costs "based on a particular company's unfamiliarity with and lack of roots in a local environment, the costs resulting from the host country environment, such as the lack of legitimacy of foreign firms and economic nationalism, and the costs from the home country environment, such as the restrictions [in terms of with whom the firm can do business]" (Zaheer, 1995; p.342). Eden and Miller (2001) use the metaphor of a "stranger in a strange land" (p. 4) to summarise: the "stranger", they suggest, is someone that the locals do not know or understand, leading to a discrimination hazard, and the "strange land", they suggest, leads to an unfamiliarity hazard, with respect to the local cultural, political, economic and regulatory environments. In the context of cross-border acquisitions, this sort of 'foreignness' suggests that, even in the absence of cultural and institutional differences, cross-border firms are at a disadvantage when it comes to accessing and to understanding their market. The existence of this liability has been the fundamental assumption driving theories of the multinational enterprise (Buckley and Casson, 1976; Dunning, 1977; Caves, 1982; Hennart, 1982) and empirical research has consistently shown it to be an empirical fact in terms of firm performance and survival rates (Zaheer, 1995; Young and Nolle, 1996; Zaheer and Mosakowski, 1997; Miller and Parkhe, 2002; Mezias, 2002). In a high tech context, 'foreignness' implies more delays, more disruptions, and more costs, and therefore 'foreignness' disadvantages the cross-border acquirer.

Thus, because borders interrupt the flow of information, and because borders imply cultural and institutional complications, as well the costs, delays and disruptions that are implied by 'foreignness', we hypothesize that domestic technological acquisitions will outperform international cross-border technological acquisitions, in terms of the post-acquisition innovative performance of the newly created firm.

Hypothesis 2. Domestic technological acquisitions will outperform international cross-border technological acquisitions.

4. Methods

4.1. Samples

4.1.1. Acquisition sample

We use *Thomson SDC* to build our acquisition sample. We refine this to include all acquisitions announced: (1) between January 1, 2003 and December 31, 2008; (2) which do not involve a recapitalisation, repurchase of own shares or a spin-off to existing shareholders. We only include deals by: (3) publicly listed acquirers; (4) seeking to buy 100% of the target shares at announcement; (5) in high tech industries. Following Cloodt et al. (2006), we define high tech industries to mean the aerospace and defence (SIC-codes 372 and 376), computers and office machinery (SIC-code 357), pharmaceuticals (SIC-code 283) and electronics and communications (SIC-code 36) industries. In doing so, we create an initial sample of 4731 acquisitions. Because it is not possible for us to attribute performance changes to one deal or another in the case of multiple acquisitions, we exclude all repeat acquirers from our sample. This reduces our sample to a set of 3683 technological mergers and acquisitions.

4.1.2. Patent sample

We collect the patent date from the *US Patent and Trademark Office* (USPTO).

We chose to use one database to avoid problems of double-counting (Hagedoorn and Cloodt, 2003),[3] and problems concerning the consistency, reliability and comparability of national patenting systems (Ahuja and Katila, 2001). We opted to use the USPTO because research suggests that the size and importance of the US market, its technological sophistication, and the level of protection it offers, makes it necessary for both US and non-US firms to file their patent applications in the US (Patel and Pavitt, 1991), but also because the vast majority of our sample involves US firms. In the results section, we demonstrate that relying on the USPTO, despite the fact that our sample includes acquirers from 52 countries, does not bias our results.

We collect the patent data manually, and use the firm's name, as listed in the acquisition databases, to search for each firm for each year.[4] For the 7366 firms in our sample, this equates to 58,928 patent queries, and results in a sample that includes 1,117,806 patent applications. In each case, we record the number of patent applications, made by each firm, four years on either side of the focal acquisition.[5]

[3] Double-counting here refers to situations in which Firm A applies for Patent B in Country C. By using more than one patenting system, it is likely that Patent B, registered in Country D will be counted as a second patent, when in fact it is the same patent registered in a different country.

[4] If a firm, listed in the acquisitions database, was not listed in the patent database, we double-checked the name, to ensure that the correct name was listed. Only after that process did we record a zero.

[5] We count only the number of patent applications that each firm makes, and do not distinguish between single and joint applications. In other words, if Firm A and Firm B jointly apply for Patent C, our approach counts Patent C twice. While in many situations this sort of double-counting could be problematic, it is not in ours given that we are simply interested in discovering if the participating firms were involved in more or less patent applications after an acquisition than forecast.

Because we use the firm's corporate name in our search, our sample includes patent application by the parent firm, and by subsidiaries that Belderbos et al. (2014) term "name variants of the parent firm". Many studies use just the parent firm's patent applications (see e.g., Hagedoorn et al., 2006), and make no mention of subsidiaries. Others argues that, for legal reasons, but also for strategic reasons – in terms of publicly defining the markets that in firm intends on competing (Arora et al., 2014; Ayerbe et al., 2014) – the majority of patents tend to be registered with the parent anyway. Belderbos et al. (2014) quantify this fact, and show that 82% of patents are registered by the parent firm, and that "18% of firm patents, on average, are filed under the name of firm subsidiaries or name variants of the parent firm". Thus, by including both the parent and the subsidiaries that were "name variants of the parent firm", we improve upon the standard approach of only using the parent, as patenting source, and capture something in excess of the 82% of the firm's patents.

4.2. Dependent

4.2.1. The event study methodology

An event-study is a tool used for assessing the way in which an event – such as an acquisition – causes a change in the value of a firm (Brown and Warner, 1985). In an event study, historical data is used to forecast 'normal' performance at a future date. Comparing this 'forecast' of how the firm should have performed – in the absence of an event – with 'actual' data on how the firm actually performed – in the presence of the event – provides an indicator of the firms 'abnormal' performance. This is the change in value, above or below the firm's expected value, attributable to the event. This technique has been applied to quantify the impact of different events, and it is, today, the most commonly employed measure of acquisition performance in the strategic literature (King et al., 2004; McNamara et al., 2008; Zollo and Miere, 2008).

4.2.2. An innovation based event study

In a traditional event study, stock prices are used to describe performance, and a positive abnormal return is interpreted to suggest that an acquisition was a success, because the associated firm's market value increased more than was expected. We use a modified version of the event study, which we apply to the firm's patent portfolio to describe the way in which an acquisition caused the firm to deviate from its expected innovation trajectory. We estimate abnormal returns – in terms of the number of patents attributable to the acquisition – as follows. Firstly, and as described above, we collect the number of patent applications made by both the target and the acquiring firm four years before and four years after an acquisition. Next, and using the number of pre-acquisition patent applications made by the target and acquiring firms, in each of the four years before the acquisition, we linearly forecast the number of patent applications that the two should have made, had they remained independent. Finally, and by comparing the actual number of patent applications that the two firms made with the forecast of what they should have made had they remained independent, we identify the number of patent applications that the newly created firm made, above or below the forecast.[6] Fig. 1 graphically summarises our approach. The resultant abnormal returns variable that we create is the product of two count variables, but is itself a non-count variable, that varies, in our case, between −494 and +1365 patents.

4.2.3. Analysis of the abnormal returns

We estimate the number of abnormal patents to the newly created firm for each of the four years after the acquisition. In our analysis, however, we focus in on the abnormal returns one year after the acquisition – and only make use of the other abnormal patent measures for robustness checking purposes – for a number of reasons.

Firstly, research suggests that: (1) given the high premiums demanded by the market for technology-based companies, acquirers are most keen to produce results in the first year to signal the success of their deal (Byrne, 1998; Valentini 2012), meaning that if there is an effect, it should be readily observable; (2) swift post deal integration yields the best results, particularly in the case of acquisitions with low external and high internal relatedness (Homburg and Bucerius, 2006), meaning that any effects are likely to be realised sooner rather than later; and (3) increasing levels of employee turnover due, for example, to differences in management style or the new 'lay of the land' in terms of internal political and hierarchical relations (Krug, 2009), mean that any benefits are either directly reaped, or lost. In other words, we focus on the first year, because in the first year we expect an observable effect from the acquisition.

Secondly, and from a more methodological perspective, the further we move from the acquisition: (1) the greater the number of unidentifiable variables, such as the way in which the acquisition was managed and (2) the greater the level of forecasting error. In other words, we focus on the first year, because the first year is the most reliable.

4.3. Independents

We use *Thomson SDC* to identify the addresses of both the target and the acquiring firms. We collect data at the city- and country-levels. Using this we identify: (1) Acquirers that cross borders in search of foreign targets. To do so, we programme a dummy variable, to distinguish between deals in which the target and the acquirer are/are not in the same country. (2) The distance between the target and the acquiring firm. To do so, we first identify the GPS coordinates of both the target and the acquiring firm, using GPS Visualizer.[7] Then, using the Haversine formula, we calculate the distance between the GPS addresses of the two firms.

Our sample includes acquirers from 52 countries and targets from 63 countries. Table 1 is a matrix of the relationships within our data, using each country's ISO Alpha 2 country codes.[8] It shows, for example, that Emirati acquirers (Row AE) acquired one Austrian (AT) target, one Canadian (CA), and one form the United States (US). The average distance between partners is 1745 km (or 1084 mi) – this is equivalent to the distance between Chicago and Houston – and 35% (n = 1310) of the deals in the sample involve cross-border partners. For illustration, Fig. 2 locates each of the acquirers in our sample, and links them to their targets. In doing so, it illustrates both the global nature of the market for technological acquisitions, and the fact that high tech acquirers do, in reality, make distant and cross-border deals.

4.4. Controls

We add three types of controls to our model:

[6] Because the vast majority of acquisitions in our sample are 100% acquisitions, the vast majority of targets cease to exist as independent, patent-registering entities after the acquisition. To ensure that total number of patent applications by the newly created firm is included, however, we do not assume that the target ceases to exist, but check if it patented in any of the four years after the acquisition. If it did, then its patents were added to the acquirers.

[7] http://www.gpsvisualizer.com/.

[8] https://www.iso.org/obp/ui/#search.

Table 1
Matrix of Acquirers (Rows) and Target (Columns).

	AE	AG	AR	AT	AU	BE	BG	BH	BR	CA	CH	CL	CN	CO	CY	CZ
AE				1						1						
AR			1													
AT				4						1	2					1
AU					30			1		1						
BE				1		3					1					2
BG							3									
BR									6							
CA					1	2				103	1		1			
CH				2		2				5	26					
CL												1				
CN													73			
CO																
DE				1		1	1				8		1			1
DK					1					2	2					
ES					1				1							
FI				1						2	1					
FR			1			2			3	3	4		3			1
GR															1	
HK					1								6			
HR																
ID																
IE					1											
IL																
IN						4	1			1	2		1			
IS							1						1			
IT									1		1		2			
JP													1	1		1
KR										1			1			
KY										1			1			
LT																
LU																
LV																
MX																
MY																
NL					1	1				3		1	2			
NO													1			
NZ					3					1						
PK																
PL											1					
PT													1			
RO																
RU																
SE					1	1				1	2					
SG											1					
SK													1			
TR																
TW				1									1			
UA																
UK						1				4	3		1			1
US	1	1		1	18	4	1		1	69	13		11			1
VG					1											
ZA																
Total	1	1	2	12	59	21	7	1	12	199	68	2	109	1	1	8

	DE	DK	ES	FI	FR	GR	GT	HK	HR	HU	ID	IE	IL	IN	IT	JM
AE																
AR																
AT	1	1												1		
AU	2				2										2	
BE	6				6	1				1					4	
BG																
BR													1			
CA	4	1	1	1	3			2					4	2		
CH	7	1	2		1							1			1	
CL							1									
CN								3		1						
CO																
DE	51	2	1	1	5								1	1	2	
DK	3	8			3							1				
ES	2		19		4											
FI	5	2		8	2			1						2		
FR	2		3	1	46			1					1	1	2	
GR					1	1										
HK								17								
HR			1						1							
ID											2					
IE					1							1	1			
IL													9	1	1	
IN	5		1		2							1		24	3	
IS		1	2											1	1	
IT	1	1	5		2							1			12	
JP	3							1						1		
KR																
KY																
LT																
LU				1												
LV																
MX																
MY								2			1					
NL	4	2	1		1			1								
NO	1				1											
NZ																
PK																
PL																
PT												1				
RO																
RU																
SE	3	4		2	1										2	
SG	1							1						2		
SK																
TR																
TW				1												
UA																
UK	11	4	3	2	9				1	1		5	2		4	1
US	54	7	6	6	25			4	2	1		8	19	11	5	
VG																
ZA																
Total	166	34	45	23	115	2	1	33	4	4	3	19	38	47	39	1

	JP	KE	KR	LU	LV	MC	MX	MY	NL	NO	NZ	PE	PK	PL	PR	PT
AE																
AR																
AT														1		
AU								1			3					
BE									2							1
BG																
BR																
CA			2						3						1	
CH									1							
CL																
CN																
CO																
DE							1		2	2						1
DK										5						
ES						1								1		2
FI							1			2						
FR									1							
GR																
HK							1									
HR																
ID																
IE																
IL															1	
IN	2						1		1							
IS																
IT	1								1							2
JP	170		1													
KR			28													
KY																
LT														1		
LU																
LV					2											
MX							1									
MY																
NL				2					11		1					
NO									1	4	1					
NZ											5					
PK													1			
PL				1										1		
PT																4
RO																
RU																
SE									1	5						
SG																
SK																
TR																
TW									1							
UA																
UK													1			
US	2	1	2	1			2		11	4		1		1	1	1
VG																
ZA																
Total	175	1	33	4	2	1	7	1	36	22	10	1	2	5	3	11

	RO	RS	RU	SA	SE	SG	SK	TH	TR	TW	UA	UK	US	VE	ZA	Total
AE													1			3
AR																1
AT							1						2			15
AU						1						4	12			59
BE					2							5	2			37
BG													1			4
BR													2			9
CA					2					1		4	75			214
CH												2	24			75
CL																2
CN													2			79
CO														1		1
DE		1	2		2	1	1			1		11	16			118
DK					3	1						1	10			40
ES												1	1			33
FI					2							1	10			40
FR					1	1			3			8	31			119
GR																3
HK						1							1			27
HR																2
ID																2
IE												2	3			9
IL	1											2	10			25
IN	1											7	13		2	72
IS	1		1						1				3			13
IT												3	5			38
JP								2				3	17			201
KR													1			31
KY													1			3
LT							1									2
LU																1
LV					1											3
MX																1
MY						2						1				6
NL												1	15		1	48
NO					1							5	4			19
NZ													2			11
PK																1
PL																3
PT												1				7
RO	1															1
RU			10													10
SE					22					1		4	4			54
SG						12										17
SK																1
TR									2							2
TW										3			3			10
UA											1					1
UK				1	4	1				1		121	91		1	274
US			2	1	12	4				12	1	80	1521		2	1931
VG																1
ZA															4	4
Total	4	1	15	2	52	24	3	2	6	19	2	267	1883	1	10	3683

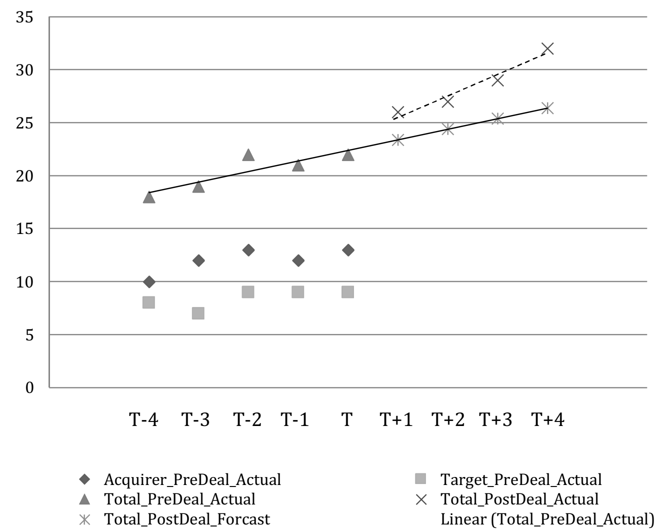

Fig. 1. Abnormal patent.

Fig. 2. Borders and Distance in Technological Acquisitions.

Firstly, research suggests that a number of non-geographic measures can be proxied by the sorts of geographical factors of interest in this study. The most commonly described are cognitive distance – that is, differences in the absorptive capacity of the target and the acquiring firm – organisational distance – that is, differences in the level of organisational overlap between the firms – social distance – that is, differences in the levels to which relationships are socially embedded within the firm – cultural distance – that is, the level of cultural similarity between the home and host nations of the two firm – and institutional distance – that is, the level of institutional distance between the home and host countries of the target and the acquiring firm (Rallet and Torre 1999; Boschma, 2005). Given the limitations implied by the level of our analysis, we control for: (1) the level of cultural distance between the home and host countries (*Cultural_Distance*), using the standard Hofstede cultural measures; and (2) the level of institutional distance between the home and host countries (*Institutional_Distance*), using the standard IPD[9] institutional measures.

Secondly, we control for other factors that are likely to impact the level of innovation following an acquisition. We control for: (1) the acquirer's *Research and Development* expenditure, in dollars, using data collected from Datastream, because the level of

[9] The IPD (Institutional Profile Database) is developed by the French Development Agency (AFD) the European Union's Directorate General of the Treasury, the Centre for Prospective Studies and International Information (CEPII) and the University of Maastricht Graduate School of Governance and is routinely used in institutional research. It reports on the institutional quality of 143 countries, using 130 indicators, derived from 330 variables, grouped into nine areas: (1) political institutions; (2) security, law and order, control of violence; (3) functioning of public administrations; (4) free operation of markets; (5) coordination of stakeholders, strategic vision and innovation; (6) security of transactions and contracts; (7) market regulations, social dialogue; (8) openness; (9) social cohesion and social mobility. The data is publically available at: http://www.cepii.fr/institutions/EN/ipd.asp.

investment made in innovation is likely to impact its innovation; (2) the *Percent Acquired*, using data reported in the SDC, because the percentage acquired is likely to impact the level of collaboration between the firms, and thus the expected level of innovative output; (3) the *Free Cash to the Acquirer* – which we calculate, using data collected from Datastream, by dividing the operating profits over the last 12 months by the market value 4 weeks prior to the announcement – because successful innovation requires the firm to have a significant 'cushion of liquidity'; (4) the level of relatedness, using a number of *Related Target Indicators,* which we set equals to 1 if the SIC codes of the target and the acquirer share the same first (1-digit), first-two (2-digit), first-three (3-digit) and four (4-digit) digit, and are therefore in the same industry, because related firms are more likely to realise synergies.[10]

Finally, we control for other factors that are likely to impact the level of innovation in an acquisition. We control for: (1) acquirer's *Prior Financial Performance*, in terms of its return on assets (ROA) at the end of the year before the year of the acquisition, using data collected from Datastream, because better performers make better acquisitions (McNamara et al., 2008); (2) the acquirers *Market-to-Book* ratio, using data collected from Datastream, because 'glamour firms', with high market values and low book values, are known to make poorer performing acquisitions; (3) *Acquirer Size*, which we proxy using the number of employees, using data collected from Datastream, because larger acquirers are known to underperform; (4) the status of the target (*Public/Private Target*) – which we identify, using data collected from the SDC, using a dummy variable set equals to one if the target was listed as private and otherwise zero – because public targets outperform private targets; (5) a *Hostile Deal Indicator* – which we identify, using data collected from the SDC, with a dummy set equal to 1 if the deal was hostile – because deal hostility impacts deal performance.

Table 2 reports the correlation and descriptive statistics for our key variables. We winsorized each control variable, between 0.5% and 99.5%, to remove extreme outliers. We test each of the controls for normality, using a Shapiro-Wilk test, and employed the logs of any variables (*Prior Performance, Market-to-Book, Research & Development, Acquirer Size,* and *Free Cash to the Acquirer*) which failed this test.

4.5. Estimation

For the main analysis, in which we consider the impact of distance and borders on the abnormal patent measure in the year after the acquisition, we make use of standard OLS regression techniques. This is appropriate, because while our dependent variable looks like a count variable, it is actually the normally distributed difference between two count variables: the actual and expected number of applications. In all cases, we control for unobserved effects by including year dummies, we correct for industry clusters using the target and acquiring firm's 3-digit SIC codes, and adjust all standard errors for heteroscedasticity. Additionally, however, and as a robustness check, we make use of a number of additional dependent variables, different model specifications, and different estimation techniques, all of which are described below.

[10] Research shows that it is of value to control for technological distance (Fischer et al., 2006), ideally by constructing a measure of technological proximity, using patent citations (e.g., Maurseth and Verspagen 2002). As our level of analysis and data does not allow for such robustness check we highlight this as an area for future research.

5. Results

5.1. Pre-acquisition normal patenting behaviour

The data suggests that the average acquirer in the sample made 36 patent applications in the year before the acquisition, and 156 over the four years prior to the acquisition, while the average target made 1.25 applications in the year before the deal, and 4.6 patent applications over the four years prior to the deal. Thus, it appears that, on average, acquisitions in the high tech industry tend to be prolific patenters acquiring less prolific patenters. Unfortunately, it is impossible to comment on the commercial value of those patents or the levels of innovation that they entail. Because the average deal was worth $313.4 million, it is reasonable to suggest, however, that these targets were involved in commercially interesting and innovative research and development.

5.2. Post-acquisition abnormal patenting behaviour

In total, the 7366 firms in our sample made 1,117,806 patent applications in the period 2000–2012, and the 3683 acquisitions in the period 2003–2008 contributed, on average, 15,060 additional patent applications. So, net effect of technological mergers and acquisitions has been positive for patent applications. As Table 2 shows, the impact of these acquisitions on the firm was also positive; the average firm made +2.16 more patent applications in the first year after the acquisition than it and the target had been forecast to make, had they remained independent. This rises to +3.06 in the second year, +5.09 in the third year and +6.89 in the fourth year. It is important to note, however, only 21.04% of firms beat their forecast[11] and therefore made more patent applications in the year after the acquisition than was expected. Of the remainder, 45.75% of firms achieved their forecast or, put another way, had no effect from the acquisition, and 33.25% made fewer applications than forecast. In other words, 79% of the acquisitions did not improve the innovative position of the firm. This tallies nicely with the suggestions of scholars, who claim that 65–85% of acquisitions fail to add financial value (see McCarthy and Dolfsma, 2012 for a review) and demonstrate concretely the risks of technological acquisitions.

5.3. Acquisitions, innovations and firm geography

Table 3 reports the result of 8 OLS models, hierarchically testing our hypotheses on the impact of geography on the firm's post-acquisition abnormal patenting behaviour.

In each of the models: (1) the dependent variable is the number of abnormal patent applications, made by the newly created firm, in the first year ($t+1$) after the deal; (2) we control for (but do not report) unobserved effects, by including year dummies; (3) correct for industry clusters, using the target and acquiring firm's 3-digit SIC codes; and (4) report standard errors that have been adjusted for heteroscedasticity.

Before interpreting the results, we check the base specification for multi-collinearity. A variance inflation factor (VIF) test reveals that the highest VIF for a single variable is 1.38, with a mean of 1.13. These values are well below the established cut-offs of 5 and 10 (Hair et al., 1992; Studenmund and Cassidy, 1992), used to indicate multi-collinearity. As a result, we can conclude that multi-collinearity is not a concern.

[11] This number varies from 15% in the aerospace and defence (n = 249), and 16% in pharmaceuticals (n = 1467), to 24% in electronics and communications (n = 1279) and 26% in the computers (n = 688).

Table 2
Descriptive Statistics.

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Abnormal1	2.16	47.13	−494	1365.8	1.00													
2	Distance_KM1000	0.17	0.22	0	1.16	0.00 (0.85)	1.00												
3	International	0.36	0.48	0	1	0.01 (0.48)	0.63 (0.00)	1.00											
4	Related_1d	0.59	0.49	0	1	0.02 (0.32)	0.03 (0.07)	0.06 (0.00)	1.00										
5	Institutional Distance	0.03	0.07	0	1.66	0.00 (0.86)	0.35 (0.00)	0.54 (0.00)	0.03 (0.07)	1.00									
6	Distance Culture	0.67	1.44	0	14.65	0.04 (0.01)	0.43 (0.00)	0.63 (0.00)	0.06 (0.00)	0.39 (0.00)	1.00								
7	Prior Financial Performance (ln)	1.9	0.81	−3	6.42	−0.06 (0.03)	0.00 (0.96)	0.01 (0.64)	−0.04 (0.11)	0.03 (0.34)	0.00 (0.91)	1.00							
8	Market-to-Book (ln)	5.94	1.03	−0.96	14.42	0.03 (0.22)	−0.02 (0.50)	0.01 (0.64)	0.02 (0.33)	0.02 (0.31)	−0.01 (0.68)	−0.34 (0.00)	1.00						
9	Research & Development (ln)	11.96	2.98	1.1	20.24	0.08 (0.00)	0.04 (0.10)	−0.01 (0.84)	−0.14 (0.00)	−0.04 (0.09)	0.08 (0.00)	−0.03 (0.31)	−0.15 (0.00)	1.00					
10	Acquirers Size (ln)	8.24	2.58	0.69	13.07	0.07 (0.01)	0.12 (0.00)	0.06 (0.01)	−0.19 (0.00)	0.01 (0.76)	0.08 (0.00)	0.03 (0.24)	−0.17 (0.00)	0.79 (0.00)	1.00				
11	Free Cash to the Acquirer (ln)	−2.81	0.89	−9.1	5.29	−0.07 (0.01)	0.04 (0.11)	0.02 (0.57)	−0.08 (0.00)	0.01 (0.72)	−0.01 (0.67)	0.89 (0.00)	−0.35 (0.00)	0.00 (0.91)	0.02 (0.46)	1.00			
12	Public/Private Target	0.12	0.32	0	1	0.02 (0.20)	0.02 (0.29)	−0.03 (0.08)	0.04 (0.01)	−0.04 (0.03)	−0.02 (0.17)	0.00 (0.97)	0.01 (0.83)	0.13 (0.00)	0.12 (0.00)	0.04 (0.17)	1.00		
13	Hostile Deal Indicator	0.03	0.18	0	1	−0.02 (0.34)	0.02 (0.30)	0.03 (0.11)	0.04 (0.01)	−0.01 (0.53)	0.02 (0.32)	0.01 (0.81)	−0.02 (0.47)	0.09 (0.00)	0.11 (0.00)	0.02 (0.44)	0.50 (0.00)	1.00	
14	Percent Acquired	97.16	10.34	3.33	100	0.01 (0.53)	0.06 (0.00)	0.02 (0.18)	0.00 (0.77)	−0.02 (0.14)	−0.01 (0.75)	0.07 (0.02)	0.00 (0.99)	−0.05 (0.06)	0.04 (0.13)	0.11 (0.00)	−0.07 (0.00)	−0.02 (0.21)	1.00
	Correlations with significance levels in parentheses																		

Table 3
The Impact of Distance and Borders on Innovation.
VARIABLES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AB + 1	AB + 1	AB + 1	AB + 1	AB + 1	AB + 1	AB + 1	AB + 1
Distance_KM1000		−2.76***		−15.93**	−16.27**	−19.72**	−17.56**	−19.00***
		(−4.312)		(−2.022)	(−2.146)	(−2.510)	(−2.442)	(−3.179)
International			4.12**	9.10*	8.79**	0.06	9.41**	3.15**
			(2.075)	(1.944)	(2.104)	(0.053)	(2.020)	(1.498)
Technological Distance					7.36	7.16	7.52	7.01
					(0.777)	(0.851)	(0.798)	(0.837)
Cultural Distance						5.10***		5.37***
						(3.451)		(2.864)
Institutional Distance							0.20	36.61
							(0.012)	(1.616)
Prior Financial Performance (ln)	4.34	4.35	3.82	3.28	2.58	3.51	3.76***	3.28
	(1.276)	(1.280)	(1.217)	(1.147)	(1.319)	(1.177)	(2.759)	(1.117)
Market-to-Book (ln)	5.00***	5.00***	4.95***	4.88***	4.86***	4.87***	5.23***	5.11***
	(4.658)	(4.527)	(5.145)	(4.871)	(6.247)	(10.591)	(6.240)	(8.122)
Research & Development (ln)	2.57	2.57	2.59	2.62	2.56	2.47	2.73	2.43
	(0.907)	(0.904)	(0.920)	(0.926)	(0.864)	(0.924)	(0.929)	(0.900)
Acquirers Size (ln)	−0.29	−0.27	−0.33	−0.26	0.18	0.31	−0.02	0.28
	(−0.136)	(−0.126)	(−0.157)	(−0.125)	(0.106)	(0.197)	(−0.011)	(0.171)
Free Cash to the Acquirer (ln)	−9.99	−9.99	−9.57	−9.10	−8.15**	−8.72***	−8.76***	−8.09***
	(−1.643)	(−1.638)	(−1.649)	(−1.639)	(−2.017)	(−4.732)	(−2.715)	(−6.221)
Public/Private Target	5.02	5.06	5.18	5.58	5.13	4.86	5.55	5.74
	(0.687)	(0.686)	(0.726)	(0.766)	(0.750)	(0.737)	(0.724)	(0.803)
Hostile Deal Indicator	−14.17	−14.25	−14.60	−15.64	−16.39	−16.46	−16.19	−15.39
	(−1.013)	(−1.021)	(−1.047)	(−1.127)	(−1.041)	(−1.149)	(−1.009)	(−1.075)
Percent Acquired	0.31	0.31	0.31	0.34	0.35	0.38	0.36	0.41
	(1.264)	(1.268)	(1.315)	(1.374)	(1.211)	(1.237)	(1.267)	(1.224)
Constant	−104.36	−104.41	−103.28	−102.28	−106.33	−111.66**	−113.59*	−136.87***
	(−1.267)	(−1.262)	(−1.279)	(−1.273)	(−1.213)	(−2.089)	(−1.812)	(−3.558)
Observations	3683	3683	3683	3683	3683	3683	3683	3683
Adjusted R-squared	0.015	0.024	0.025	0.025	0.026	0.030	0.025	0.029
F-Values	6.708	6.944	8.059	7.709	6.285	5.647	7.205	7.107

t-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Each model is estimated with year dummies. In all cases, we cluster by acquirer and target industry

Model 1 presents the base set of control variables. The relatively low adjusted r-squared here – 1.5% – is typical of event studies and not therefore of concern.[12]

To this, *Model 2* first adds the distance between the target and acquiring firm in thousands of kilometres. A negative and significant coefficient indicates that distance is, as predicted, negatively and significantly related to the post-acquisition abnormal innovative performance of the combined firm. The coefficient suggests that every thousand kilometres costs the newly combined firm 2.76 patent applications.

Model 3 adds the international dummy to the base specification. A positive and significant coefficient – in contradiction to our expectations – indicates that, all else equal, international deals result in 4.12 patents above expectation. In doing so, we not only fail to support the suggestion that international borders create costs, but actually show that, in technological mergers and acquisitions, borders actually create value.

In *Model 4*, both the distance and border variables are entered simultaneously to confirm the main effect in each other's presence. *Models 5–7* then hierarchically add the other distance measures described to this specification. *Model 5* adds the proxy for technological distance,[13] *Model 6* adds the measure of cultural distance, and *Model 7* adds the measure of institutional distance. Finally, *Model 8* presents the complete model, in which all factors are entered simultaneously.

Each model paints a consistent picture of the impact of geographic distance and borders on the post-acquisition innovative performance of the newly combined firm. The results of *Model 9* suggest that, controlling for the other distance measures, every 1000 km costs the newly created firm 19 patent applications, in terms of what was forecast before the deal, while crossing a national border leads the same firms to improve upon its patent forecast by 3.15 additional patent applications.

5.4. Additional analyses

We perform a number of additional analyses as robustness checks.

1. We re-estimate the models using the other abnormal patent dependents.

We use the two, three, and four-year abnormal patent measures in place of the one-year measure used in the main analysis to

[12] For example: writing in the *Journal of Finance*, Moeller and Schlingemann (2005) use an event study, and OLS estimation, to investigate the performance of 6596 mergers and acquisitions, and report adjusted R-squares of 2.4–5.6% (p.775); writing in the *Journal of International Economics*, Morck and Yeung (1992) use an event study, and OLS estimation, to investigate the announcement of 322 internationalisations, and report R-squares of 0–4.3% (pg. 49); writing in the *Strategic Management Journal*, Muller and Kräussl (2011) use an event study, and OLS estimation, to study the announcement of 354 corporate disaster donations, and reports adjusted R-squares of 4–6% (p.919); and writing in *Research Policy*, McNamara and Baden-Fuller (2007) use an event study, and OLS estimation, to investigate the financial returns to R&D announcement by biotechnology firms, and report R-squares of 1–7%, using a sample of 180 firms, and 2–8% using a sample of 237 firms.

[13] We also ran this analysis using the other measures of relatedness – that is, the 2-digit, 3-digit and 4-digit measure – but do not report them because the results are effectively the same.

check for robustness. Our results – not reported but available upon request – confirm the main findings: distance is negatively related to innovation, and borders positively.

2. We re-estimate the models using disaggregated versions of the data.

We disaggregate the distance variable, splitting it into quartiles, to consider the impact of distance in each of the four distance segments. Deals within the 1st distance quartile are within 143 km, those in the 2nd are between 143 and 770 km, those in the 3rd are between 770 and 2541 km, and those in the 4th distance quartile are above 2541. Table 4 presents some of the results. *Model 1* shows that, within the 1st distance quartile (<143 km) distance does not matter, while *Model 2* shows that, within the 4th distance quartile (>2541 km) every additional 1000 km costs the firm 39.26 lost patent applications. *Models 3* and *4* zoom in further, to consider the impact of distance on deals within the closest 10% (<6.3 km) and the furthest 10% (>5320 km) of the distribution. *Model 3* confirms the conclusion that distance doesn't matter in when two firms are in each other's back yard, and *Model 4* suggests that every additional 1000 km over 5320 costs 86.7 patents. Because there are too few border crossing acquisitions in the case of targets and acquirers within the 1st distance quartile, we do not repeat this exercise for border crossing dummy.

3. We re-estimate the models using other estimation techniques

Our dependent variable is a normally distributed, non-count variable, making ordinary least square regression the appropriate estimation technique. If, however, we only look at the positive side of the distribution – that is, the cases in which the number of abnormal patents to the newly created firm is positive – we may use a Poisson regression to measure the impact of our independent variables. Our results – not reported but available upon request –

support the suggestion that distance is negatively related to the positive number of post-acquisition patent applications, while borders are positively related to the positive number of post-acquisition patent applications.

4. We re-estimate the models using only US-Domestic deals

Our sample includes acquirers from 52 countries and targets from 63 countries. Using one national patenting system to measure the innovation output leads to credible suggestions of bias. For robustness, therefore, we re-test the basic model using only the 1512 US-domestic acquisitions in our sample. Table 5 presents the results. *Model 1* presents the base specification. To this, *Model 2* adds the distance variable, and *Model 3* adds the levels of relatedness. Both *Models 2* and *3* clearly demonstrate the negative effect of distance, and show that the potential bias of using only the USPTO database is not problematic. The size of the coefficient suggests, however, that our model may overestimate the scale of the impact of distance on post-acquisition innovative performance. Again, and for obvious reasons, we cannot estimate the impact of borders, or of cultural or institutional distance, in this setting.

6. Discussion & conclusions

1. Main findings

The literature on the performance of technological mergers and acquisitions ignores the impact of geography. The benefits of a technological acquisition – in terms of new knowledge, innovation and increased absorptive capacity – are assumed to be directly realizable, irrespective of where the target firm is located. Our starting point in this paper was not only to suggest that geography matters in mergers and acquisitions – insofar as the location of the target and acquiring firms in space impacts the realizability of the synergies – but that the costs implied by geography – as highlighted in the transaction cost and international business literatures – may even be amplified in the specific case of technological mergers and acquisition. We find that:

2. Most technological acquisitions end unspectacularly

The net effect of the technological acquisition in our sample was an increase in patent application; there were, on average, 15,060 more patent applications, per year, after these 3683 acquisitions, than forecast. From the perspective of an individual firm, however, the results are far less positive; we report that only 21% of firms in the sample beat their forecast, and were more innovative in the year after the deal than had been expected, that 45.75% had no effect from the acquisition and that 33.25% made fewer applications than forecasted. In other words, 79% of the acquisitions in our sample did not improve the innovative position of the firm. This demonstrates, quite concretely, the uncertainty that comes with technological acquisitions.

3. Distance impacts the innovative performance of a technological acquisition

Our results suggest that the physical distance between the target and acquiring firm, in kilometres, predicts the post-acquisition innovative performance of the firm. We report that every 1000 km costs 19 patents in terms of lost innovation. Or, put another way, every kilometre costs 0.019 patent applications. With the market value of a patent ranging between $400,000 to $1.25 million, based on the price paid by *Google* and *Microsoft*, it is clear that, in technological acquisitions distance quickly becomes a significant predictor of post-acquisition innovative performance. This finding fits with our expectation and the suggestions of the literature that distance increases transaction, monitoring, agency and asymmetric information costs, while at the same time reducing the benefits of soft information. Our findings contribute to the academic discussion on distance too (Howells, 2002; Boschma, 2005), because we isolate the impact of geographical distance, controlling for other distance measures. For managers the implications are obvious: stay local with technological acquisitions.

4. Borders matter, but as not in the way we expected

The international business literature argues that 'foreignness is a liability' (Zaheer, 1995) and, looking at financial performance indicators, finance scholars have confirmed that domestic acquisitions outperform cross-border acquisitions (Eckbo and Thorburn, 2000; Moeller and Schlingemann, 2005). Looking at the post-acquisition innovative performance of high tech acquisitions, however, our results suggest that the opposite is the case; all else equal, international, cross-border deals result in 3.15 abnormal patents. In doing so, we not only fail to support the suggestion that international borders create costs for acquiring firms, but support the suggestion that foreignness can be more of an asset than a liability (Nachum, 2010). Why might this be the case?

The international business literature states that borders imply both risks – in terms of cultural and institutional problems (e.g., Delios and Henisz, 2000; Hofstede, 2001; Brouthers, 2002) – and rewards – in terms of new products, new markets, new technologies, new customers, and new ways of doings things (e.g., Dunning, 1980; Dunning, 1988). The literature claims, furthermore, that the net effect is typically negative (Hymer, 1976; Zaheer, 1995), and that there is a 'liability of foreignness'. There are two possible explanations for why international technological acquisitions are different. Firstly, it could be that the rewards for expanding across borders are higher for technological acquirers. In other words, foreign technological acquisitions might offer acquirers more benefits than the average foreign acquisition. Secondly, it could be that the risks from expanding across borders are lower for technological acquirers. In other words, it could be that the sorts of costs predicted by the international business literature might be reduced in the case of high tech acquisitions.

The first suggestion unfortunately is not possible to test, given the level of our analysis, but the second is, using the Hofstede mea-

Table 4
Robustness Checking – Distance Quartiles.

	(1)	(2)	(3)	(4)
VARIABLES	AB + 1 Closest 25%	AB + 1 Furthest 25%	AB + 1 Closest 10%	AB + 1 Furthest 10%
Distance_KM1000	726.02	−39.26**	64.84	−86.73***
	(0.689)	(−2.113)	(3.450)	(−6.251)
Prior Financial Performance (ln)	−18.40	66.09**	78.50***	−16.62
	(−0.860)	(2.100)	(6.708)	(−0.928)
Market-to-Book (ln)	12.40***	3.70***	13.11	−10.09***
	(2.807)	(3.933)	(0.979)	(−3.344)
Research & Development (ln)	1.27	2.43	3.93**	2.65***
	(0.616)	(0.799)	(2.221)	(4.181)
Acquirers Size (ln)	3.39**	−1.10	4.54***	−4.25***
	(2.064)	(−0.319)	(12.361)	(−9.364)
Free Cash to the Acquirer (ln)	1.78	−72.01**	−90.86***	−24.95***
	(0.125)	(−2.025)	(−4.312)	(−3.230)
Public/Private Target	−22.66	27.80***	5.75	11.26
	(−1.161)	(3.016)	(0.260)	(0.460)
Hostile Deal Indicator	13.85	−33.43**	−41.17	−1.18
	(0.462)	(−2.331)	(−1.515)	(−0.056)
Percent Acquired	0.61*	−0.09	1.44	−0.83**
	(1.947)	(−0.270)	(1.092)	(−2.133)
Constant	−102.83**	−305.22***	−724.79***	173.87
	(−2.411)	(−3.134)	(−2.883)	(1.631)
Observations	729	1119	235	453
Adjusted R-squared	0.074	0.035	0.187	0.151
F	3.610	2.295	6.108	4.180

t-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Each model is estimated with year dummies. In all cases, we cluster by acquirer and target industry

Table 5
Robustness Checking – US-Domestic Deals.

	(1)	(2)	(3)
VARIABLES	AB + 1	AB + 1	AB + 1
Distance_KM1000		−7.53*	−7.61*
		(−1.900)	(−1.747)
Related Target Indicator			2.56
			(0.313)
Prior Financial Performance (ln)	−1.48	−1.46	−1.74
	(−0.423)	(−0.410)	(−0.400)
Market-to-Book (ln)	5.24***	5.29***	5.36***
	(4.457)	(4.630)	(3.876)
Research & Development (ln)	4.18*	4.18*	4.24
	(1.686)	(1.672)	(1.488)
Acquirers Size (ln)	−3.27*	−3.22*	−3.08**
	(−1.888)	(−1.806)	(−2.149)
Free Cash to the Acquirer (ln)	−2.27	−2.27	−1.96
	(−1.076)	(−1.076)	(−0.657)
Public/Private Target	5.02	5.06	4.61
	(0.687)	(0.686)	(0.666)
Hostile Deal Indicator	−4.99	−5.18	−5.33
	(−0.537)	(−0.563)	(−0.532)
Percent Acquired	0.33**	0.32**	0.35
	(2.362)	(2.245)	(1.598)
Constant	−65.81	−64.98	−69.30
	(−1.657)	(−1.631)	(−1.262)
Observations	1521	1521	1521
Adjusted R-squared	0.019	0.027	0.026
F	6.013	7.197	10.41

t-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Each model is estimated with year dummies. In all cases, we cluster by acquirer and target industry.

sure of cultural distance, and the IPD measures of institutional distance, which we include as controls in our model. The coefficients on these suggest that institutional differences do not play a significant role in predicting post-acquisition innovative performance, but cultural distance does. In fact, we find that, cultural distance predicts 5.37 abnormal patents, and moderation analysis (not reported but available upon request) suggests that as many as 3 of the 3.15 abnormal patents that come from cross-border acquisitions are attributable to cultural difference. Again, this finding runs contrary to most of the findings in the international business literature. Thus, while cultural differences usually present a hurdle to general acquirers – due to differences in language, behaviours and assumptions – cultural difference in the high tech sector seem to represent an asset. This may be due to the fact that different cultures have a tendency to approach the same problem in different ways (Shane, 1993), or simply because 'newness' leads to innovation (Zahra et al., 2000). Clearly, further work is warranted to understand the mechanism behind this empirical observation. For now, however, the result is clear: borders increases innovation in technological deals.

6.1. Limitations

As with all empirical research ours, of course, has a number of limitations.

Firstly, and in terms of the models that we employ, it is important to note that we do not control for level of social and organisational distance between the two firms, and only imperfectly control for the level of technological distance between the two. We do so because we are limited by the data that we employ and by the level of analysis of our study. We recognise, however, that these are important predictors of innovation, and that they strongly overlap with other geographical distance measures (Boschma, 2005), meaning that our model not only misses important variables, but misses variables necessary to fully isolate the effects that we aim to describe.

Secondly, and in terms of the data that we use, it is important to note that: (1) we only consider the case of once-off acquirers. We do so because, in the case of repeat acquirers, it is not possible for us to attribute a new patent to one deal or another. Nevertheless it might be that repeat acquirers behave differently, in terms of their post-acquisition performance, by virtue of the fact that they are experienced and as such may benefit from learning effects or benefits of scale. (2) We do not consider the value of the patents generated after the deal, but only the number. It may be, however, that while the number of patent applications increases after a deal, the quality or the financial value of the patent decreases, or vice versa. (3) Our data does not provide us with insights on the exact portfolio of patents, making us approach patents as singular entities of innovative outcome. Technological acquisition may, however, be aimed at creating patent portfolios, and may be aimed, in other words, at achieving a particular configuration of patents, irrespective of cost, but in financial and innovation terms.

Finally, and in terms of the dependent that we employ, it is important to note that what we do differs from the norm, in the financial literature, in two important ways: (1) financial event studies are conducted using stock market data, available at a daily rate, but we use patent data, collect at a yearly rate; and (2) financial scholars make forecasts using tens, if not hundreds of historical points, while we use only four. We recognise that our abnormal patent forecasts are likely to be less precise, and less accurate than the abnormal share price forecasts made by financial event studies.

6.2. Contributions

Much work needs to be done, of course, but our findings contribute in a number of important ways to the literature on technological acquisitions in general, and to an understanding of geography on post-acquisition innovative performance in particular.

Firstly, we demonstrate that while technological acquisitions make sense, from a societal perspective, they remain a gamble for the acquiring firm. In doing so, we offer practical insights on the post-acquisition performance of technological acquisitions. Secondly, we demonstrate the significance of geography-based measures of distance on the post-acquisition performance of a technological acquisition. In doing so, we relax the theoretical assumption that geography does not matter, because firms inhabit an 'aspatial world' (Howells and Bessant, 2012) and add to the limited empirical evidence on the relationship between innovation and geography (Prabhu et al., 2005; Cefis et al., 2009). Thirdly, we empirically separate the 'liability of distance and foreignness', which typically tend to be lumped together, even in the geographical literature (e.g. Zaheer, 1995; Larsson and Finkelstein, 1999; Qian, Li, Rugman, 2013), to demonstrate their individual effects on the firms innovation. We show that both matter, in the case of technological acquisitions, and not always as we expected. Finally, and as a methodological contribution, we introduce a new measure for post-acquisition innovative performance, in terms of innovation-based event study that we employ, which allows us to describe performance, not only in terms of what actually happened, but in terms of what was expected to happen too without the deal.

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