MANCHESTER INSTITUTE
OF INNOVATION RESEARCH

To acquire or not to acquire?
Duration of due diligence in technology acquisitions

BY

XAVIER CASTANER, PANOS DESYLLAS, HUMA JAVAID, ORIETTA MARSILI

MIOIR WORKING PAPER SERIES NO. 2023/02

MANCHESTER 1824
The University of Manchester

EXPLAINING THE LENGTH OF THE DUE DILIGENCE PROCESS IN TECHNOLOGY ACQUISITIONS: HOW LONG SHOULD ACQUIRERS EXAMINE A DESIRED TARGET BEFORE DECIDING OR NOT TO ACQUIRE IT?

Authors

Huma Javaid*

Alliance Manchester Business School

Manchester Institute of Innovation Research

The University of Manchester

Xavier Castaner

Department of Strategy, Globalisation and Society

Faculty of Business and Economics

University of Lausanne

Panos Desyllas

School of Management

University of Bath

Orietta Marsili

School of Management

University of Bath

This version: March 16, 2023

MIOIR Working Paper Series

**Corresponding Author: Huma Javaid, Alliance Manchester Business School, The University of Manchester, M15 9PB, United Kingdom.*
E-mail: huma.javaid@manchester.ac.uk

Acknowledgements: *The authors would like to thank participants and/or reviewers at the Academy of Management Annual Conference 2022, Strategic Management Society Annual Conference 2022 and European Academy of Management Annual Conference 2022 for helpful reviews and comments on the paper. An earlier version of the paper won the Best Paper Award by the EURAM (2022) Strategic Management Interest Group.*

EXPLAINING THE LENGTH OF THE DUE DILIGENCE PROCESS IN TECHNOLOGY ACQUISITIONS: HOW LONG SHOULD ACQUIRERS EXAMINE A DESIRED TARGET BEFORE DECIDING OR NOT TO ACQUIRE IT?

Abstract

Based on information economics and organizational learning literatures, we investigate how information asymmetry and uncertainty regarding the value of technological resources of target firms influence the due diligence process after an acquisition announcement is made by the acquirer. We study how information asymmetry between the acquirer and target firm captured by the technological distance between the two firms' patent portfolio extends the due diligence process. Additionally, we study how uncertainty about target firms' technological resources explained by the pending patent applications of target firms tends to prolong the duration of due diligence. Further, we argue that business similarity reduces information asymmetry between the acquirer and target firm and shortens the duration of due diligence. We test the predictions on a sample of acquisitions of privately held technology firms in the UK and find a significantly positive effect of targets' pending patent applications on due diligence duration that is amplified by technological distance but reduced by business similarity. The findings of the study contribute to the M&A literature that higher information asymmetry and uncertainty lengthen the due diligence process of the acquirers when evaluating prospective target firms.

Keywords:

Mergers and Acquisitions (M&A); Due diligence; Information asymmetry; Uncertainty.

INTRODUCTION

The value creation potential in technology acquisitions depends on accurate evaluation of the stand-alone value of the target firm and the synergistic potential of the deal (Barney, 1988; King et al., 2004; Haleblian et al., 2009), as well as the extent to which the target exhibits a strategic fit (Jemison & Sitkin, 1986; Shelton, 1988) with the corporate strategy of the acquirer. A key challenge in the acquirer's evaluation of technology targets is asymmetric information as target firms have first-hand information about their assets. According to information economics, information asymmetry refers to the fact that sellers know better about the true quality of their assets than buyers, which causes the economic problem of adverse selection (Akerlof, 1970). The target firm can provide inflated assessment of its technologies, inventions and assets or may hide important information to achieve a higher acquisition price (Graebner et al., 2010; Coff, 1999). As a result, acquirers may carry out an acquisition that they should have avoided or overpay for acquiring the target firm (Puranam et al., 2006; Roll, 1986).

The recent research by Reuer and Sakhartov (2021) and Welch et al. (2019) suggests that the primary way acquirers can reduce the risk of inappropriate acquisition decision, in terms of target selection is by conducting detailed and multifaceted due diligence. This process of due diligence is conducted during the time between the announcement of the initial intent to acquire and the closing of the deal (completion or abandonment) (Puranam et al., 2006; Bing, 1996; Lajoux & Elson, 2000). It allows an acquirer to identify, confirm or disconfirm the business reasons for the proposed deal (Haspeslagh & Jemison, 1991; Harvey & Lusch, 1995), to determine the target standalone value and synergies entailed in a transaction (Sirower, 1997). To conduct a thorough due diligence, the acquirer may require a broad set of expertise of accounting, financial, and legal advisors to collect and analyze data on tangible and intangible characteristics of the target firms (Jemison & Sitkin, 1986;

DePamphilis, 2010). A robust due diligence process allows informed assessment of an acquisition candidate (Wangerin, 2019). Otherwise, acquirers may fail to 'discover' information that devalues the target firm. The due diligence process might also uncover information which leads to the revision of the bid or completely withdraw from a bid (Puranam et al., 2006).

Despite the significance of due diligence in academic and practitioner learning work and consulting, there is little research on how much due diligence is appropriate to balance anticipated benefits and costs. Additionally, the recent review on M&A research by Welch et al. (2019) suggests that the knowledge on various pre-deal activities such as selection, negotiation and due diligence is relatively limited and encouraged further research in this direction. Therefore, this research attempts to bridge this gap in M&A literature by examining the *(pre-deal)* due diligence process. Puranam et al. (2006) carry out an experimental study on how acquiring firm managers utilize information obtained during due diligence but do not consider duration of due diligence. Only Reuer and Sakhartov (2021) recently examined a theoretical framework of the optimal level of due diligence and suggest that it is highly context specific. In their study, the authors find that it depends on (1) the nature of synergy that the acquirer anticipates, (2) the relatedness between the acquiring and acquired firms, and (3) the degree of ambiguity about the synergistic potential. Reuer and Sakhartov (2021) suggest that a high level of due diligence is optimal when synergy entails resource redeployment and sharing and the two companies are modestly related, as well as, when synergy entails resource sharing, and it is subject to considerable ambiguity.

The study by Reuer and Sakhartov (2021) provides a much-needed impetus to research this critical question in management of M&A. We propose a modified theoretical framework and expose it to empirical test. The modifications to their theoretical framework are twofold: first, we see relatedness as the main source for economic synergies in

acquisitions (Penrose, 1959; Ansoff, 1965) also in acquisitions (Barney, 1988; Seth, 1990; Teece, 1994) and abstract away for now on how the resource relatedness needs to be exploited to generate the expected economic synergy (resource redeployment or resource sharing, which is often very difficult to observe). Further, while Reuer and Sakhartov (2021) focus on ambiguity or ambivalence defining it as a situation where there are multiple different possible values, their ambiguity notion differs from informational incompleteness. It does not explicitly refer to the uncertainty, that is, clarity about the future standalone value of the target and/or of its synergistic value with the acquirer. Given that we think that informational incompleteness (gap) and uncertainty need to be explicitly considered in the context of technology acquisitions, we focus on the uncertainty of target technological resources rather than ambiguity of the synergy potential (relatedness) and examine its interaction with relatedness (similarity and complementarity) as well as with the information gap (asymmetry) the acquirer faces to try to understand the target. (Please note that the information gap is not the opposite of relatedness, given that the information gap equals differences and relatedness only includes complementary differences).

Our study offers an extended theoretical framework, while controlling for some of the arguments made by Reuer and Sakhartov (2021), namely the degree of similarity between the acquirer and the target (we cannot measure complementarity ex ante). Drawing on information economics (Akerlof, 1970; Makadok & Barney, 2001) and the organizational learning literature (Cohen & Levinthal, 1989, 1990), we predict that a higher degree of uncertainty regarding the actual value of the target firm's resources will prolong the due diligence process. We further anticipate that this relationship will be exacerbated by the information gap the acquiring firm faces in understanding the target, that is, the distance (or differences) between the acquirer and target in a given resource type but mitigated by the acquirer's absorptive capacity (proxied through overall business similarity).

We explore the role of information asymmetry and uncertainty affecting due diligence in the context of technology acquisitions, defined as acquisitions where a central goal of the acquirer is technology acquisition, usually in the form of patents (or pending patents), to improve innovation outcomes. We focus on technology firms because target firms' resources exhibit information asymmetry (Zahra, 1996; King et al., 2008) which contributes to uncertainty regarding inventive activities and outputs of target firms (Damanpour, 1996; Tushman, 1978). The evaluation of targets by prospective acquirers depends on the latter's absorptive capacity (Cohen & Levinthal, 1990; Makadok, 2001), which is a function of both business and technological similarity.

We capture due diligence in the period of public takeover process. After the official announcement by the acquirer of a public offer, the acquirer and the target enter the public takeover period (Dikova et al., 2010; Boone & Mulherin, 2007; Wangerin, 2019). Our focus is on this intermediary phase in acquisition process which begins with the first recorded announcement date of the buyer's acquisition intent to the date the transaction was closed or abandoned.[1] Hence, due diligence is measured by the number of days between the deal announcement date and deal closing date.

The focus on technology acquisitions allows us to explore how *uncertainty* regarding the current and future value of the target resources impacts due diligence. We observe the number of target firms' pending patent applications at the time of the initial acquisition announcement. According to patent statistics from the US Patent Office during the period covered by our sample (2002–2016), only approximately 52% of the patents filed were approved. We argue that a higher number of pending patent applications will generate a more uncertain situation, though potentially valuable. In addition to the uncertainty of target resources' future value, the *informational challenge* for acquirers in technological

[1] We include withdrawn bids to avoid a selection problem.

acquisitions is compounded by the *information asymmetry* between the acquiring and acquired firms which we capture through their technological distance with reference to the technological classes of the two firms' patent portfolio. We expect that as the technological distance between the two firms increases, it will be more difficult for the acquirer to evaluate the technologies of the acquisition candidate. To examine whether an acquirer can overcome the information asymmetry the acquisition represents (in terms of distance), we measure its potential absorptive capacity to identify the possible value in the target through business similarity between the acquiring and acquired firms (Cohen & Levinthal, 1990; Todorova & Durisin, 1998) as similar buyers are better able to evaluate the overall resource base of their prospective targets (Zaheer et al., 2013).

Our study not only offers an expanded theoretical framework to consider different informational conditions affecting the difficulty (or ease) of the informational problem faced by acquirers (information asymmetry, resource value uncertainty and business similarity) but also among the first empirical accounts of studies on due diligence determinants.

THEORETICAL BACKGROUND AND HYPOTHESES

The due diligence process

Acquisitions of technology firms allow acquirers to gain access to technological resources and new products of target firms (Ahuja & Katila, 2001). However, information asymmetry between the acquirer and the target introduces uncertainty about the value of a target firm's resources (Coff, 1999). Information asymmetry arises when sellers possess better information about their resources and prospects than buyers, which leads to the risk of adverse selection (Akerlof, 1970). The value of technology firms depends on promising products in the pipeline than on the existing products which makes buyers cautious about purchasing target firms for which they cannot see the goods even though the targets realize the full value of their company (Graebner et al., 2010). This information asymmetry problem can have the

following outcomes: (1) uncertainty about the value of target technological resources, (2) acquirer is likely to make an adverse selection and (3) uncertainty about expected synergies.

This sheds light on the importance of due diligence to determine the appropriateness and value-creation potential of a deal (Reuer & Sakhartov, 2021). A thorough due diligence may require an acquirer to involve its top managers and executives to coordinate activities with external experts such as investment banks, lawyers and consultants (Jemison & Sitkin, 1986; Chahine & Ismail, 2009), bear their hefty fees (Chuang, 2017), manage stock market investors' expectations (Trautwein, 1990) and withstand price pressures around the time of the deal (Mitchell et al., 2004). Extensive due diligence also entails significant costs, as it is the case with decision making comprehensiveness or rationality in general (Fredrickson, 1984, 1987; Eisenhardt & Bourgeois, 1988). It might lead the acquirer to miss the opportunity if there are competing bids (Barney, 1988). Further, this may divert the attention of acquirers' top managers from the day-to-day running of the business (Hitt et al., 2001; Kale & Singh 1999; Zollo & Singh, 2004). While a robust due diligence may take longer, it holds considerable promise by enabling buyers to make a more informed acquisition decision.

Thus, our study seeks to address the question: *How much (pre-deal) due diligence should an acquiring firm undertake, and thus relatedly what may this level depend on?* To this end, we focus on duration of due diligence as the key indicator for the due diligence, proxied as the point at which the acquirer announces initial intent to acquire a particular target until the deal is closed (completed or withdrawn).

We view the information or valuation challenges and the due diligence duration as the interplay between three main factors: first, informational distance regarding the specific target resource, that is, technological distance between the two corporations (distance includes differences which some might be complementary thus a determinant of potential

synergies as well) which constitutes the core valuation challenge that acquirers face in technology acquisitions. Even if the acquisition is motived by technological exploration (March, 1991; Rosenkopf & Nerkar, 2001; Rothaermel, 2001), technological distance creates a learning challenge for the acquirer. Second, uncertainty about the (future) value of target specific resources, which generates another informational challenge which is compounded by technological distance, and third, business similarity which reduces the information challenge as it facilitates understanding between resource types when two firms are in the same primary business.

Technological distance: The core informational gap in technology deals

Technology acquisitions are motivated by acquirer's desire to acquire a technology, patented or non-patented, which it can leverage through its own resources (Bower, 2001; Graebner et al., 2010; Haspeslagh & Jemison, 1991; Makri et al., 2001; Puranam et al., 2006; Schweizer, 2006). The desired technologies, whether embedded in product designs or referred to product development and operations, may be technologies which the acquirer does not currently have, constituting an attempt at renewing its business (Haspeslagh & Jemison, 1991) by adding new product designs, leveraging a new product development (R&D) technology or a new operating technology (such as AI). The acquisition can be aimed at achieving competitive parity in technology or even leapfrogging competitors. Thus, technology acquisitions might vary in the extent to which the target technologies are distant from the acquirer's technology portfolio (Bena & Li, 2014; Schildt & Laamanen, 2006). The cost of failure from an acquisition is more than the cost of due diligence which requires more due diligence effort that translates to longer due diligence time. The greater the technological distance between the two, even if the acquirer might perceive value in target technologies and in combining them with its own, the greater the informational challenge the acquirer faces or, in other words, the lower its actual absorptive capacity (Cohen & Levinthal, 1990). The increase in

the technological distance, increases the due diligence effort of the acquirer which in turn lengthens the due diligence process. Thus, we hypothesize the following:

Hypothesis 1: The higher the technological distance between the acquiring and the potential target firm, the longer the duration of due diligence.

Target resource value uncertainty in technology deals

The nature of technology acquisitions can make the probability distribution of a deal's valuation much less predictable for the acquirer. This is because value creation in technology deals is usually related to the acquired knowledge-based assets, such as scientific, technological, and technical knowledge that the target has or is developing such as patents, product designs, software, and trade secrets, as well as the underlying assets which generate them, both in terms of human and other physical capital (such as R&D laboratories) (Grant, 1996). The value of these assets is uncertain as scientific and technological change can make it obsolete (Schumpeter, 1941). In the technological arena there is a specific asset category which is intrinsically fraught with uncertainty: pending patent applications. While granted patents – even those which are pre-emptive – have clear value in that they establish a uniqueness and thus protected monopolistic position for the firm in a given knowledge domain, pending patents are claims to uniqueness which still need to be ascertained by the regulator. Therefore, pending patents bring an additional informational challenge to the acquirer, to try to ascertain whether the patent is likely to be granted and how valuable this might be for the target business and the expected synergies.

The existence of patent protection can provide acquirers with some assurance that the target firm's technology can become the basis of revenue generation either through the development of new offerings or through licensing it to third parties. Similarly, the knowledge underpinning a patented invention can contribute to synergy through knowledge sharing and redeployment between the acquiring and acquired firms (Karim & Capron, 2016;

Kogan et al., 2017). However, things are less clear-cut when some of the target firms' inventions have not yet received formal patent protection at the time of an acquisition, despite the fact that the target has filed a patent application to the corresponding patent office. Indeed, this is a common phenomenon in practice.

Therefore, pending patent applications contribute to the information challenge in the due diligence process, possibly making it more arduous and thus longer. Based on a formal model Reuer and Sakhartov (2021) arrive at a similar conclusion though they use the term ambiguity rather than uncertainty. They draw from the definition of ambiguity as the 'subjective experience of missing information *relevant to a prediction*' (Frisch & Baron, 1988). We believe the use of the term uncertainty is more conventional than ambiguity which is often referred more directly to a situation where there are multiple different possible values. (Dealing with uncertainty from a probabilistic point of view might give rise to multiple possible values, but it is a consequence of dealing with uncertainty not uncertainty per se).

Further, from their formal model Reuer and Sakhartov (2021) show that a high level of due diligence effort is needed when synergy entails resource sharing, and it is subject to considerable ambiguity. The claim about the role of uncertainty in affecting duration of due diligence is independent here from the mechanism of synergy generation or the extent of potential synergies altogether.

Resources of uncertain value amplify the acquirer's information challenge when evaluating a potential target. Therefore, we predict that target pending patent applications will necessitate further scrutiny of the target firm's assets, leading to a longer due diligence process. While we use the term uncertainty, it refers to the effect of ambiguity on the acquirer's effort that needs to be devoted to due diligence. Thus, we hypothesize:

Hypothesis 2: The higher the uncertainty of the technological resources of a potential target firm, the longer the duration of due diligence.

The compounding effect of knowledge distance and uncertainty

Technological distance between the acquiring and the target firms augments the informational problem acquirers face when dealing with the uncertain value of targets' resources. The more unfamiliar an acquirer is with a given class, category or type of assets of a potential target, such as technological resources, the more difficult it will be for the acquirer to engage in probabilistic (risk) assessments of the likely value of those resources.

Therefore, given the focus on technology acquisitions, we claim that technological distance exacerbates the relationship between the value uncertainty of the technological resources of the potential target and the duration of due diligence. Thus, we hypothesize the following:

Hypothesis 3: As the technological distance between the acquiring and the potential target firm increases, the effect of the number of pending patent applications of the potential target firm on the duration of due diligence increases.

Business similarity as potential absorptive capacity

Business similarity between the acquirer and the target is one of the two dimensions of relatedness (the other being complementarity) may lead to economic synergies as many authors have argued (Penrose, 1959; Ansoff, 1965; Seth, 1990).[2] Business similarity also constitutes the main indicator of overall potential absorptive capacity (Cohen & Levinthal, 1990) for acquirers in dealing with prospective targets. As a result of business similarity, the acquirer is likely to understand the basic functioning of the target firm and more specifically how different resources can be combined with the acquirer's (Zaheer et al., 2013; Van Den Bosch et al., 1999). Cohen and Levinthal (1990) defined absorptive capacity precisely as the

[2] We account for this main effect.

capacity to understand, value and internalize external knowledge or more broadly resources. Given that the focus here is on the pre-deal valuation stage leading to the decision of whether or not make the acquisition, we refer to the capacity of understanding and valuing and thus to what Zahra and George (2006) called potential absorptive capacity, prior to actual attempts at internalizing the external resources.

Therefore, business similarity in terms of matching of the primary activity of both firms is likely to reduce the informational challenge that technological distance generates. While the two companies might exhibit substantial technological distance (in underlying scientific and technical knowledge), the fact that they are similar business-wise means that the acquirer can assess and thus value the other target resources (products, distribution channels, human resource profiles etc.) and therefore how the different technology might contribute to enhance the acquirer's products and vice versa how the acquirer's operational and marketing resources may contribute to leverage the target's different technological resources (Teece, 1986; Makri et al., 2010). The higher the business similarity, the positive (increasing) effect of technological distance on duration of due diligence will be reduced. Therefore, we predict:

Hypothesis 4: Increasing business similarity between the acquiring and the potential target firm mitigates the informational challenge of technological distance on the duration of due diligence.

METHODOLOGY

Data and sample

To examine how technological information asymmetry, uncertainty and business similarity impact the likelihood of acquirer's announcement of initial intent to acquire and the subsequent duration of due diligence, we gathered data on mergers and acquisitions (M&A) of private firms in the technology sectors of the UK from 2002–2016 by public acquirers in

UK, US, France, and Switzerland. The problem of asymmetric information and uncertainty is significantly profound in acquisitions of privately held technology firms which make an interesting case to study (Capron & Shen, 2007; Ragozzino & Reuer, 2009).

The sample of M&A was drawn from Thomson One Mergers and Acquisitions database, which is one of the most comprehensive databases on M&A deals. We included M&A deals that meet the following requirements: (i) privately held acquired firms active in one of the following six industries: SIC 28 chemicals and allied products, SIC 35 industrial and commercial machinery and computer equipment, SIC 36 electronics and electrical equipment, SIC 37 transportation equipment, SIC 38 measuring, analysing and controlling instruments, photographic, medical and optical goods, SIC 48 communications, (ii) M&A deals where the acquirer company increased its ownership to at least 50% of target shares, (iii) M&A deals where the acquirer is a public firm based in UK, US, France and Switzerland.

The information on financial variables for the target firm sample was obtained from FAME as it provides extensive coverage on public and private companies in the UK. We used OSIRIS to extract financial and accounting data for the sample of acquiring firms as it provides comprehensive coverage on worldwide public companies. The financial information for US public acquirers was checked from Compustat section of the Wharton Research Data Services (WRDS) and FAME was used to check the financial information on public acquiring firms based in UK. The final sample comprises 311 actual acquisition deals with information on financial, accounting and demographic variables. Table 1 presents further information related to deals announced, completed and withdrawn. Table 2 presents information on deals by acquirer industry.

Insert Table 1 and 2 about here

The patent data on acquired and acquiring firms was gathered from the OECD Patent database (2018) which collects information on patents from PATSTAT which is EPO's Worldwide Statistical Patent Database. The patent measures including pending patent applications of the target firm, patent stock of the target and acquiring firms, as well as the technological distance (technology classes) of the target and acquiring firms were constructed using this database. The data on prior ties between the acquirer and target comes from SDC Platinum, Joint Ventures/Alliances section and has been used in prior studies as well (Schilling, 2009; Porrini, 2004).

Research design

In this section, we investigate whether information asymmetry, uncertainty and business similarity influence the duration of due diligence. In this research, duration of due diligence can *only* be observed for deals that are announced. This compounds two possible sources of sample selection bias in the estimation of a regression model for the duration of due diligence. The first is a problem of self-selection of the pair of potential target and potential buyer that engage in an acquisition with respect to those that do not. This entails decision process on both sides of a potential acquisition deal: the buyer and the seller. The key explanatory variables for the duration of due diligence, uncertainty and information asymmetry, are likely to play a role in both acquisition decision making processes, that affects the probability of the acquisition process to be initiated, and therefore the probability for the acquirer-target pair to be included in the sample. Therefore, only sampling announced deals would lead to sample selection bias.

The second source of sample selection bias may arise because of 'incidental truncation' (Certo et al., 2016; Wooldridge, 2010) when the duration of due diligence can be observed only conditionally on other variables that assume certain values. In this case, once a pair of potential acquirer-target firm is matched and an acquisition deal is initiated, the

duration of due diligence can be measured only if (and when) a potential deal is announced. The acquirer's announcement of initial intent to acquire may correlate with various factors, which in turn may affect the duration of due diligence, for example, the acquiring firms may be residing in different countries and in this case, the institutional differences need to be considered (Dikova et al., 2010).

Sample matching. To address the first concern of sample selection, a case-control methodology is adopted in which each treated unit is matched with one or more non-treated units based on similar observable characteristics (Wu & Reuer, 2021; Chow et al., 2021; Rogan & Sorenson, 2014; Hamilton & Nickerson, 2003). The matching method follows the principle of observable equivalence between cases and controls with respect to several covariates that are known to be related to the outcome (Stuart, 2010). This enables a comparison of outcomes among treated and non-treated units and controls for potential selection bias (Blackwell et al., 2009). In this case, the approach is to match each deal announced (case) to a set of counterfactual deals (controls) which could have been announced. To achieve this, we applied coarsened exact matching (CEM) without replacement in two steps.

First, each acquired firm (treated) is matched with observably equivalent non-acquired firms (non-treated) that could have been acquired. The covariates used in the CEM procedure are total assets as measure of firm size, return on assets as measure of profitability, and exact matched on the industry (4-digit SIC code). Second, each acquiring firm (treated) is matched with observably equivalent non-acquiring firms (non-treated) that could have announced a deal. We applied the same CEM procedure, selecting firms at random without replacement that matched the acquirers on total assets as measure of firm size, return on assets as measure of profitability, and exact matched on geographic region and industry (4-digit SIC code). The two matched samples of acquiring and acquired firms are then combined

randomly to form dyads of acquirer-target firm pairs to generate counterfactual deals. For each actual deal, at least one matched potential acquirer was randomly combined with at least one matched potential acquired firm to generate deals that could have happened. There is no rule on the choice of ratio used to match an acquired firm with the controls but using fewer controls to match each deal produce large standard errors (Rogan & Sorenson, 2014). Therefore, we used one case deal to five control deals. As a result, for our sample of 311 deals, we obtained 1,533 counterfactual deals.

Two stages estimation model. To address the second possible source of sample selection, we apply a Heckman two-stage model (Heckman, 1976) because the measurement of the duration of due diligence is conditional on the deal announcement. A two-stage Heckman model has been widely used to control for sample selection bias in studies of acquisition outcomes (Capron & Shen, 2007). Specifically, the first stage of the Heckman model on the matched sample of actual and counterfactual deals estimates the probability of acquirer's announcement of initial intent to acquire (Probit regression). The study calculates the inverse Mill's ratio (λ) from the first stage, which is then incorporated into the outcome equation of the second stage in the Heckman correction procedure. The inverse Mill's ratio is a proxy of the sample selection effect because of unmeasured firm characteristics, a component that otherwise would be omitted and lead to inconsistent estimators.

The 'exclusion restrictions' in the first-stage Heckman procedure require that at least one independent variable in the selection equation, that model the probability of deal announcement, is unrelated to the dependent variable of the outcome equation in the second stage of Heckman procedure (Certo et al., 2016; Wooldridge, 2010). In this case, the duration of due diligence is the dependent variable of the outcome equation in the second stage of the Heckman model. We use a Poisson regression since the dependent variable is a count of the number of days between deal announcement and deal completion and/or withdrawal. The

exclusion restriction includes: the percentage of firms acquired in target industries. The underlying assumption is that this variable defines environment conditions that reflect the demand for acquisitions, which affect the probability of an acquisition but not the duration of due diligence.

Measures

Dependent variables. Our first dependent variable is *deal announcement* because in the first stage of the Heckman estimation procedure, the study used the matched sample of 1,844 acquisitions comprising the 311 actual deals reported as announced in Thomson One and 1,533 counterfactual deals. This is operationalized by a dichotomous variable equal to 1 for each of the 311 actual acquisitions announced and equal to 0 for each counterfactual deal. Our second dependent variable is *duration of due diligence* because in the second stage, the study measures the duration of due diligence process. This is operationalized as the number of days between the announcement of a deal to the deal closing date.

Independent variables. We proxy the uncertainty of target technological resources using *target pending patent applications* which is measured as the number of patent applications filed by a target firm that are pending prior to or at acquisition announcement date.

We estimate information asymmetry by the *technological distance* and follow Jaffe (1986):

$$\text{Acq-Targ} = \sqrt{(F_{acq} - F_{targ})(F_{acq} - F_{targ})'},$$

where, $F_{acq} = (F_{acq,1}, \ldots, F_{acq,K})$ captures the acquirer's patent profile across K technological classes and $F_{targ} = (F_{targ,1}, \ldots, F_{targ,K})$ the target's patent profile across the same classes. $F_{targ,\,k}$ ($F_{acq,\,k}$) is the ratio of number of awarded patents to the target (acquirer firm) in technology class k to the total number of awarded patents to the target (acquirer firm) in all technology

classes with k = [1, K]. This measure is largely adopted in studies on technological proximity between acquirers and targets (Bena and Li, 2014).

We follow Montgomery and Hariharan (1991) to construct the measure of *business similarity*. The index ranges in value from a minimum of 0 to a maximum of 4 where it is 0 when target and acquirer are not in the same four-digit industry, 1 when acquirer and target are in the same first digit industry, 2 when acquirer and target are in same two digit industry, 3 when acquirer and target are in same three digit industry and 4 when the acquirer and target are in the same four digit industry.

Control variables. A number of important factors were controlled in the regression analyses. These include target and acquiring firm characteristics as well as deal characteristics.

Target firm characteristics. We control for *target firm size,* defined as the log of the total assets ($m) of target firm in the year prior to or at acquisition announcement date. The *target firm profitability* is defined as the return on total assets of a target firm in the year prior to or at acquisition announcement date. *Target firm age* is defined as the difference between the year of acquisition of a target firm and the founding year of the target firm (Benson & Ziedonis, 2009; Ransbotham & Mitra, 2010) and we take the logarithm due to skewness. We also control for *target firm patent stock* which is defined as the number of patent applications that are granted to a target firm prior to or at acquisition announcement date and take the log (x+1) due to skewness.

Acquirer firm characteristics. We control for *acquirer firm size,* defined as the log of the total assets ($m) of an acquirer firm in the year prior to or at acquisition announcement date. The *acquirer firm profitability* is defined as the return on total assets of an acquirer firm in the year prior to or at acquisition announcement date. *Acquirer firm age* is defined as the difference between the year of acquisition announcement and the founding year of the

acquiring firm and the variable has been log transformed due to skewness. *Acquirer patent stock,* is defined as the number of patent applications that are granted to an acquirer prior to or at acquisition announcement date and use transformation of log (x+1) due to skewness. *Acquirer R&D intensity*, is defined as the ratio of the R&D expenditure ($m) to total assets ($m) of an acquiring firm in the year prior to or at an acquisition announcement date. For missing values of R&D expenditure of the acquirer, we replace the missing values with a 0 and incorporate a dummy variable, *acquirer R&D missing,* coded 1 if R&D expenditure ($m) is missing and 0 otherwise. We also control for *acquirer's acquisition experience*, defined as the number of acquisitions completed by the acquirer five years before the acquisition announcement date (Barkema & Schijven, 2008; Haleblian & Finkelstein, 1999; Hayward, 2002; Mitchell & Shaver, 2003).

Deal characteristics. We follow Chakrabarti and Mitchell (2016) to measure *geographic distance* by calculating the number of miles between the acquirer's headquarters and the location of the target company. The measure draws on spherical geometry to calculate the distance between the two points, *i* and *j* as

$$d_{ij} = C\{\arccos[\sin(\text{lat}_i)\sin(\text{lat}_j) + \cos(\text{lat}_i)\cos(\text{lat}_j)\cos(|\text{long}_i - \text{long}_j|)]\},$$

where latitude (lat) and longitude (long) are measured in radians and C represents a constant based on the radius of the sphere that converts the result into linear units of measure. To convert the result to miles on the surface of the Earth, we use C = 3,437.

We also control for *cultural distance* and the index is built following Kogut and Singh (1988):

$$CD_j = \Sigma \{(I_{ij} - I_{iu})^2 / V_i \} / 6,$$

Where I_{ij} stands for the index for the *i*th cultural dimension and *j*th country, V_i is the variance of the index of the *i*th dimension, *u* indicates the United Kingdom (since all target firms are located in UK), and CD_j is cultural difference of the *j*th country from the United

Kingdom. We constructed six dimensions on the country level which include power distance, individualism, masculinity, uncertainty avoidance, long term orientation and indulgence.

We include *prior ties* between the acquirer and the target as a control variable which is a dichotomous variable coded 1 when there is a prior tie between the acquirer and target and 0 otherwise (Porrini, 2004). Finally, we control for *competing bidders*, defined as the number of competing bidders on a deal.

FINDINGS

Table 3 presents the descriptive statistics of the target and acquiring firm characteristics and the dyadic characteristics for both actual deals announced and hypothetical deals. Table 4 displays the correlations of the M&A pair characteristics of the first stage model on acquirer's announcement of initial intent to acquire. Table 5 shows the descriptive statistics for deals announced, completed and withdrawn. Table 6 presents the correlations of the variables of the second stage model on the duration of due diligence in technology acquisitions. On average the time spanning between announcement and completion of the deal is of 24 days with a standard deviation of 47 days. The estimates of the selection equation for deal announcement which allows deriving the inverse Mill's ratio are reported in Table 7. The results of the second stage (Poisson regression) model, which regresses the duration of due diligence on the independent and control variables is presented in Table 8. These models also incorporate the inverse Mill's ratio which enables us to control for the potential presence of endogeneity biases and obtain unbiased estimates.

The results of the effect of technological information asymmetry between the acquirer and target on the duration of due diligence along with the control variables is shown in Model 1. The baseline model which includes the direct effect of technological distance, target pending patent applications and business similarity, on due diligence duration, while also accounting for other control variables is shown in Model 2. The joint effect of technological

distance and target pending patents on the duration of due diligence is incorporated in Model 3. The joint effect of technological distance and business similarity is assessed in Model 4. Lastly, Model 5 presents the complete model which includes the interaction terms of technological distance with both target pending patents and business similarity.

Insert Table 3, 4, 5, 6, 7 and 8 about here

Hypothesis 1 predicted that the technological distance between the acquiring and the potential target firm increases the duration of due diligence. Model 1 shows a statistically significant positive effect of technological distance on duration of due diligence (β=2.697, p<0.01). Thus, the results provide clear support for Hypothesis 1.

The second hypothesis predicted a positive relationship between the uncertainty of the technological resources of the potential target firm and the duration of due diligence. In line with this argument, there is a positive and statistically significant effect of target firm's pending patents on the duration of due diligence in Model 2 (β=0.209, p<0.01). Therefore, Hypothesis 2 is supported.

According to the third hypothesis, the technological distance between the acquiring and the potential target firm will exacerbate the positive effect of the uncertainty of the technological resources of the potential target firm on the duration of due diligence (Hypothesis 3). The results reported in Model 3 show that the coefficient of the interaction term between target pending patents and technological distance is positive and statistically significant (β=0.860, p<0.01). Figure 1 displays the duration of due diligence as a function of pending patent applications of the target firm at different levels of the technological distance between the acquirer and the target firm. When the technological distance between the acquirer and the target is one standard deviation above the mean, it intensifies the positive relationship between the pending patent applications of the target firm and the duration of due

diligence. No such effect exists when the technological distance between the acquirer and the target firm is low (one standard deviation below the mean). Thus, Hypothesis 3 is supported.

Finally, the fourth hypothesis predicted that the business similarity between the acquiring and the potential target firm mitigates the informational challenge of technological distance on the duration of due diligence. Regression results in Model 4 show a statistically significant negative interaction effect between technological distance and business similarity (β=-0.645, $p<0.01$). To further investigate this finding, Figure 2 plots the duration of the due diligence as a function of technological distance between the acquirer and the target firm at high and low levels of business similarity between the acquirer and the target firm. At high levels of business similarity between the acquirer and the target firm (one standard deviation above the mean), it mitigates the effect of technological distance on the duration of due diligence compared to low business similarity (one standard deviation below the mean). Thus, the figure confirms the findings of Hypothesis 4.

Insert Figure 1 and 2 about here

DISCUSSION

Contribution and Implications

The research explored the question of how much time an acquiring firm spends on gathering information about the target and what this may depend on. We captured the due diligence process by considering the amount of time taken from acquirer's announcement of initial intent to acquire to deal closing date, which involves the detailed audit of the target firm's resources and the negotiation between the acquirer and the target firm leading to transaction closure. The empirical framework explains the due diligence process, which is taken to reflect the informational challenge faced by acquirers when they consider making an acquisition, by the interplay between three main factors: the informational distance regarding

the specific target resource; the uncertainty about the current or future value of target-specific resources; and the business similarity between the acquiring and acquired firms which reduces the informational challenge by facilitating the acquirers' absorptive capacity.

Consistent with the predictions, results from endogeneity-corrected regression revealed a significantly positive effect of the technological distance between the acquiring and acquired firms on the duration of due diligence, which is, however, mitigated by the degree of business similarity between the two firms. Furthermore, the study found that the existence of uncertainty about the future value of the target's inventions (captured by the target's pending patent applications) leads to a longer due diligence duration; and that this effect is exacerbated by the technological distance of the patent portfolios of the acquiring and targeted firms. We conclude that the acquirers' informational disadvantage is determined by the information gap they face in understanding target firm resources and/or by the uncertainty regarding these resources' future value, with the acquirers' disadvantage being exacerbated when these two factors co-occur. These effects, however, can be counterbalanced by acquirers' absorptive capacity to identify the possible value in the target firm's resources through business similarity. Otherwise, investing considerable time and effort into a more thorough due diligence of shortlisted target firms seems to be seen by prospective acquirers as a necessary condition for synergy.

This research attempts to bridge the gap between theoretical and experimental studies on due diligence process and the scant empirical research on this critical facet of M&A (Puranam et al., 2006; Reuer & Sakhartov, 2021; Welch et al., 2019). The analysis builds on Reuer and Sakhartov's (2021) theoretical model which conditions the optimal due diligence on the nature and degree of uncertainty of synergy. Specifically, the work accounts for the importance of knowledge sharing in technology acquisitions (Ahuja & Katila, 2001; Graebner et al., 2010). The findings provide empirical support to Reuer and Sakhartov's

(2021) theoretical prediction that higher levels of due diligence are required when synergy rests on resource sharing between the acquiring and acquired firms and it is subject to considerable ambiguity (here uncertainty).

The findings also have straightforward implications for practitioners and consultants, who often blame insufficient due diligence to justify deal failure. This study provides an analytical framework that helps executives to rationalize the resources they devote to the due diligence process depending on the severity of the information challenge each transaction poses. It also cautions managers that due diligence process should be focused on business activities that are most critical to value creation and capture from a particular transaction. This framework can help managers make more informed acquisition decisions and avoid making costly mistakes, such as not walking away from value-destroying deals or overpaying for acquisitions.

Limitations and Future Research Directions

The findings of this study are subject to some limitations, which open new avenues of research. First, the theorizing and empirical analysis on due diligence process were built around the public takeover period and lacks information about informal, preliminary and confidential communications and exchanges between the acquiring firm and potential target firms which take place in the private takeover period described in Boone and Mulherin (2007). Here the focus on due diligence is the period during which acquirers obtain access to their preferred acquisition candidate's internal documents, receive detailed due diligence reports, refine deal structure and valuation, develop an integration plan, negotiate, and close (or abandon) the deal (Wangerin, 2019). It is possible that this period may be preceded by some preliminary due diligence which includes an acquirer's scouting to identify potential acquisition targets based on confidential communications between the acquirer and the shortlisted targets' executives of private firms to explore the feasibility of a potential deal. In

this sense, the measure, duration of due diligence, may introduce some conservatism bias by making the detection of relationships between a deal's information asymmetry and uncertainty and the corresponding due diligence duration less plausible. Future research can delve deeper into how informal and confidential communications between the acquiring firm and potential acquisition candidates may influence the unravelling of due diligence and how they are jointly shaped by transaction features.

Second, the study focused on high technology deals involving acquisitions of privately held targets by publicly traded acquirers. These choices may limit the generalizability of the study. This empirical context was appealing to test the framework because of the informational challenges acquirers experience in acquiring private targets which are greater than when acquiring public targets, and target firms' inventive activities and outputs are shrouded in uncertainty. The general framework is not specific to technology acquisitions but addresses the general notions of information challenge, driven by informational distance, target resources' value uncertainty and overall potential absorptive capacity. Future works can consider information asymmetry and uncertainty regarding non-patentable technologies and non-technological resources. It can also consider investor's reaction to acquisition announcement and the subsequent deal completion or withdrawal. Nevertheless, it would be worthwhile for future research to examine whether this framework is applicable to all acquisitions, including other sectors of the economy and both private and public target firms.

REFERENCES

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

Akerlof, G. 1970. The market for 'lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics,* 84:488-500.

Ansoff, H.L. 1965. *Corporate strategy*. McGraw-Hill, New York.

Barkema H. G., Schijven M. 2008. How do firms learn to make acquisitions? A review of past research and an agenda for the future. *Journal of Management,* 34: 594-634.

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

Bena, J., & Li, K. 2014. Corporate innovations and mergers and acquisitions. *Journal of Finance,* 19:1923-1960.

Benson, D., & Ziedonis, R.H. 2009. Corporate venture capital as a window on new technologies: Implications for the performance of corporate investors when acquiring startups. *Organization Science,* 20:329-351.

Bing, G. 1996. *Due diligence techniques and analysis: Critical questions for business decisions*. Quorum Books, New York.

Blackwell, M., Iacus, S., King, G., & Porro, G. 2009. Cem: Coarsened exact matching in Stata. *Stata Journal,* 9:524-546.

Boone, A.L., & Mulherin, J.H. 2007. How are firms sold? *Journal of Finance,* 62:847-875.

Bower, J.L. 2001. Not all M&As are alike - And that matters. *Harvard Business Review,* 79:93-101.

Capron, L., & Shen, J.C. 2007. Acquisitions of private vs. public firms: Private information, target selection, and acquirer returns. *Strategic Management Journal,* 28:891-911.

Certo, S.T., Busenbark, J.R., Woo, H.S., & Semadeni, M. 2016. Sample selection bias and heckman models in strategic management research. *Strategic Management Journal,* 37:2639-2657.

Chahine, S., & Ismail, A. 2009. Premium, merger fees and the choice of investment banks: A simultaneous analysis. *Quarterly Review Economics and Finance,* 49:159-177.

Chakrabarti, A., & Mitchell, W. 2016. The role of geographic distance in completing related acquisitions: Evidence from U.S. chemical manufacturers. *Strategic Management Journal,* 37:673-694.

Chow, D.Y., Louca, C., Petrou, A.P., & Procopiou, A. 2021. Marriage to the same kind: Organizational political ideology and mergers and acquisitions. *Organization Studies,* 43:521-546.

Chuang, K.S. 2017. The role of investment banks on the impact of firm performance in mergers and acquisitions: Evidence from the Asia-Pacific market. *Review of Quanterly Finance and Accounting,* 48:677-699.

Coff, R. 1999. How buyers cope with uncertainty when acquiring firms in knowledge-intensive industries: Caveat emptor. *Organization Science,* 10:144-161.

Cohen, W.M., & Levinthal, D.A. 1989. Innovation and learning: The two faces of R&D. *Economics Journal,* 99:569-596.

Cohen, W.M., & Levinthal, D.A. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* 35:128-152.

Damanpour, F. 1996. Organizational complexity and innovation: Developing and testing multiple contingency models. *Management Science,* 42:693-716.

DePamphilis, D. 2010. *Mergers and acquisitions basics: all you need to know*. Academic Press, Burlington, MA.

Dikova, D., Sahib, P.R., & Witteloostuijn, A. 2010. Cross-border acquisition abandonment and completion: The effect of institutional differences and organizational learning in the international business service industry. *Journal of International Business Studies,* 41:223-245.

Eisenhardt, K.M., & Bourgeois, L.J. 1988. Politics of strategic decision making in high-velocity environments: Toward a midrange theory. *Academy of Management Journal,* 31:737-770.

Fredrickson, J.W. 1984. The comprehensiveness of strategic decision processes: Extension, observations, future directions. *Academy of Management Journal,* 27:445-466.

Fredrickson, J.W. 1986. An exploratory approach to measuring perceptions of strategic decision process constructs. *Strategic Management Journal,* 7:473-483.

Frisch, D., & Baron, J. 1988. Ambiguity and rationality. *Journal of Behavioral Decision Making,* 1:149-157.

Graebner, M.E., Eisenhardt, K.M., & Roundy, P.T. 2010. Success and Failure in Technology Acquisitions: Lessons for Buyers and Sellers. *Academy of Management Perspectives,* 24:73-92.

Grant, R.M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal,* 17:109-122.

Haleblian, J., Devers, C.E., McNamara, G., Carpenter, M.A., & Davison, R.B. 2009. Taking stock of what we know about mergers and acquisitions: A review and research agenda. *Journal of Management,* 35:469-502.

Haleblian, J., Finkelstein, S. 1999. The influence of organizational acquisition experience on acquisition performance: A behavioral learning perspective. Administrative Science Quarterly, 44: 29-56.

Hamilton, B.H., & Nickerson, J.A. 2003. Correcting for endogeneity in strategic management research. *Strategic Organization,* 1:51-78.

Harvey, M.G., & Lusch, R.F. 1995. Expanding the nature and scope of due diligence. *Journal of Business Venturing,* 10:5-21.

Haspeslagh, P.C., & Jemison, D.B. 1991. *Managing acquisitions: creating value through corporate renewal*. Free Press, New York, London.

Hayward, M. L. A. 2002. When do firms learn from their acquisition experience? Evidence from 1990-1995. *Strategic Management Journal*, 23: 21-39.

Heckman, J.J. 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annals of Economics and Social Measurement,* 5:475-492.

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

Jaffe, A.B. 1986. *Technological opportunity and spillovers of R&D: Evidence from firm's patents, profits and market value.* NBER Working paper series.

Jemison, D.B., & Sitkin, S.B. 1986. Corporate acquisitions: A process perspective. *Academy of Management Review,* 11:145-163.

Kale, P., & Singh, H. 1999. Alliance capability & success: A knowledge-based approach. *Academy of Management Proceedings,* 1999, 01-06.

Karim, S., & Capron, L. 2016. Reconfiguration: Adding, redeploying, recombining and divesting resources and business units. *Strategic Management Journal,* 37:E54-E62.

King, D.R., Dalton, D.R., Daily, C.M., & Covin, J.G. 2004. Meta-analyses of post-acquisition performance: Indicators of unidentified moderators. *Strategic Management Journal*, 25:187-200.

King, D.R., Slotegraaf, R.J., Kesner, I. 2008. Performance implications of firm resource interactions in the acquisition of R&D-intensive firms. *Organization Science,* 19(2):327-340.

Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. 2017. Technological innovation, resource allocation and growth. *Quarterly Journal of Economics,* 132:665-712.

Kogut, B., & Singh, H. 1988. The effect of national culture on the choice of entry mode. *Journal of International Business,* 19:411-432.

Lajoux, A.R., & Elson, C.M. 2000. *Art of M&A due diligence.* McGraw-Hill, New York.

Makadok, R. 2001. Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal,* 22:387-401.

Makadok, R., & Barney, J.B. 2001. Strategic factor market intelligence: An application of information economics to strategy formulation and competitor intelligence. *Management Science,* 47:1621-1638.

Makri, M., Hitt, M.A., & Lane, P.J. 2010. Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions. *Strategic Management Journal,* 31:602-628.

March, J.G. 1991. Exploration and exploitation in organizational learning. *Organization Science,* 2:71-87.

Mitchell, M., Pulvino, T., & Stafford, E. 2004. Price pressure around mergers. *Journal of Finance* 59:31-63.

Mitchell, W., Shaver, J. M. 2003. Who buys what? How integration capability affects acquisition incidence and target choice. *Strategic Organization,* 1: 171-202.

Montgomery, C.A., & Hariharan, S. 1991. Diversified expansion by large established firms. *Journal of Economics and Behaviour Organizations,* 15:71-89.

Organization for Economic Cooperation and Development. 2018. Triadic Patent Families database.

Penrose, E. 2009. *The theory of the growth of the firm.* Wiley, New York.

Porrini, P. 2004. Can a previous alliance between an acquirer and a target affect acquisition performance? *Journal of Management,* 30:545-562.

Puranam, P., Powell, B.C., & Singh, H. 2006. Due diligence failure as a signal detection problem. *Strategic Organization,* 4:319-348.

Ragozzino, R., & Reuer, J.J. 2009. Contingent earnouts in acquisitions of privately held targets. *Journal of Management,* 35:857-879.

Ransbotham, S., & Mitra, S. 2010. Target age and the acquisition of innovation in high-technology industries. *Management Science,* 56:2076-2093.

Reuer, J.J., & Sakhartov, A.V. 2021. Economies of scope and optimal due diligence in corporate acquisitions. *Organization Science,* 32:1-20.

Rogan, M., & Sorenson, O. 2014. Picking a (poor) partner: A relational perspective on acquisitions. *Administrative Science Quarterly,* 59:1-29.

Roll, R. 1986. The hubris hypothesis of corporate takeovers. *Journal of Business,* 59:197-216.

Rosenkopf, L., & Nerkar, A. 2001. Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal,* 22:287-306.

Rothaermel, F.T. 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal,* 22:687-699.

Schildt, H.A., & Laamanen, T. 2006. Who buys whom: information environments and organizational boundary spanning through acquisitions. *Strategic Organization,* 4:111-133.

Schilling, M.A. 2009. Understanding the alliance data. *Strategic Management Journal,* 30:233-260.

Schumpeter, J.A. 1941. Alfred Marshall's Principles: A semi-centennial appraisal. *American Economic Review,* 31:236-248.

Schweizer, L. 2006. Organizational integration of acquired biotechnology companies into pharmaceutical companies: The need for a hybrid approach. *Academy of Management Journal,* 48:1051-1074.

Seth, A. 1990. Sources of value creation in acquisitions: An empirical investigation. *Strategic Management Journal,* 11:431-446.

Shelton, L.M. 1988. Strategic business fits and corporate acquisition: Empirical evidence. *Strategic Management Journal,* 9:279-287.

Sirower, M. 1997. *The synergy trap: How companies lose the acquisition game.* Simon and Schuster, New York.

Stuart, E.A. 2010. Matching methods for causal inference: A review and a look forward. *Statistical Science,* 25:1-21.

Teece, D. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy,* 15:185-305.

Teece, D. 1994. Understanding corporate coherence. *Journal of Economic Behaviour in Organizations,* 23:1-30.

Todorova, G., & Durisin, B. 2007. Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review,* 32:774-786.

Trautwein, F. 1990. Merger motives and merger prescriptions. *Strategic Management Journal,* 11:283-295.

Tushman, M.L. 1978. Technical communication in R&D laboratories: The impact of project work characteristics. *Academy of Management Journal,* 21:624-645.

Van Den Bosch, F.A., Volberda, H.W., & Boer, M.D. 1999. Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science,* 10:551-568.

Wangerin, D. 2019. M&A due diligence, post-acquisition performance, and financial reporting for business combinations. *Contemporary Accounting Research,* 36:2344-2378.

Welch, X., Pavicevic, S., Keil, T., & Laamanen, T. 2019. The pre-deal phase of mergers and acquisitions: A review and research agenda. *Journal of Management,* 46:843-878.

Wooldridge, J.M. 2010. *Econometric Analysis of Cross Section and Panel Data.* MIT Press, Cambridge, MA.

Wu, C-W., & Reuer, J.J. 2021. Acquirers' reception of signals in M&A market: Effects of acquirer experiences on target selection. *Journal of Management Studies,* 58:1237-1266.

Zaheer, A., Castaner, X., & Souder, D. 2013. Synergy sources, target autonomy, and integration in acquisitions. *Journal of Management,* 39:604-632.

Zahra, S.A. 1996. Technology strategy and new venture performance: A study of corporate sponsored and independent biotechnology ventures. *Journal of Business Venturing,* 11:289-321.

Zahra, S.A., & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review,* 27:185-203.

Zollo, M., & Singh, H. 2004. Deliberate learning in corporate acquisitions: post-acquisition strategies and integration capability in U.S. bank mergers. *Strategic Management Journal,* 25:1233-1256.

TABLES AND FIGURES

Table 1. Deals announced, completed and withdrawn during the period 2002 – 2016.

Year	Deals announced	Deals completed	Deals withdrawn	% withdrawn
2002	35	33	2	5.71
2003	23	22	1	4.35
2004	28	28	0	0.00
2005	33	32	1	3.03
2006	28	28	0	0.00
2007	23	21	2	8.70
2008	12	12	0	0.00
2009	15	15	0	0.00
2010	17	17	0	0.00
2011	9	9	0	0.00
2012	14	14	0	0.00
2013	25	24	1	4.00
2014	24	24	0	0.00
2015	19	19	0	0.00
2016	6	6	0	0.00
Total	311	304	7	2.25

Table 2. Deals by acquirer industry.

Acquirer Industries	Number	%
13 Oil and gas extraction	2	0.64
15 Building construction	2	0.64
20 Food and kindred products	2	0.64
28 Chemicals and allied products	54	17.36
30 Rubber and miscellaneous products	1	0.32
33 Primary metal	3	0.96
34 Fabricated metal products	4	1.29
35 Industrial and commercial machinery	18	5.79
36 Electronics	62	19.94
37 Transportation	20	6.43
38 Measuring, analysing and controlling instruments; photographic, medical and optical goods	35	11.25
39 Manufacturing	1	0.32
44 Water transportation	3	0.96
48 Communications	32	10.29
49 Electric and gas services	1	0.32
50 Wholesale trade, durable goods	5	1.61
51 Wholesale trade, nondurable goods	1	0.32
59 Retail	3	0.96
60 Depository	1	0.32
63 Insurance	1	0.32
65 Real estate	3	0.96
67 Holding and other investments	6	1.93
73 Business services	32	10.29
79 Amusement and recreation	1	0.32
80 Health services	3	0.96
87 Engineering, accounting, research, management and related services	15	4.82
Total	311	100

Table 3. Descriptive statistics of actual deals announced and counterfactual deals by UK, US, Swiss and French acquirers during the period 2002–2016.

Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: Target firm characteristics	All Deals = 1844		Announced Deals = 311		Counterfactual Deals = 1533	
Deal announcement	0.17	0.37	1	0	0	0
Target pending patents (log)	0.13	0.58	0.41	0.90	0.07	0.47
Target total assets (log)	2.67	2.07	2.74	2.09	2.65	2.06
Target ROA	3.73	28.72	-0.78	36.25	4.65	26.86
Target age (log)	2.72	0.91	2.56	0.97	2.75	0.89
Target patent stock (log)	0.23	0.90	0.51	1.06	0.17	0.86
Panel B: Acquiring firm characteristics						
Acquirer total assets (log)	5.55	2.35	6.53	2.40	5.35	2.29
Acquirer ROA	5.15	10.04	4.77	11.43	5.23	9.74
Acquirer age (log)	2.96	1.09	3.29	1.14	2.89	1.07
Acquirer acquisition experience	0.47	1.12	1.64	1.36	0.24	0.90
Acquirer patent stock (log)	0.63	1.53	1.94	2.26	0.36	1.16
Acquirer R&D intensity	0.03	0.06	0.04	0.06	0.03	0.06
Acquirer R&D missing (dummy)	0.18	0.38	0.11	0.31	0.19	0.40
Panel C: Dyadic characteristics						
Technological distance	0.39	0.13	0.37	0.14	0.39	0.13
Business similarity	1.45	1.48	1.52	1.48	1.43	1.47
Geographic distance (log)	8.26	0.70	8.26	0.69	8.26	0.70
Cultural distance	1.74	5.21	1.82	5.42	1.72	5.17

Table 4. Correlation of first stage model of acquirer's announcement of the initial intent to acquire.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1) Deal announcement	1																
2) Target pending patents (log)	0.22	1															
3) Technological distance	-0.05	-0.08	1														
4) Business similarity	0.02	0.04	0.02	1													
5) Target total assets (log)	0.02	0.16	0.02	0.04	1												
6) Target ROA	-0.07	-0.08	-0.02	-0.11	0.01	1											
7) Target age (log)	-0.08	-0.02	0.01	0.00	0.27	0.12	1										
8) Target patent stock (log)	0.14	0.78	-0.08	0.05	0.15	-0.07	0.00	1									
9) Acquirer total assets (log)	0.19	0.07	0.00	0.01	0.13	-0.01	0.04	0.01	1								
10) Acquirer ROA	-0.02	-0.04	0.01	0.04	0.02	0.09	0.08	-0.07	0.19	1							
11) Acquirer age (log)	0.14	0.03	0.02	0.08	0.05	0.05	0.05	0.02	0.26	0.19	1						
12) Acquirer acquisition experience	0.47	0.20	-0.05	0.10	0.01	-0.02	-0.04	0.13	0.11	0.06	0.15	1					
13) Acquirer patent stock (log)	0.39	0.18	-0.03	0.12	0.11	-0.07	-0.01	0.11	0.32	0.04	0.20	0.19	1				
14) Acquirer R&D intensity	0.02	0.04	0.00	0.08	-0.02	-0.11	-0.04	0.02	-0.08	-0.40	0.00	-0.05	0.17	1			
15) Acquirer R&D missing (dummy)	-0.09	-0.06	0.02	-0.13	0.01	0.00	0.02	-0.04	0.01	0.04	-0.10	-0.14	-0.15	-0.25	1		
16) Geographic distance (log)	0.00	0.00	-0.02	-0.03	0.04	0.03	0.05	-0.01	0.08	0.02	0.05	0.01	-0.02	0.00	0.07	1	
17) Cultural distance	0.01	-0.01	0.03	0.06	0.02	0.01	0.00	-0.03	0.08	0.02	0.15	-0.06	0.01	-0.05	-0.01	0.15	1

Table 5. This table presents the descriptive statistics of deals announced, completed and withdrawn by US, UK, French and Swiss acquiring firms during the period 2002–2016. The acquired firms are based in UK technology sectors 28, 35, 36, 37, 38 and 48. Panels A–C present statistics on variables included in the empirical analysis.

Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: Target firm characteristics	Announced Deals = 311		Completed Deals = 304		Withdrawn Deals = 7	
Target pending patents (log)	0.41	0.90	0.40	0.89	0.71	1.22
Target total assets (log)	2.74	2.09	2.67	2.06	5.89	1.17
Target ROA	-0.78	36.25	-0.66	36.53	-5.99	21.70
Target age (log)	2.56	0.97	2.54	0.95	3.53	1.11
Target patent stock (log)	0.51	1.06	0.49	1.05	1.02	1.53
Panel B: Acquiring firm characteristics						
Acquirer total assets (log)	6.53	2.40	6.51	2.40	7.45	2.23
Acquirer ROA	4.77	11.43	4.84	11.28	1.49	17.36
Acquirer age (log)	3.29	1.14	3.28	1.14	3.95	1.04
Acquirer acquisition experience	1.64	1.36	1.65	1.37	1.29	0.49
Acquirer patent stock (log)	1.94	2.26	1.92	2.26	3.08	1.84
Acquirer R&D intensity	0.04	0.06	0.04	0.06	0.04	0.07
Acquirer R&D missing (dummy)	0.11	0.31	0.11	0.31	0.14	0.38
Panel C: Dyadic characteristics						
Duration of due diligence	24.13	47.02	23.28	46.67	60.71	51.74
Technological distance	0.37	0.14	0.37	0.14	0.34	0.17
Business similarity	1.52	1.48	1.51	1.49	1.86	1.07
Geographic distance (log)	8.26	0.69	8.26	0.69	8.21	0.73
Cultural distance	1.82	5.42	1.84	5.48	0.88	0.60
Prior ties	0.09	0.29	0.09	0.29	0.14	0.38
Competing bidders	0.01	0.10	0.01	0.08	0.14	0.38

Table 6. Correlation of second stage model on the duration of due diligence in technology acquisitions.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1) Duration of due diligence	1																		
2) Target pending patents (log)	0.32	1																	
3) Technological distance	0.14	-0.08	1																
4) Business similarity	-0.01	0.04	0.02	1															
5) Target total assets (log)	0.41	0.16	0.02	0.04	1														
6) Target ROA	-0.06	-0.08	-0.02	-0.11	0.01	1													
7) Target age (log)	0.00	-0.02	0.01	0.00	0.27	0.12	1												
8) Target patent stock (log)	0.32	0.78	-0.08	0.05	0.15	-0.07	0.00	1											
9) Acquirer total assets (log)	0.10	0.07	0.00	0.01	0.13	-0.01	0.04	0.01	1										
10) Acquirer ROA	0.04	-0.04	0.01	0.04	0.02	0.09	0.08	-0.07	0.19	1									
11) Acquirer age (log)	0.11	0.03	0.02	0.08	0.05	0.05	0.05	0.02	0.26	0.19	1								
12) Acquirer acquisition experience	-0.01	0.20	-0.05	0.10	0.01	-0.02	-0.04	0.13	0.11	0.06	0.15	1							
13) Acquirer patent stock (log)	0.16	0.18	-0.03	0.12	0.11	-0.07	-0.01	0.11	0.32	0.04	0.20	0.19	1						
14) Acquirer R&D intensity	0.06	0.04	0.00	0.08	-0.02	-0.11	-0.04	0.02	-0.08	-0.40	0.00	-0.05	0.17	1					
15) Acquirer R&D missing (dummy)	-0.05	-0.06	0.02	-0.13	0.01	0.00	0.02	-0.04	0.01	0.04	-0.10	-0.14	-0.15	-0.25	1				
16) Geographic distance (log)	0.02	0.00	-0.02	-0.03	0.04	0.03	0.05	-0.01	0.08	0.02	0.05	0.01	-0.02	0.00	0.07	1			
17) Cultural distance	0.19	-0.01	0.03	0.06	0.02	0.01	0.00	-0.03	0.08	0.02	0.15	-0.06	0.01	-0.05	-0.01	0.15	1		
18) Prior ties	0.09	0.23	-0.05	0.07	0.03	-0.09	-0.07	0.11	0.09	-0.04	0.02	0.16	0.17	0.10	-0.06	-0.01	-0.03	1	
19) Competing bidders	-0.01	0.09	-0.01	0.00	0.03	0.00	0.02	0.02	0.03	-0.06	0.02	0.10	0.01	0.00	0.02	0.00	-0.01	0.10	1

Table 7. The table reports the estimates of the selection equation for acquirer's announcement of the initial intent to acquire.

	(1)
VARIABLES	Deal Announcement
Target pending patents (log)	0.280**
	(0.111)
Technological distance	-0.377
	(0.330)
Business similarity	-0.0154
	(0.0429)
Target firm characteristics	
Target total assets (log)	-0.0372
	(0.0232)
Target ROA	-0.00234
	(0.00151)
Target age (log)	-0.120**
	(0.0524)
Target patent stock (log)	-0.0609
	(0.0749)
Acquiring firm characteristics	
Acquirer total assets (log)	0.0433*
	(0.0228)
Acquirer ROA	-0.0120**
	(0.00500)
Acquirer age (log)	0.0848*
	(0.0467)
Acquirer acquisition experience	0.538***
	(0.0366)
Acquirer patent stock (log)	0.281***
	(0.0291)
Acquirer R&D intensity	-1.563*
	(0.855)
Acquirer R&D missing (dummy)	0.0362
	(0.147)
Dyadic characteristics	
Geographic distance (log)	-0.0282
	(0.0646)
Cultural distance	0.00533
	(0.00941)
Exclusion criteria	
Percentage of firms acquired in target industries	0.00886*
	(0.00457)
Acquirer & target industry dummies	Yes
Year dummies	Yes
Constant	-0.770
	(0.888)
Observations	1,844
Pseudo R–squared	0.354
p–value	0.00
Log likelihood	-540.4
Chi–squared	592.7
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Table 8. This table reports the Poisson estimates of the duration of due diligence in technology acquisitions.

VARIABLES	(1) Duration of due diligence	(2) Duration of due diligence	(3) Duration of due diligence	(4) Duration of due diligence	(5) Duration of due diligence
Technological distance	2.697***	2.725***	2.071***	2.671***	2.153***
	(0.131)	(0.132)	(0.150)	(0.129)	(0.139)
Target pending patents (log)		0.209***	0.214***		0.0273
		(0.0268)	(0.0273)		(0.0287)
Business similarity		-0.0773***		-0.0597***	-0.0736***
		(0.0133)		(0.0136)	(0.0138)
Target pending patents (log) * Technological distance			0.860***		1.103***
			(0.121)		(0.137)
Technological distance * Business similarity				-0.645***	-0.659***
				(0.0879)	(0.0864)
Target firm characteristics					
Target total assets (log)	0.353***	0.324***	0.327***	0.351***	0.346***
	(0.00856)	(0.00909)	(0.00916)	(0.00857)	(0.00927)
Target ROA	-0.00175***	-0.00170***	-0.00181***	-0.00106**	-0.00131***
	(0.000489)	(0.000484)	(0.000480)	(0.000502)	(0.000499)
Target age (log)	-0.182***	-0.214***	-0.221***	-0.192***	-0.201***
	(0.0158)	(0.0162)	(0.0164)	(0.0157)	(0.0161)
Target patent stock (log)	0.109***	0.00180	-0.0243	0.127***	0.110***
	(0.0133)	(0.0209)	(0.0208)	(0.0135)	(0.0192)
Acquiring firm characteristics					
Acquirer total assets (log)	-0.188***	-0.172***	-0.186***	-0.183***	-0.189***
	(0.00948)	(0.00961)	(0.00959)	(0.00953)	(0.00984)
Acquirer ROA	0.0195***	0.0160***	0.0187***	0.0170***	0.0201***
	(0.00178)	(0.00184)	(0.00191)	(0.00181)	(0.00194)
Acquirer age (log)	-0.0195	-0.0239	-0.0113	-0.0216	-0.0148
	(0.0169)	(0.0170)	(0.0170)	(0.0171)	(0.0173)

Acquirer acquisition experience	-0.184***	-0.0904***	-0.0909***	-0.156***	-0.130***
	(0.0259)	(0.0269)	(0.0274)	(0.0258)	(0.0278)
Acquirer patent stock (log)	0.0163	0.0622***	0.0675***	0.0322**	0.0458***
	(0.0145)	(0.0151)	(0.0153)	(0.0146)	(0.0153)
Acquirer R&D intensity	3.179***	2.829***	3.067***	2.955***	3.215***
	(0.241)	(0.246)	(0.249)	(0.243)	(0.251)
Acquirer R&D missing (dummy)	-0.325***	-0.341***	-0.345***	-0.347***	-0.384***
	(0.0614)	(0.0611)	(0.0614)	(0.0622)	(0.0625)
Dyadic characteristics					
Geographic distance (log)	0.0243	0.0275	0.0582**	0.0234	0.0581**
	(0.0237)	(0.0239)	(0.0243)	(0.0238)	(0.0242)
Cultural distance	0.0154***	0.0172***	0.0160***	0.0164***	0.0156***
	(0.00217)	(0.00219)	(0.00218)	(0.00221)	(0.00222)
Prior ties	0.336***	0.298***	0.189***	0.468***	0.431***
	(0.0470)	(0.0498)	(0.0495)	(0.0492)	(0.0497)
Competing bidders	0.136	0.145	0.286*	0.139	0.311**
	(0.152)	(0.149)	(0.155)	(0.150)	(0.154)
Inverse Mill's Ratio	-0.484***	-0.143*	-0.141*	-0.410***	-0.331***
	(0.0772)	(0.0840)	(0.0851)	(0.0771)	(0.0865)
Acquirer & target industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Constant	-15.62	-15.55	-15.80	-16.12	-16.33
	(1,372)	(1,186)	(1,288)	(1,523)	(1,387)
Observations	311	311	311	311	311
Pseudo R–squared	0.491	0.495	0.496	0.495	0.498
p–value	0.00	0.00	0.00	0.00	0.00
Chi–squared	9869	9964	9983	9955	10022
Log likelihood	-5122	-5074	-5065	-5079	-5046
Standard errors in parentheses					
*** p<0.01, ** p<0.05, * p<0.1					

Figure 1. Effect of pending patent applications of target firm on the duration of due diligence by level of technological distance. The graph shows the values of technological distance when it is one standard deviation above and below the mean.

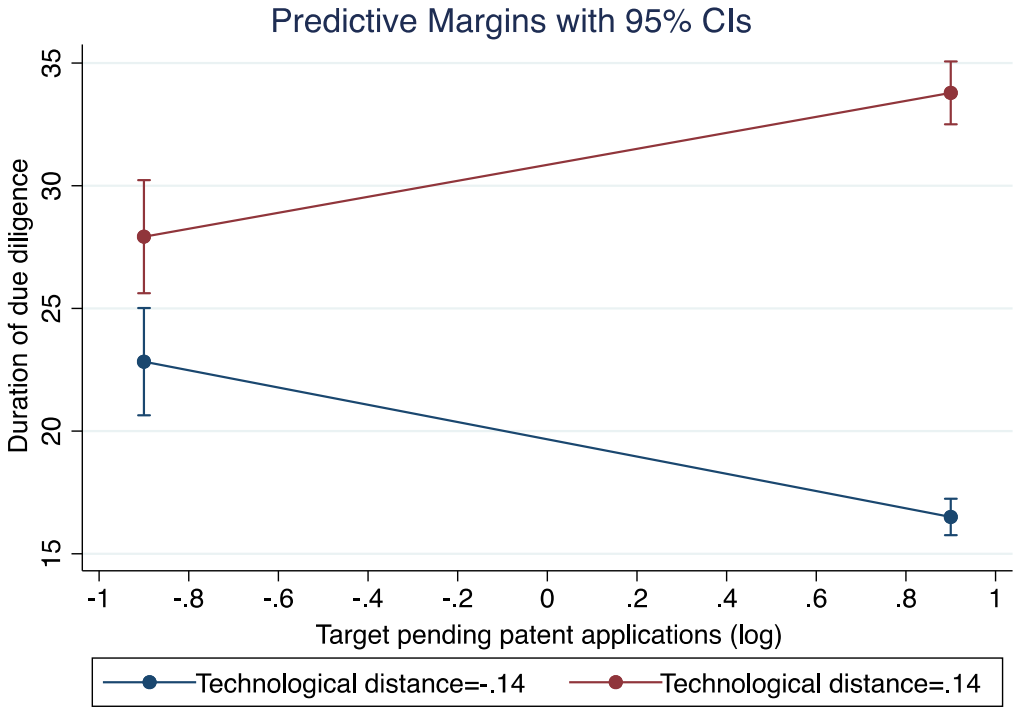
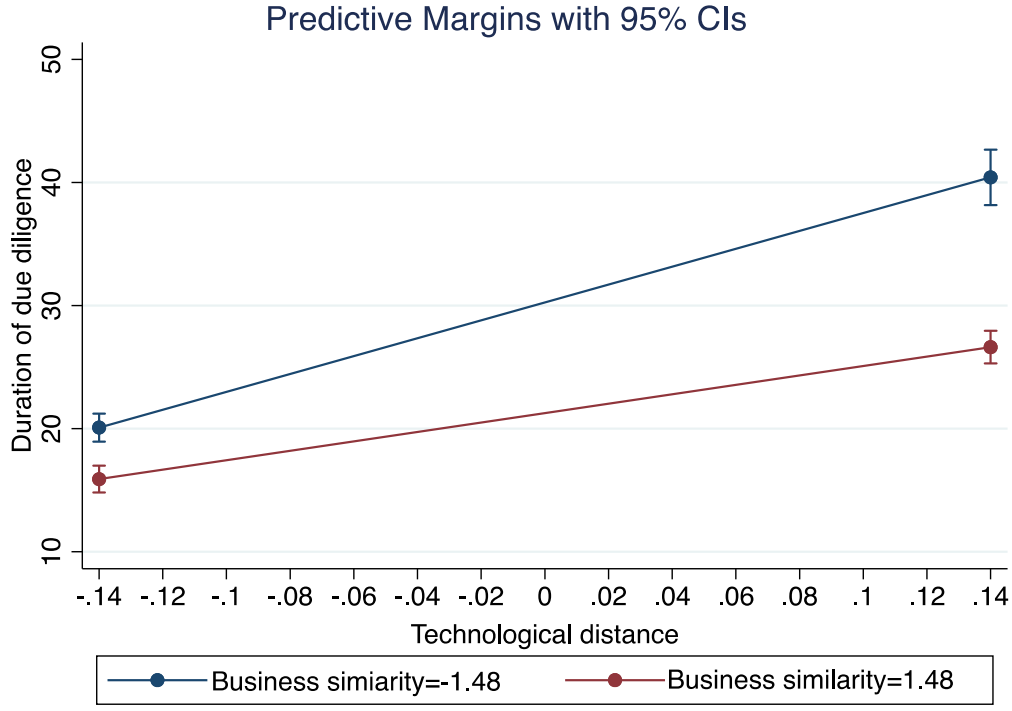


Figure 2. Effect of technological distance on the duration of due diligence by level of business similarity. The graph shows the values of business similarity when it is one standard deviation above and below the mean.



MANCHESTER 1824
The University of Manchester

THE MANCHESTER INSTITUTE OF INNOVATION RESEARCH IS A CENTRE OF EXCELLENCE IN THE FIELD OF INNOVATION STUDIES.

MANCHESTER INSTITUTE OF INNOVATION RESEARCH

Alliance Manchester Business School
The University of Manchester
Booth Street West
Manchester M15 9PB

http://www.mioir.manchester.ac.uk