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Abstract

We study the post-acquisition R&D persistence (R&D spending as a function of its own past level) of both targets and acquirers involved in cross-border acquisitions (CBAs). R&D persistence suggests knowledge accumulation over time within a company, but little is known about whether and how it is affected by CBAs. We identify two opposing forces driving post-CBA R&D persistence, which we refer to as managerial diversion and disruption (MDD) and knowledge and resource transfer (KRT). We hypothesize that MDD will have a direct and negative effect on R&D persistence in both the acquirer and the target, with the impact on the target being greater, and that KRT will positively moderate that effect through the transfer of knowledge and resources, with the moderating effect on the target being greater. Tracking multiple years prior to and after 272 cross-border deals, involving 28 home markets and 34 host markets, we find supportive evidence.

Keywords	Cross-border acquisitions; R&D persistence; Post-acquisition performance; R&D location
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- There are two opposing effects of cross-border acquisitions on R&D persistence of both the acquirer and the target
- Cross-border acquisition effects on R&D are overall negative in the short run, asymmetric between acquirers and targets, and asynchronous between short-term and long-term effects after an acquisition
- While both acquirers and targets experience post acquisition declines in R&D in the short run, the impact is greater for targets
- As time goes on, the negative effect continues to dominate for targets, but not for acquirer

Post-Acquisition R&D Persistence:

Unpacking the Impact on Acquirers and Targets in Cross-Border Acquisitions

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Post-Acquisition R&D Persistence:

Unpacking the Impact on Acquirers and Targets in Cross-Border Acquisitions

Abstract: We study the post-acquisition R&D persistence (R&D spending as a function of its own past level) of *both* targets and acquirers involved in cross-border acquisitions (CBAs). R&D persistence suggests knowledge accumulation over time within a company, but little is known about whether and how it is affected by CBAs. We identify two opposing forces driving post-CBA R&D persistence, which we refer to as managerial diversion and disruption (MDD) and knowledge and resource transfer (KRT). We hypothesize that MDD will have a direct and negative effect on R&D persistence in both the acquirer and the target, with the impact on the target being greater, and that KRT will positively moderate that effect through the transfer of knowledge and resources, with the moderating effect on the target being greater. Tracking multiple years prior to and after 272 cross-border deals, involving 28 home markets and 34 host markets, we find supportive evidence.

Keywords: Cross-border acquisitions, R&D persistence, Post-acquisition performance, R&D location.

1. Introduction

There is a substantial literature on the determinants and consequences of mergers and acquisitions (Haleblian, Devers, McNamara, Carpenter and Davison, 2009), which has been increasing over time [for a review, see, e.g., Ferreira, Santos, de Almeida & Reis (2014)]. A specific question that has long attracted scholarly attention in many disciplines regards the impact of mergers and acquisitions on the post-acquisition R&D expenditures of firms (Hitt, Hoskisson, Ireland & Harrison, 1991a, b; Veugelers, 2006; Bertrand & Zuniga, 2006; Bertrand, 2009; Stiebale, 2013; 2016). This is an important question because R&D expenditures capture the internal stock of knowledge of a firm (Berchicci, 2013), reflecting a firm's capacity for both conducting internal innovation and assimilating external knowledge (Cohen & Levinthal, 1990; Stock, Greis & Fischer, 2001).

Early studies did not examine cross-border acquisitions, and suggested that on balance acquisitions had a net negative impact on R&D expenditures for the combined entity [for a review, see Veugelers (2006)] and more recent studies have confirmed the negative outcome for both target and acquirers (Szücs, 2014). However, this broad conclusion has been challenged by studies focusing on cross-border deals where the evidence to date on the effect of cross-border acquisitions on firms' R&D is more mixed and has for the most part focused on single countries and either targets or acquirers, but not both. On one hand, there is emerging evidence to suggest that R&D expenditures increase post-acquisition in, for instance, French, Swedish and Chinese targets (Chen, Hua, & Boateng, 2017; Bandick, Görg & Karpaty, 2014; Bertrand, 2009; Eliasson, Hansson & Lindvert, 2017) and German acquirers (Stiebale, 2013). On the other hand, Stiebale (2016), who analyzes both targets and acquirers, finds that the consolidated post-acquisition R&D of European firms involved in cross-border transactions increases, with increases in the acquirer offsetting declines in the target. Håkanson and Kappen (2016) find that the closure rate of subsidiary R&D labs in Sweden was higher post acquisition.

We aim to advance our understanding of the impact of cross-border acquistions on R&D expenditures by organizing and synthesizing insights from the existing literature to inform our empirical analysis, and to provide an improved empirical design. Based on the strategic management and international business (IB) literatures, we suggest that these conflicting results reflect two distinct and contradictory theoretical perspectives on post-acqusition performance. One perspective focuses on the strains placed on corporate financial and managerial resources following an acquisition, which result in declining post-acquisition R&D. The post acquisition environment is characterized by anxiety, uncertainty and disruptions that hinder innovation and R&D (Srikanth & Micki, 2012). Managerial attention is diverted from longer run investments such as R&D to shorter-term issues such as short-run financial performance, departure of key personnel, and post-acquisition integration and restructuring costs (Cannella & Hambrick, 1993; Hambrick & Cannella, 1993; Hitt et al., 1991a, b; Iverson & Pullman, 2000). We refer to this perspective as managerial disruption and diversion (MDD), and we propose that MDD factors have a negative impact on R&D persistence in both acquirer and target after a cross-border acquisition. We use this as our baseline hypothesis.

On the other hand, recent strategic management and IB literature on multinational enterprises (MNEs) emphasizes the two-way flows of knowledge across borders and between headquarters and subsidiaries (e.g., Bertrand & Capron, 2015; Cantwell, 2017; Driffield, Love & Yang, 2016; Rabbiosi & Santangelo, 2013; Yang, Mudambi & Meyer, 2008), and highlights the possibility that such redeployment may in fact increase R&D in both acquirers and targets. Similarly, it is argued that acquisitions create opportunities for both technological exploitation and exploration that may also facilitate R&D efforts overtime (Phene, Tallman & Almeida, 2012). We refer to this perspective as knowledge and resource transfer (KRT) and propose that it can positively moderate the negative MDD effect in both the target and the

acquirer. Moreover, although we propose that MDD and KRT will impact both targets and acquirers, we also argue that their effects will be asymmetric, and in particular that both the negative MDD effects and the positive moderating KRT effects are more salient in targets, relative to acquirers (Capron & Guillén, 2009; Walsh, 1988; Driffield et al., 2016).

Empirically, we advance the literature in three ways. First, we focus on R&D *persistence*, defined as the current level of R&D spending as a function of its own past level, to understand whether R&D persistence increases or decreases in the post-acquisition period. Prior studies have largely focused on R&D spending or intensity and paid little attention to persistence (Máñez, Rochina-Barrachina, Sanchis-Llopis & Sanchis-Llopis, 2015; Roper & Hewitt-Dundas, 2008; Tavassoli & Karlsson, 2015). Our focus on R&D persistence introduces consideration of the overall R&D trend of both target and acquirer, and is an indicator of knowledge accumulation and the continuity of innovative capacity over time within a company (Antonelli et al., 2012; Tavassoli & Karlsson, 2015).

Second, we use a broad cross-national sample of both acquirers and targets to study the persistence of R&D in both the acquirer and the target over time after cross-border acquisitions. Our sample consists of 272 cross-border deals, involving 28 home markets and 34 host markets, with data on the pre- and post-acquisition R&D spending of both domestic targets and foreign acquirers. Third, we test our hypotheses with a two-equation (acquirer and target) model using a specification grounded in the economics model of endogenous growth (Romer, 1990). In this model, R&D persistence is characterized by an equation in which current (own) R&D is a function of past (own) R&D (Antonelli et al., 2012; Bertrand and Zuniga, 2006; Cefis and Marsili, 2015). We use a two-equation (acquirer and target) conditional (recursive) mixed process (CMP) model (Roodman, 2009, 2015), which is appropriate in our setting because it allows for correlations and simultaneity between equations as well as nonlinear modeling.

Our primary contribution is therefore the development and estimation of a theory-based empirical model that addresses gaps in the extant empirical literature. Specifically, we contrast two relatively separate perspectives from the literature (MDD and KRT), and integrate them in a single model. Prior research does not isolate KRT considerations from MDD considerations so that most analyses of the relative post-acquisition performance of targets and/or acquirers conflate the two. Our results provide strong and robust evidence for both the direct negative MDD effect and a positive moderating KRT effect, for both the acquirer and the target. We also show that the overall trend of R&D continuity is disrupted post-acquisition, even in the face of the possibility of knowledge transfer.

In addition, our model allows us to consider outcomes in terms of both time and place. We find that the outcomes are both asymmetrical and asynchronous. That is, the post-acquisition declines in R&D persistence are more pronounced for the target (asymmetrical), and in fact are reversed for the acquirer over time (asynchronous). These results contribute to the IB literature regarding R&D resource deployment and location decisions by MNEs. The deployment of R&D and other creative resources across countries is among the most important location decisions of MNEs (Lehrer and Asakawa, 2002; Mudambi, Narula and Santangelo, 2018). Our results point to a centralization of R&D in the acquirer in the long run. Thus, although knowledge and resources may flow in both directions, the outcome favours location of R&D resources in the acquirer country.

2.Literature Review and Hypotheses

2.1. Managerial diversion and disruption (MDD)

The management literature (e.g., Baber, Fairfield & Haggard, 1991; Hitt et al., 1991a, b; Krishnan, Hitt & Park, 2007; Marginson & McAulay, 2008) generally suggests that post-acquisition R&D declines because managerial attention in both the acquirer and the target is diverted away from R&D investments for various reasons (Hitt et al., 1991a, b).

First, acquisitions are often associated with acquisition premiums and/or increases in debt, leading to increased attention to short-run balance sheets and possible decreases in R&D expenditures. Acquisition premiums place pressure on managers to increase shareholder returns, making managers more risk averse and short-term oriented, thus limiting long-term investments such as R&D (Baber et al., 1991; Krishnan et al., 2007; Marginson & McAulay, 2008). Similarly, increases in debt are associated with greater financial risk thus putting pressure on managers to use cash flows to service and repay the debt, at the expense of R&D investments (Hitt et al, 1991a). Acquirer managers may transfer some of the pressure to target managers through asset restructuring, disposal, and recombination (Capron, 1999; Capron, Dussauge & Mitchell, 1998). Such activities will also divert attention of target managers from focusing on R&D investments.

Second, managerial stress and conflict between the acquirer and the target in post-acquisition integration suggests that more attention in both acquirer and target is given to short-run concerns related to stricter financial controls and integration rather than long-run investments in innovation (Hitt et al., 1990; Hitt, Hoskisson, Johnson & Moesel, 1996; Krishnan et al., 2007). In addition, the post-acquisition period is often associated with the departure of high level executives (Hambrick & Cannella, 1993; Krug & Hegarty, 1997) and skilled employees in target firms including those involved in R&D (Iverson & Pullman, 2000). These departures not only divert managerial attention and shorten time horizons, but they also disrupt the firm's ability to effectively maintain its R&D capacities.

Although these arguments have not explicitly focused on cross-border acquisitions, we suggest that they are likely more relevant in a cross-border context. For example, Shimizu, Hitt, Vaidyanath and Pisano (2004) in a literature review of cross-border mergers point to the increased complexity of integrating units across borders and the degree to which this may distract managers from focusing on longer-run issues. Similarly, other scholars also

point to the increased acquisition costs arising from cross-cultural integration and employee retention (Ahammad, Tarba, Liu & Glaister, 2016; Weber, Yedidia Tarba & Reichel, 2009).

Following these arguments, we propose as a baseline hypothesis that other things equal, the persistence of R&D spending is expected to decline, post-acquisition. As R&D persistence captures current R&D as a function of past R&D, the hypothesis implies that R&D spending is less related to its own past level in both targets and acquirers after the acquisition.

H1a: Other things equal, R&D persistence will decline in the acquirer after a cross-border acquisition.

H1b: Other things equal, R&D persistence will decline in the target after a cross-border acquisition.

We next discuss whether the decline in R&D persistence will be asymmetric between acquirer and target. With respect to MDD, there is evidence that acquired company employees often find themselves in conflict with the acquiring company managers (Aguilera & Dencker, 2004; Capron & Guillén, 2009; Puranam, Singh & Zollo, 2006). In contrast to the acquirer, whose ownership and control remain relatively unchanged, the target is subject to new management (i.e., a foreign parent) and potential management turnover (Conyon, Girma, Thompson & Wright, 2002; Walsh, 1988), all of which might divert target managerial attention away from longer-term strategies and create relatively greater pressures to reduce R&D. Potential centralized hierarchy may therefore direct resources to the acquirer (Seru, 2014), limit the incentive of target managers to innovate (Brusco & Panunzi, 2005), cause innovative managers to leave to form their own firms (Gompers, Lerner & Scharfstein, 2005), or even shut down entirely R&D activities of the target (Maksimovic, Phillips & Prabhala, 2011). Together, these factors all indicate that due to power asymmetry, MDD factors are likely to impact the target to a larger degree relative to the acquirer (Capron, 1999), so that

the impact of asset restructuring is "mostly directed at the target" (Capron & Guillén, 2009: 804). On balance, this suggests that any decline in post-acquisition R&D persistence will be higher in the target than in the acquirer:

H2: The decline in R&D persistence in the target, as hypothesized in H1b, is more salient than that in the acquirer, as hypothesized in H1a, after a cross-border acquisition.

2.2. Knowledge and resource transfer (KRT)

Although the MDD arguments focusing on costs associated with restructuring and integration point to a post-acquisition decline in R&D, what we refer to as the KRT literature suggests the opposite. That literature, developed mostly in strategic management and IB, implies that acquisitions may involve the two-way transfer of knowledge and resources between acquirer and target and can therefore mitigate the negative effects of MDD on R&D investment by both.

Specifically, in the strategic management literature, a series of studies, including Capron et al. (1998), Ahuja and Katila (2001), Finkelstein and Haleblian (2002), Capron and Guillén (2009), and Bertrand and Capron (2015), suggest the importance of resource redeployment in the post-acquisition period, including two-way knowledge transfers between the acquirer and the target. Here asset redeployment refers to the use by one firm (target or acquirer) of the resources of the other business, and this sharing can involve the transfer of both physical and intangible assets (Capron et al, 1998).

Similarly, the IB literature, which first focused on the transfer of knowledge from parent to subsidiary (Dunning, 1983), now also suggests that two-way cross-border transfers of knowledge are increasingly common (Driffield, Love & Menghinello, 2010; Driffield et al., 2016; Mudambi & Navarra, 2004; Narula, 2014; Singh, 2007; Yang et al., 2008). For instance, based on a survey covering 921 foreign affiliates in Italy, Driffield et al. (2010) find that 30% of affiliates experience two-way technology flows between parents and affiliates.

The idea that acquisitions facilitate two-way flows of knowledge and information is also implicit in the literature on knowledge complementarity (Cassiman & Valentini, 2016), knowledge spillovers (Henderson & Cockburn, 1996), and absorptive capacity (Cohen & Levinthal, 1990). While these studies often focus on the complementarity between internal and external sources of knowledge, we suggest that firms can benefit from knowledge transfers and spillovers across different firm subunits (e.g., parents and subsidiaries), which can, in turn, develop the capacity of the firm to absorb both internal and external knowledge.

We therefore follow previous literature in assuming that the past internal R&D expenditures of both acquirers and targets represent investments in building an internal stock of knowledge (Berchicci, 2013) as well as the "ability to evaluate and utilize outside knowledge" (Cohen and Levinthal, 1990: 128). Thus, we test the idea that two-way knowledge transfers between the acquirer and target are complements, where complementarity implies that undertaking more of one activity increases the marginal returns of another activity (Milgrom & Roberts, 1990). While the literature to date has typically examined complementarity between internal and external knowledge (Cassiman & Valentini, 2016), we explore the same issue from the vantage point of acquirer and target.

Thus, we hypothesize that other things equal, knowledge and resource transfer effects can positively moderate the negative MDD effects discussed above for both targets and acquirers.

H3a: The decline in R&D persistence in the acquirer, as hypothesized in H1a, is less salient, the higher is the target R&D.

H3b: The decline in R&D persistence in the target, as hypothesized in H1b, is less salient, the higher is the acquirer R&D.

As was the case for MDD, we also argue that KRT's moderating effects are asymmetric in their impact on targets and acquirers. First, the IB literature often finds that the

parent firm possesses superior knowledge and thus foreign acquisitions are meant to facilitate market entry, using knowledge from the parent. For example, Capron et al. (1998) suggest that managerial redeployment of R&D from the acquirer to the target is more likely because acquirers use their resources to improve the target in many ways, while reverse transfers occur only under specific conditions. Second, while subsidiaries may also possess and develop knowledge resources, we suggest that knowledge flows are more likely to go from the home country acquirer to the host country target so that the benefits to the target are more salient. This is because knowledge transfers from the acquirer (the headquarters) to the target (the subsidiary) are typically more voluntary. For example, Awate, Larsen and Mudambi (2015) argue that the parent's commitment to learning from subsidiaries is less than the subsidiaries' commitment to learning from the MNE parent.

None of this implies that reverse transfers (from target to acquirer) do not occur, only that they are likely to be less salient. Empirically, focusing on foreign affiliates in Italy, Driffield et al. (2010) find that there is a very minor percentage (6%) of affiliates experiencing technology flows exclusively from affiliates to parents. Similarly, Bandick et al. (2014) suggest that in Sweden, foreign technology transfers mostly from parents to Swedish affiliates accompanied cross-border acquisitions.

On balance, we therefore suggest that the KRT effect is stronger from acquirer to target:

H4: The positive moderating effect of KRT on R&D persistence from the acquirer to the target, as hypothesized in H3b, is more salient than that from the target to the acquirer, as hypothesized in H3a.

3. Method

3.1. Estimation model

In order to test our hypotheses we adopted a specification for our two R&D equations (acquirer and target) grounded in Romer's model of endogenous growth (Romer, 1990). The model suggests current R&D is a function of past R&D (Antonelli et al., 2012; Bertrand & Zuniga, 2006; Cefis & Marsili, 2015), which models the persistence of innovative capability. Persistence in innovation activity is taken to reflect the innovative capabilities of a firm (Cefis & Marsili, 2015; Geroski, Van Reenen & Walters, 1997) and the MDD argument implies that these capabilities are diminished in the post-acquisition period. We follow Cohen and Levinthal (1990), Berchicci (2013), Hagedoorn and Wang (2012) and Mudambi and Swift (2012) in using R&D as a measure of a firm's ability to generate and absorb knowledge and García-Quevedo, Pellegrino and Vivarelli (2014) in using changes in persistence as the basis for hypothesis testing. Our test of the MDD argument is therefore whether R&D persistence declines post-acquisition in both acquirer and target. Our test of the moderating role of KRT is whether acquirer (target) lagged R&D positively moderates the decline in R&D persistence of target (acquirer). Formally, we estimate simultaneously:

$$(1) R\&D^{a}_{i,t} = a_0 + a_1 \cdot R\&D^{a}_{i,t-1} + a_2 \cdot PE \cdot R\&D^{a}_{i,t-1} + a_3 \cdot R\&D^{t}_{i,t-1} \cdot PE \cdot R\&D^{a}_{i,t-1} + \sum^{K}_{k=4}(a_k \cdot X_k) + e^{a}_{i,t}$$

$$(2) R\&D^{t}_{i,t} = b_0 + b_1 \cdot R\&D^{t}_{i,t-1} + b_2 \cdot PE \cdot R\&D^{t}_{i,t-1} + b_3 \cdot R\&D^{a}_{i,t-1} \cdot PE \cdot R\&D^{t}_{i,t-1} + \sum^{K}_{k=4}(b_k \cdot X_k) + e^{b}_{i,t}$$

Where superscript *a* denotes acquirer and *t* target respectively, subscripts *i* the *i*th deal and *t* year *t*, *PE* is a *post-acquisition* dummy (1 if in a year after acquisition completion, and 0 otherwise), $\sum^{K}_{k=4}(a_k \cdot X_k)$ and $\sum^{K}_{k=4}(b_k \cdot X_k)$ represent control variables and $e^{a}_{i,t}$ and $e^{b}_{i,t}$ the residuals in each equation. Assuming $\sum^{K}_{k=4}(a_k \cdot X_k)$ and $\sum^{K}_{k=4}(b_k \cdot X_k)$ are constant between the pre- and post-acquisition periods, our hypothesis tests are that persistence is reduced post-acquisition in both acquirer and target (H1a: $a_2<0$; H1b: $b_2<0$); that persistence reduction is higher in the target (H2: $a_2>b_2$); that R&D of the acquirer (target) positively moderates persistence of the target (acquirer) (H3a: $a_3>0$; H3b: $b_3>0$); and that the positive moderation effects are stronger from the acquirer to the target (H4: $a_3>b_3$).

Thus, we conducted a type of event study analysis to examine the persistence of R&D expenditures of both acquirers and targets between the years prior to and after an acquisition (in total an 11-year window described below). To allow for simultaneous effects between the acquirer and the target R&D activities and to test for potential asymmetric effects, we employed the CMP estimation model (Roodman, 2009, 2015) to estimate equations (1) and (2). The CMP model is appropriate for several reasons. First, it allows for residual terms in different equations to be correlated. Second, unlike two-stage modeling, it runs equations simultaneously, which is consistent with our argument that the acquirer and the target R&D levels are mutually dependent after a transaction. Third, unlike some other two-equation modeling techniques such as seemingly unrelated regressions, it allows non-linear relationships between the dependent and the right-hand-side variables. In our case, both dependent variables are supposed to be non-negative and thus present a corner solution problem. We therefore use random-effects Tobit regressions in both CMP equations and report clustered standard errors by firm identity.

3.2. Data and sample

We created an international data sample by merging the cross-border M&A deals by non-financial acquirers from Thomson SDC Platinum M&A Data with BvD Zephyr data. We compared the two data sources to fill missing values and removed duplications based on deal and firm identities. We then merged the deal-level data with firm-level information from BvD Orbis, Compustat, and Mergent Online databases. We also created industry-level information by aggregating firm-level data in these databases. We collected data for cross-border institutional distance measures following Berry, Guillén and Zhou (2010) and market-level minority shareholder protection following Guillén and Capron (2015). The sources for these data include Hofstede's website and the World Bank databank. We kept only transactions that were valued at over US$1 million (Miller, LeBreton-Miller & Lester, 2010) and involved an

acquisition of at least 20% voting shares in the target firm, which is often seen as a sign of control (Claessens, Djankov & Lang, 2000; Dinç, 2005). To exclude potential outliers, we further removed any home or host markets where there was only one transaction. Lastly, not all acquisitions are driven primarily for R&D activities (Schiffbauer, Siedschlag, & Ruane, 2017). Since it is impossible to directly observe the motivations of each acquisition, we selected a sample to which we think R&D is relevant, if not a motivation, for the deals. To do so, we eliminated transactions in which both acquirers and targets reported zero or missing R&D throughout the entire sample period, because R&D activities may be irrelevant to these firms.

After removing missing values, we arrived at a panel of 2,718 acquirer-target-year observations, representing 272 cross-border acquisitions. These transactions were completed between 1990 and 2009, as Table 1 reports. The firm-level data for each acquirer-target pair covers the years between 1985 and 2014. In this way, we allowed for a maximum of an 11-year window (from five years prior to and five years after an acquisition) for each acquirer-target pair. More than 90% of the acquirer-target pairs reported complete data for the entire range of 11 years. However, our imposition of an 11-year window does limit the sample size.

[Tables 1 and 2]

We report industry distributions in Table 2. In terms of firm-year observations, the acquirers represent all non-financial industries, including agriculture, forestry, and fishing (0.63%), mining (2.39%), construction (4.42%), manufacturing (58.65%), transportation, communications, electric, gas and sanitary (15.67%), wholesale trade (2.21%), retail trade (3.75%), services (10.74%), and non-classifiable establishments (1.55%). The targets represent all industries, including agriculture, forestry, and fishing (0.33%), mining (4.01%), construction (1.03%), manufacturing (59.35%), transportation, communications, electric, gas and sanitary (16.26%), wholesale trade (4.05%), retail trade (1.51%), finance, insurance and

real estate (1.40%), services (11.66%), and non-classifiable establishments (0.40%). In our sample, about 43% of deals (or 45% firm-year observations) were related transactions within the same two-digit SIC codes. In terms of geography, the sample represents 28 home markets and 34 host markets (see Supplement I. Table S1). The most represented home markets are France (33 deals), Japan (32), Germany (29), United Kingdom (22), and United States (19), together representing about 50% of the sample. The most represented host markets are Germany (36 deals), India (20), Australia (17), United States (17), France (15), and Canada (11), collectively representing about 43% of the sample. These statistics suggest that most of cross-border acquisitions were conducted within the developed world, which is representative of R&D-active multinational enterprises worldwide (e.g., Castellani, Montresor, Schubert, & Vezzani, 2017).

3.3. Variables

3.3.1. Dependent variables

Acquirer R&D and *Target R&D* are measured respectively as the logarithmic transformation of R&D expenditure in US$ thousands (plus one before logarithm) of the acquirer firm and the target firm in the current year. We kept unconsolidated R&D values for the acquirers to avoid double counting of the targets' R&D after an acquisition.

3.3.2. Independent variables

To capture R&D persistence, we included *Acquirer lagged R&D* and *Target lagged R&D*, which are values of dependent variables in the previous year.

3.3.3. Moderating variables

In relation to hypotheses H1a and H1b, we interacted the independent variables with *Post-acquisition* dummy to test for structural changes in R&D persistence after an acquisition entered the time window as an event. This dummy takes the value 1 if in the year after the acquisition completion, and 0 otherwise. We interacted independent variables with the other

firm's *lagged R&D* (measured in the post-acquisition period) to test for H3a and H3b. We also conducted coefficient inequality tests for H2 and H4. Because we focus on how moderators impact the R&D persistence after an acquisition, all moderators are censored to value zero prior to an acquisition.

As robustness checks, following the literature that the potential change in long-term performance is often found three years after an acquisition (e.g., Rau & Vermaelen, 1998), we further divided the post-acquisition period into two dummies, *Post-acquisition short-term (ST)* (1-2 years after the completion of a deal) and *Post-acquisition long-term (LT)* (3 or more years after the completion of a deal).

3.3.4. Control variables

We controlled for a series of variables at the levels of firm, industry, home and host markets, following the prior literature on cross-border acquisitions (e.g., Bertrand & Capron, 2015; Capron & Guillén, 2009; Shimizu et al., 2004; Xie, Reddy, & Liang, 2017). Specifically, we controlled for the other firm's lagged R&D to account for potential strategic coordination between the acquirer and the target in their R&D expenditure after an acquisition. At both the acquirer and the target levels, we controlled for *Firm-specific initial conditions* in R&D activities, measured as the logarithm of the earliest R&D spending of each firm in the database (mostly in the year of IPO), *Firm assets*, measured as the logarithm of total assets, *Firm size*, measured as the logarithm of total number of employees, and *Prior M&A experience*, measured as the logarithm of total number of completed domestic and cross-border M&As in the last ten years prior to a focal acquisition. These firm-specific variables control for the existing financial, human, and knowledge resources a firm can exploit after an acquisition.

At the industry level, we controlled for *Industry R&D intensity* for both the host and the home markets, calculated as the total R&D expenditure divided by total assets at the four-

digit SIC level. We also included *Industry competition* at the four-digit SIC level for both the home and the host markets, measured as the Herfindahl score of the sales of the largest four companies in the industry. These two variables capture the industry norms and market competitive pressures for R&D activities.

In both the home and the host market levels, we controlled for *Economic size*, measured as the logarithm of GDP in purchasing power parity, and *Economic development*, measured as the logarithm of GDP per capita (Xie et al., 2017). Following Guillén and Capron (2015), we also included *Minority shareholder protection* of the home and the host markets to account for potential impact on R&D expenditure by short-term shareholder pressures in both markets.

At the bilateral level, we controlled for *Acquirer-target industry relatedness*, measured as 1 if they share the same four-digit SIC codes, 0.75 if different four-digit SIC codes but the same three-digit SIC codes, 0.5 if different three-digit SIC codes but the same two-digit SIC codes, 0.25 if different two-digit SIC codes but the same one-digit SIC codes, and 0 if different one-digit SIC codes. We also controlled for a series of country-level dyadic distance measures to control for team coordination problems due to differences between home and host markets (Ambos & Schlegelmilch, 2004). *Economic distance* is based on the difference in four dimensions (income, inflation, exports, and imports) between country pairs; *Demographic distance* is based on the difference in life expectancy, birth rate, population under 14, and population under 65, from Berry et al. (2010); *Cultural distance* is measured using Hofstede's cultural dimensions (Kogut & Singh, 1988); and *Minority shareholder protection distance*, calculated as the percentage difference in the minority shareholder protection score between the home and the host markets.

Lastly, we included in both equations a series of dummy variables for year, home and host market, and the acquirer's (the target's) industry based on two-digit SIC codes.

3.4. Results and analysis

We first report our summary statistics, correlation matrix, and variance inflation factors (VIFs) in Table 3. The sample presents no severe multicollinearity, because no correlation between any right-hand side variables is above 0.6 and no VIF exceeds a value of 5.

[Tables 3 and 4]

The CMP regression results are reported in Table 4. In Model 1, we estimated a simple persistence model with only the control variables included. The persistence coefficient (the coefficient on lagged own R&D) is estimated to be 0.59 (0.51) for the acquirer (target). In Model 2, we added the interaction of the *Post-acquisition* dummy with lagged own R&D, which is the basic test for H1a and H1b (R&D persistence declines after the acquisition). The χ^2 test suggests that this specification is preferred to Model 1. Results indicate that a cross-border acquisition has a slightly negative but statistically insignificant ($b=-0.02$, $p>0.1$) impact on the R&D persistence of the acquirers, but a negative and statistically significant ($b=-0.13$, $p<0.001$) impact on the targets. This asymmetry is also supported by the t-test of coefficient equality ($p<0.001$), the test for H2. Thus, these results support H1b and H2, but not H1a.

In Model 3, we included the other firm's lagged R&D after acquisition as a moderator, and the results indicate a positive moderating impact on the R&D persistence in both the acquirer ($b=0.03$, $p<0.001$) and the target ($b=0.02$, $p<0.1$), thus providing support for H3a and H3b. However, we found no evidence of any asymmetry ($p>0.1$ for coefficient equality test) in that the positive effects appear to apply equally to target and acquirer. These findings support H3a and H3b, but not H4. We explore this further below.

Results for some control variables show evidence of asymmetric R&D effects in the acquirer-target relationship. First, acquisition with high control (equity share greater than 50%) seems to be unrelated to the acquirer's R&D but has a negative impact on the target's

R&D. Second, the acquirer's M&A experience improves the acquirer's R&D after the acquisition, but reduces the target's R&D. This implies that more experienced acquirers are more sophisticated in using the target to both reduce costs and transfer knowledge.

We also note that, minority shareholder protection is negatively related to R&D of both the acquirers and targets, suggesting that resources may be diverted away from R&D if the overall capital market protects relatively short-term financial interests, thus providing some additional support for the MDD view.

To estimate the economic significance of these results, we need to hold $\sum^{K}_{k=4}(a_k \cdot X_k)$ and $\sum^{K}_{k=4}(b_k \cdot X_k)$ constant between pre- and post-acquisition periods to rule out any confounding effects not related to the moderating effects of the post-acquisition dummy and the other firm's lagged R&D.[1] We estimate that the mean value of acquired lagged R&D of 6.46 would lead to a decline of about US$46.82 thousand or 17.62% from pre- to post-acquisition periods. Based on a similar calculation, a mean value of target lagged R&D of 5 would lead to a decline of US$30.97 thousand or 64.43%, which is significantly higher than the percentage in the acquirer. In a similar way, we can estimate the economic significance of KRT effects.[2] An increase in the target lagged R&D from 0 to 6 would lead to an increase in the acquirer R&D by about US$481.38 thousand or 219.89%, when acquirer lagged R&D is at its mean value of 6.46. The same increase in the acquirer lagged R&D would lead to an increase in the target R&D by about US$7.84 thousand or 82.21%, when target lagged R&D is at its mean value of 5. This suggests that the positive moderating effect of the acquirer lagged R&D on the target is smaller. We simulated the above discussion on the economic significance of the *post-acquisition* dummy (evidence for H1a, H1b, and H2) in Figure 1 and the other firm's *lagged R&D* (evidence for H3a, H3b, and H4) in Figure 2. These findings suggest that there is potentially an offset between the general post-acquisition decline in R&D persistence and an increase in it due to the other firm's lagged R&D level. However,

our estimation results suggest that the magnitude of cross-firm R&D effects is insufficient to compensate for the post-acquisition decline in R&D persistence in both acquirers and targets (See detailed calculations in the Supplement II).

3.5. Robustness checks

[Table 5]

As robustness checks of our hypotheses, we divide the post-acquisition period into the short term (1-2 years) and the long term (3 or more years), and report results in Table 5. In Models 4 and 5, we replicated the main regressions by replacing the post-acquisition dummy with short-term and long-term dummies. Specifically, results in Model 4 suggest that an acquisition caused a salient decline of R&D persistence in both the acquirer ($b=-0.12$, $p<0.001$) and in the target ($b=-0.13$, $p<0.05$) in the short term after acquisition. However, R&D persistence bounced back in the acquirers over the long term ($b=0.08$, $p<0.05$), compared to a continued decline in the targets in the same period ($b=-0.13$, $p<0.05$). Findings also suggest that the asymmetry is only statistically significant in the long-term period ($p<0.001$). These results suggest that both the MDD effects and asymmetry are asynchronous. We simulated these findings in Figure 3.

[Figure 3]

Model 5 suggests statistically significant cross effects of lagged R&D in both firms. In the short term, the effects of the target's R&D on the acquirer's R&D are higher ($b=0.03$, $p<0.001$) than the other direction ($b=0.01$, $p<0.1$), with the asymmetry being statistically significant ($p<0.1$). This is different from our prediction in H4 that more knowledge transfer will take place from the acquirer to the target. It is likely because in the short term the acquirer can forcefully relocate R&D resources such as patents, technicians and researchers, and R&D managers from the target to the headquarters, which would boost the acquirer's R&D spending more quickly. It may also be because foreign subsidiaries in our sample

(mostly located in advanced markets) were playing active knowledge-creating roles for their parent (Cantwell & Mudambi, 2005). However, such cross effects between the two firms tend to converge over the long term ($b=0.02$, $p<0.001$ for acquirer R&D; $b=0.02$, $p<0.05$ for target R&D; coefficient equality result is statistically insignificant), perhaps because increasingly effective communications, accumulative inter-organizational learning, and setting of common routines and goals between the two firms over time facilitate knowledge transfer in both directions. We simulated these findings in Figure 4.

[Figure 4]

The cross-border context we are studying presents an opportunity to examine other issues that have been raised in the literature, and in particular cross-country factors that might moderate post-acquisition R&D performance. For example, the argument that shareholders pressure companies to become more short-sighted in the post-acquisition period may differ across institutional contexts, as the structure of capital markets differs across countries (Capron & Guillén, 2009; Gedajlovic & Shapiro, 1998; Marginson & McAulay, 2008). Therefore, as a supplementary test, we use the quality of *home minority shareholder protection* to capture the degree to which minority shareholder interests will be material and examine whether it moderates the degree of R&D persistence.

In addition, *cultural distance* can increase the costs of post-acquisition integration and can impact the performance of both the target and acquirer in cross-border acquisitions (Basuil & Datta, 2015) and can in particular divert managerial attention from R&D investments. A variety of studies argue that cultural distance can increase integration costs of knowledge transfer and foster internal conflict, although there are possibly offsetting contextual factors that might limit its negative impact (Ahammad et al., 2016; Björkman, Stahl & Vaara, 2007; Reus & Lamont, 2009; Slangen, 2006; Stahl & Voigt, 2008; Vaara, Sarala, Stahl & Björkman, 2012). Few studies focused specifically on innovation but Bauer,

Matzler and Wolf (2016) suggest that cultural similarity enhances the innovation outcomes of acquisitions. Thus, we test for the possibility that larger differences in national cultures between home and host country firms may increase integration difficulties in the short term, thus diverting managerial attention away from long-term investments such as R&D and so negatively moderating the negative MDD effect.

These results are reported and discussed fully in the Supplement III. Specifically, home minority shareholder protection increases R&D persistence of the acquirer but reduces it in the target. But such asymmetric patterns are only significant in the short term. Cultural distance has a weak impact on the acquirer, but significantly reduces R&D persistence in the target. Unlike shareholder pressures, this asymmetry is only significant in the long term. The main conclusion is that including these moderating variables does not alter our primary results, and in fact supports the conclusion that the negative R&D consequences of cross-border acquisitions falls mainly on the targets. Results are discussed more fully in the Supplement III.

4. Discussion

4.1. Implications for research

In this paper, we have used the existing literature in strategic management and IB to identify two broad and opposing forces that can affect post-acquisition R&D performance: one that focuses on the factors that reduce post-acquisition R&D (MDD) and one that works to increase it (KRT). To estimate their separate effects, we employ a simple, but theoretically supported specification in which the R&D of the acquirer (target) in the current period depends on its own lagged R&D, with the R&D of the target (acquirer) acting as a positive moderating variable. We therefore ask whether the R&D process is equally persistent before and after the acquisition, whether the process is the same for acquirers and targets (asymmetry), and whether the relative weights of the positive and negative forces change

over time (asynchronous). Although recent studies include both acquirers and targets in their estimation (Stiebale, 2016; Szücs, 2014), we are the first to focus on R&D persistence, to distinguish between MDD and KRT effects, and to employ an estimation technique (CMP) that is consistent with both the potential linkage between the error terms of the equations for acquirer and target, particularly post-acquisition, and the non-linear nature of our equations.

Our results contribute to the understanding of several issues previously identified in the literature. First, our finding that there are both positive and negative forces driving post-acquisition R&D helps to more clearly define the cases where one may dominate the other and cautions against studies that focus on only one. Our empirical findings based on a global sample suggest that R&D persistence declines immediately after the acquisition for both the acquirer and the target, lending evidence to the dominating role of MDD in negatively affecting R&D spending in the short term. We also find asymmetry between acquirer and target in their R&D persistence over time; acquirer R&D persistence increases whereas target R&D persistence continues to decrease in the long term, suggesting that KRT factors offset R&D reductions due to MDD for the acquirer but not for the target.

Second, our finding that reductions in R&D persistence are more pronounced in targets than in acquirers is broadly consistent with similar asymmetrical results found in Stiebale (2016) and Szücs (2014). However, we also find that R&D persistence in acquirers first declines, but then increases, so that over time the R&D performance of acquirers increases (asynchronous). This is consistent with Stiebale's (2016) evidence for cross-border acquisitions, but not with Szücs (2014), who did not focus exclusively on cross-border acquisitions. One possible implication is the knowledge transfers from targets to acquirers are more likely to occur in cross-border settings and more research on this issue is warranted.

Third, we contribute to the discussion of the bi-directional nature of knowledge and resource transfers across borders. We find evidence that knowledge and resource transfers are

bi-directional and equal in the longer run; in the short run, they are bi-directional but not equal (favouring the acquirer). We predicted more knowledge transfer from parent (acquirer) to subsidiary (target) but our results do not support this hypothesis in the short run or in the longer run. This result is likely driven by short run consolidation efforts by the acquirer involving immediate relocation and transfer of R&D resources and knowledge from the target to the acquirer. However, these apparently diminish over time, and more attention should be paid to the motivations and mechanisms that drive these decisions.

Fourth, while our evidence, like that in Stiebale (2016), points to lower levels of R&D in targets post-acquisition, there is country-specific evidence discussed above, suggesting the reverse. Future research should focus on the question of whether and why cross-country evidence is different from within-country evidence. We suspect that the former studies, such as ours, focus on larger firms and deals, and that our results may therefore not hold for smaller firms and transactions.

Finally, and in summary, our analysis points to the advantages of examining both acquirers and targets at the same time. Decisions regarding R&D are made simultaneously, and their effects are linked. Our results suggest that both MDD and KRT outcomes reflect a power imbalance between the two firms, with the acquirer in a more powerful position than the target in terms of resource allocation and restructuring. Therefore, any separate examination of each firm without controlling for the other or any aggregated outcome for the combined entity would confound the nuanced asymmetric links between the two firms. Exactly how they are linked, that is why, how and where decisions are made in cross-border settings remains an important research issue.

4.2. Limitations and future directions

In addition to the issues raised above, we note several other areas where future research might focus. First, while R&D spending (and its persistence) is a direct measure of

the innovation inputs of a firm, future studies should consider innovation outputs including new products and patents. Second, our conclusion on the asymmetry and asynchronicity of R&D activities of acquires and targets requires more research that provides more precise empirical evidence regarding the exact mechanisms that define MDD and KRT. Third, we have not distinguished acquisitions by motive, and future studies should differentiate knowledge-seeking from knowledge-exploiting acquisitions to determine how robust our results are. Lastly, while in this study we focus on firm-level factors (e.g., MDD and KRT), we suggest the acquisition effects on R&D persistence also depend on many country-specific conditions at home, host, and bilateral levels. Our additional analysis of home-country minority shareholder protection and home-host national cultural distance provides some evidence that these factors are important, but future research may wish to focus more fully on the country-level moderators that may impact the negative consequences of acquisitions on R&D persistence.

4.3. Conclusion

Our evidence suggests the cross-border acquisition effects on R&D are overall negative in the short run, asymmetric between acquirers and targets, and asynchronous between short-term and long-term effects after an acquisition. We do find evidence of two-way knowledge transfer, but it is not sufficient in the short run to overcome the negative short run effects of the acquisition. Thus, R&D persistence declines in both acquirers and targets immediately after the acquisition, but the impact on targets is greater. As time goes on, the negative effect continues to dominate for targets, but not for acquirers, so that acquirer R&D persistence ultimately rises.

Our results have implications for both innovation management practices and public policy. First, both parties to an acquisition should clearly understand the two basic forces we have identified, and their implications. For example, acquirers should be aware that any

expected R&D synergies from an acquisition may not materialize for several years, and in the interim R&D performance may suffer.

Second, public policy makers like screening agencies of inward foreign direct investment, should understand the potential consequences of allowing foreign firms to acquire local firms with R&D capabilities. Our results suggest that the R&D investments of local firms may diminish over time after a cross-border acquisition. Policies can be designed to minimize the loss of R&D resources and capabilities, ranging from creating a favorable business environment that attracts foreign R&D activities to blocking foreign acquisitions aiming to take over local R&D resources. To the extent that a host country (and targets) have as a goal the maintenance of a strong local innovation presence, they may wish to attach conditions on the acquisition that will protect local R&D resources.

FOOTNOTES

[1] That is, we need to hold all confounding factors constant that are not directly related to R&D persistence. We therefore included acquirer-related industry relatedness, control at entry, economic distance, demographic distance, cultural distance, minority shareholder protection distance at zeros because their values are meaningless until there is formally a parent-subsidiary relationship, fixed-effects dummy variables at zeros, and all other control variables at their mean values. Under this assumption, we have $\sum^{K}_{k=4}(a_k \cdot X_k)$= 1.7711 and $\sum^{K}_{k=4}(b_k \cdot X_k)$ =0.2552. Therefore, the decline in R&D for acquirer from pre- to post-acquisition is $e^{(0.59\times6.46+1.7711)}$-$e^{[(0.59-0.03)\times6.46+1.7711]}$ =US$46.82 thousand or 46.82/$e^{(0.59\times6.46+1.7711)}$=17.62%, when its lagged R&D is at the sample's mean value of 6.46. The decline for target is $e^{(0.56\times5+0.2552)}$-$e^{[(0.56-0.16)\times5+0.2552]}$ =US$30.97 thousand or 30.97/$e^{(0.56\times5+0.2552)}$=64.43%, when its lagged R&D is at the sample's mean value of 5.

[2] We followed the same approach as we did to calculate the moderating effects of *post-acquisition* dummy. When the target's lagged R&D increases from 0 to 6 as a moderator, the increase in R&D for acquirer is $e^{[(0.59-0.03+0.03\times6)\times6.46+1.7711]}$-$e^{[(0.59-0.03)\times6.46+0.7711]}$=US$481.38 thousand or 219.89%, when its lagged R&D is at the sample's mean value of 6.46. The same increase in the target would however be $e^{[(0.56-0.16+0.02\times6)\times5+0.2552]}$- $e^{[(0.56-0.16)\times5+0.2552]}$=US$7.84 thousand or 82.21%, which is significantly less than the acquirer.

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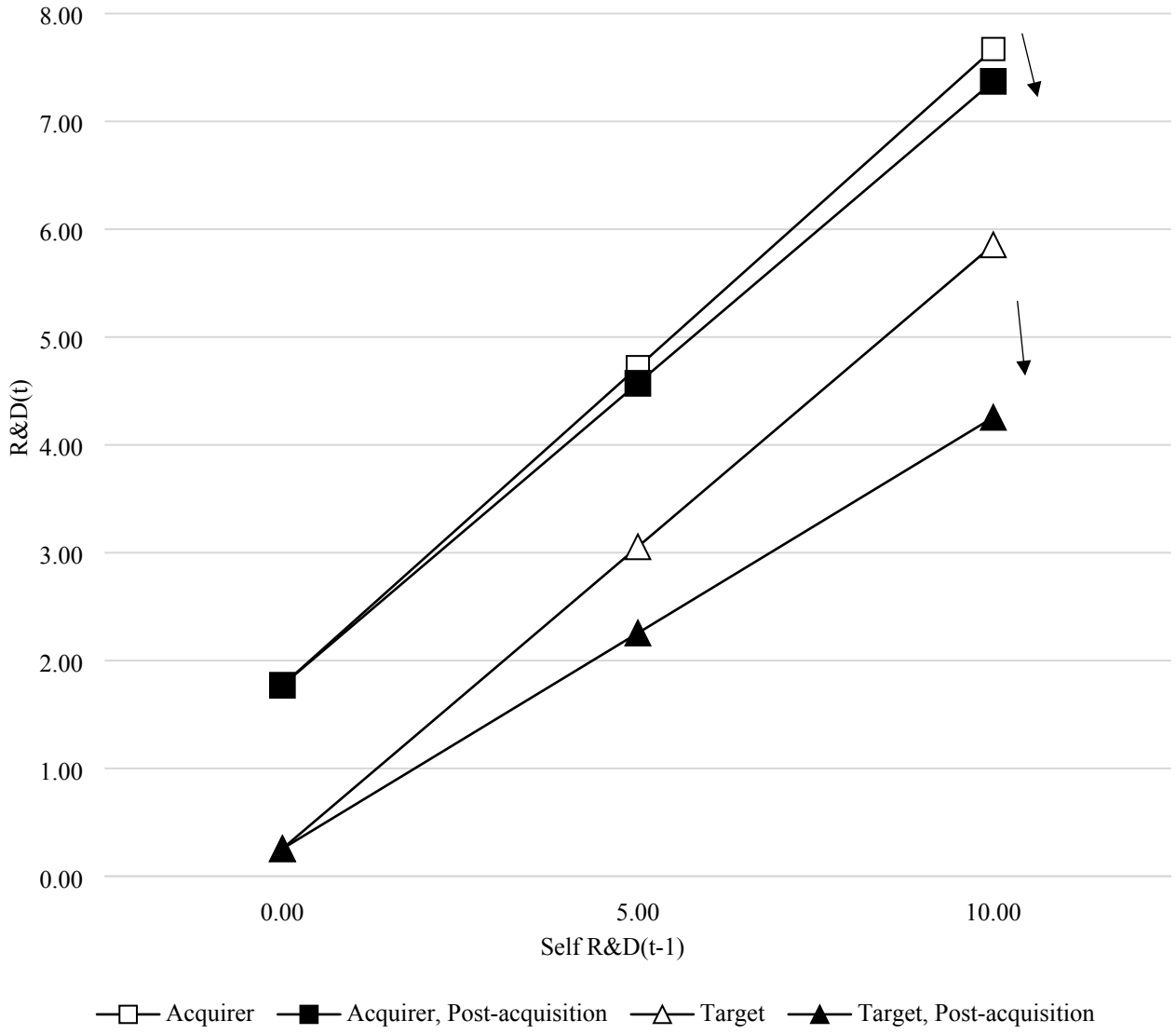
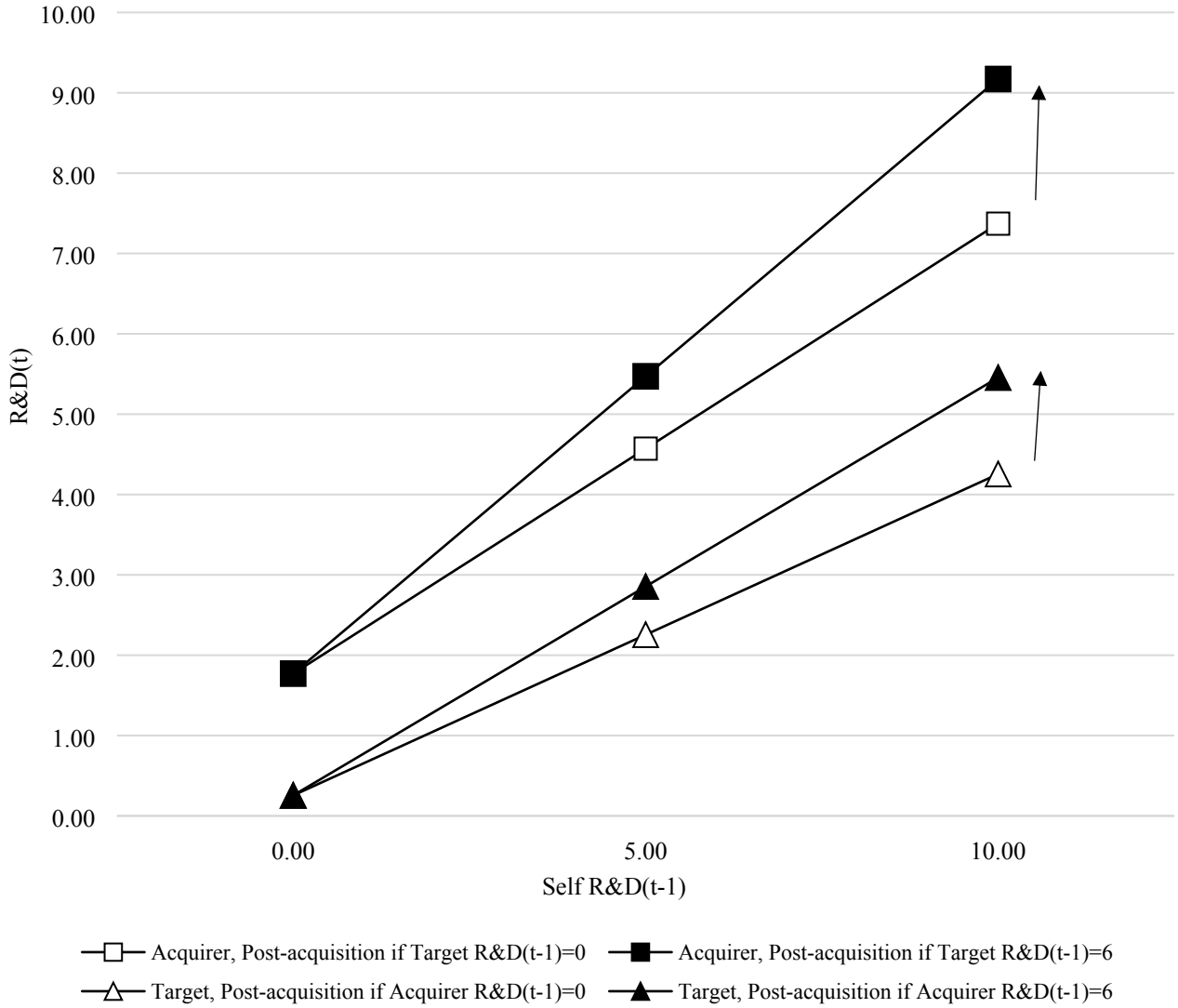
Figure 1. Simulation of the Moderating Effects of Post-Acquisition on R&D Persistence



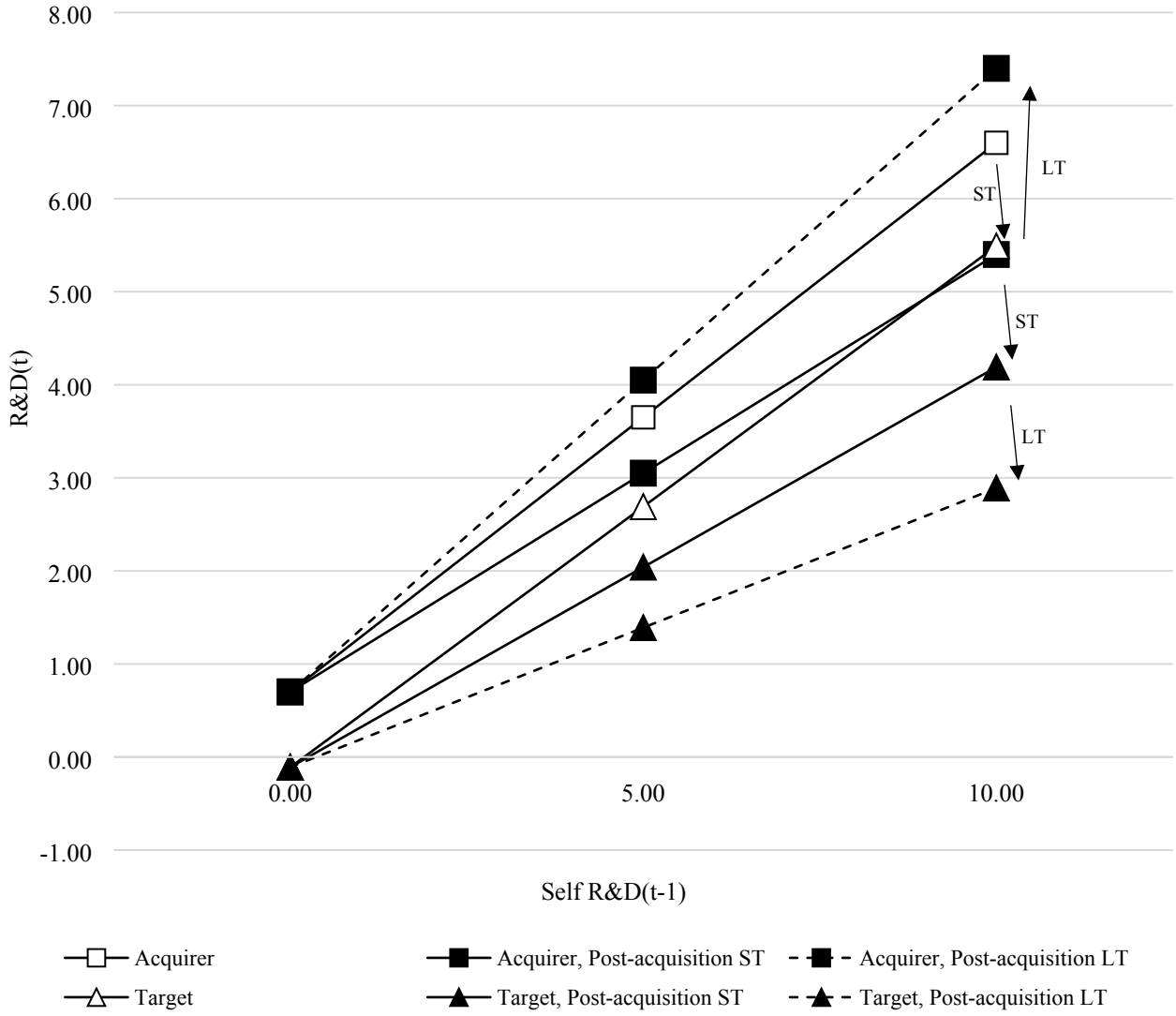
R&D values are in natural logarithm terms. All simulations are based on Model 3 in Table 4.

Figure 2. Simulation of the Moderating Effects of Post-Acquisition R&D of the Other firm on R&D Persistence



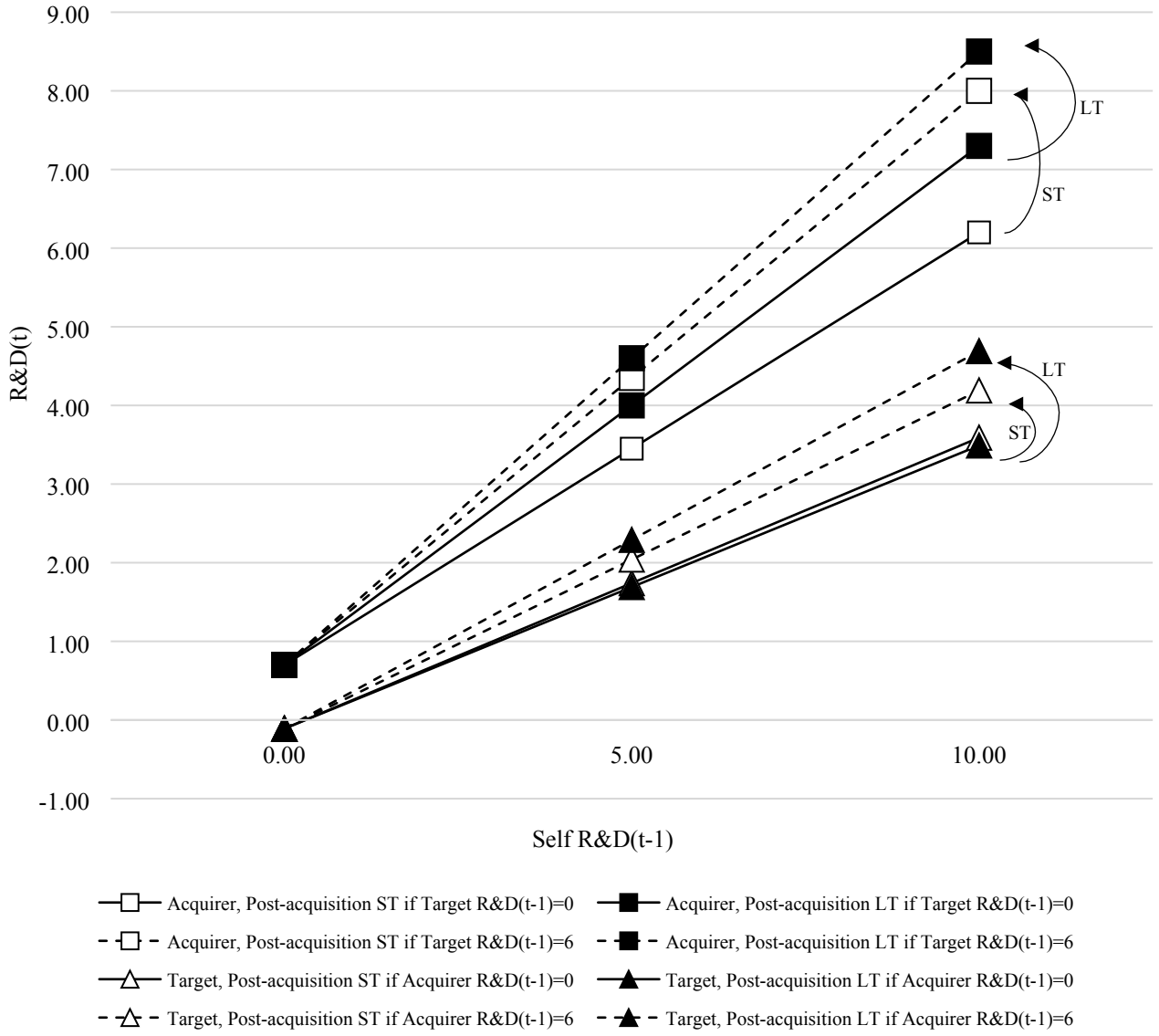
R&D values are in natural logarithm terms. All simulations are based on Model 3 in Table 4.

Figure 3. Simulation of the Moderating Effects of Post-Acquisition (ST vs. LT) on R&D Persistence



R&D values are in natural logarithm terms. All simulations are based on Model 3 in Table 5.

Figure 4. Simulation of the Moderating Effects of Post-Acquisition R&D of the Other firm on R&D Persistence



R&D values are in natural logarithm terms. All simulations are based on Model 5 in Table 5.

Table 1. Sample Distribution by Year of M&A Completion

Year of deal completion	Number of deals	%	Number of firm-year observations	%
1990	3	1.10	49	1.80
1991	5	1.84	58	2.13
1992	5	1.84	55	2.02
1993	7	2.57	88	3.24
1994	5	1.84	51	1.88
1995	4	1.47	40	1.47
1996	2	0.74	9	0.33
1997	8	2.94	79	2.91
1998	18	6.62	183	6.73
1999	22	8.09	210	7.73
2000	31	11.40	302	11.11
2001	22	8.09	204	7.51
2002	13	4.78	114	4.19
2003	13	4.78	128	4.71
2004	9	3.31	94	3.46
2005	21	7.72	214	7.87
2006	20	7.35	183	6.73
2007	24	8.82	267	9.82
2008	23	8.46	222	8.17
2009	17	6.25	168	6.18
Total	272	100.00	2,718	100.00

Table 2. Sample Distribution by Acquirer and Target Industry (SIC2)

Industry	SIC2	Acquirer Industry				Target Industry			
		N of deals	%	N of obs	%	N of deals	%	N of obs	%
Agriculture,	01-09	1	0.37	17	0.63	1	0.37	9	0.33
forestry	01	0	0.00	0	0.00	1	0.37	9	0.33
and fishing	08	1	0.37	17	0.63	0	0.00	0	0.00
Mining	10-14	8	2.94	65	2.39	12	4.41	109	4.01
	10	3	1.10	25	0.92	5	1.84	60	2.21
	12	0	0.00	0	0.00	1	0.37	11	0.40
	13	4	1.47	29	1.07	6	2.21	38	1.40
	14	1	0.37	11	0.40	0	0.00	0	0.00
Construction	15-17	11	4.04	120	4.42	3	1.10	28	1.03
	15	6	2.21	69	2.54	1	0.37	11	0.40
	16	3	1.10	29	1.07	1	0.37	7	0.26
	17	2	0.74	22	0.81	1	0.37	10	0.37
Manufacturing	20-39	155	56.99	1,594	58.65	154	56.62	1,613	59.35
	20	13	4.78	133	4.89	13	4.78	145	5.33
	21	1	0.37	6	0.22	1	0.37	6	0.22
	22	1	0.37	11	0.40	0	0.00	0	0.00
	23	3	1.10	40	1.47	1	0.37	12	0.44
	24	1	0.37	11	0.40	1	0.37	12	0.44
	25	2	0.74	10	0.37	3	1.10	21	0.77
	26	7	2.57	58	2.13	6	2.21	58	2.13
	27	3	1.10	32	1.18	2	0.74	22	0.81
	28	21	7.72	195	7.17	24	8.82	228	8.39
	29	7	2.57	80	2.94	6	2.21	79	2.91
	30	4	1.47	37	1.36	6	2.21	49	1.80
	31	5	1.84	45	1.66	4	1.47	42	1.55
	32	14	5.15	170	6.25	16	5.88	205	7.54
	33	14	5.15	167	6.14	11	4.04	138	5.08
	34	3	1.10	30	1.10	3	1.10	34	1.25
	35	20	7.35	198	7.28	21	7.72	201	7.40
	36	16	5.88	165	6.07	13	4.78	125	4.60
	37	10	3.68	98	3.61	11	4.04	105	3.86
	38	8	2.94	81	2.98	9	3.31	99	3.64
	39	2	0.74	27	0.99	3	1.10	32	1.18
Transportation,	40-49	43	15.81	426	15.67	45	16.54	442	16.26
communications,	44	1	0.37	12	0.44	3	1.10	35	1.29
electric,	45	1	0.37	11	0.40	1	0.37	11	0.40

gas	47	7	2.57	79	2.91	5	1.84	43	1.58
and sanitary	48	19	6.99	173	6.36	18	6.62	159	5.85
	49	15	5.51	151	5.56	18	6.62	194	7.14
Wholesale	50-51	7	2.57	60	2.21	10	3.68	110	4.05
trade									
	50	5	1.84	40	1.47	5	1.84	55	2.02
	51	2	0.74	20	0.74	5	1.84	55	2.02
Retail	52-59	9	3.31	102	3.75	4	1.47	41	1.51
trade									
	52	2	0.74	41	1.51	0	0.00	0	0.00
	54	1	0.37	11	0.40	1	0.37	11	0.40
	55	2	0.74	8	0.29	0	0.00	0	0.00
	57	1	0.37	12	0.44	0	0.00	0	0.00
	59	3	1.10	30	1.10	3	1.10	30	1.10
Finance, insur-	60-67	0	0.00	0	0.00	3	1.10	38	1.40
rance, real estate	67	0	0.00	0	0.00	3	1.10	38	1.40
Services	70-89	34	12.50	292	10.74	39	14.34	317	11.66
	70	1	0.37	14	0.52	3	1.10	24	0.88
	73	23	8.46	205	7.54	28	10.29	227	8.35
	77	1	0.37	7	0.26	0	0.00	0	0.00
	78	3	1.10	21	0.77	2	0.74	17	0.63
	79	1	0.37	1	0.04	0	0.00	0	0.00
	80	1	0.37	11	0.40	0	0.00	0	0.00
	87	2	0.74	17	0.63	6	2.21	49	1.80
	89	2	0.74	16	0.59	0	0.00	0	0.00
Non-classifiable	99	4	1.47	42	1.55	1	0.37	11	0.40
Total		272	100.00	2,718	100.00	272	100.00	2,718	100.00

Table 3. Summary Statistics, Correlation Table, and Variance Inflation Factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	VIF (Eq. 1)	VIF (Eq. 2)
1Acquirer R&D	1.00																
2Target R&D		1.00															
3Acquirer lagged R&D	0.74	0.40	1.00													1.42	1.99
4Target lagged R&D	0.38	0.68	0.44	1.00												2.20	1.47
5Acquirer firm-specific initial conditions	0.13	0.08	0.15	0.11	1.00											2.04	
6Acquirer firm assets	0.21	0.05	0.21	0.09	0.51	1.00										1.52	
7Acquirer firm size	0.18	0.22	0.21	0.25	0.29	0.30	1.00									2.02	
8Acquirer prior M&A experiences	-0.06	-0.19	-0.07	-0.18	0.07	0.03	-0.06	1.00								1.11	1.12
9Home RD intensity	-0.08	0.07	0.00	0.09	0.44	0.30	-0.01	0.11	1.00							1.35	
10Home industry competition	-0.03	0.05	-0.01	0.05	-0.04	-0.08	0.45	0.00	-0.27	1.00						1.62	
11Home economic size	0.11	-0.03	0.11	-0.01	0.37	0.37	-0.20	0.07	0.37	-0.41	1.00					2.33	
12Home economic development	-0.04	0.00	-0.03	0.02	0.11	0.05	-0.09	0.09	0.20	-0.04	0.39	1.00				1.45	
13Home minority shareholder protection	0.00	-0.11	0.01	-0.10	0.13	0.16	-0.10	0.03	0.08	-0.17	0.42	-0.02	1.00			2.26	
14Target firm-specific initial conditions	0.06	0.07	0.05	0.08	0.07	0.14	0.13	-0.02	0.15	0.08	0.06	0.13	-0.01	1.00			1.39
15Target firm assets	0.11	0.15	0.13	0.15	0.30	0.41	0.27	0.03	0.13	0.12	0.05	0.03	-0.03	0.41	1.00		1.23
16Target firm size	0.10	0.11	0.13	0.12	0.08	0.08	0.50	-0.11	-0.14	0.28	-0.24	-0.13	-0.07	0.03	0.22		1.43
17Host RD intensity	0.01	-0.05	0.03	-0.04	0.09	0.04	-0.11	-0.02	0.29	-0.20	0.22	0.15	0.04	0.23	-0.04		1.28
18Host industry competition	0.02	0.04	0.03	0.04	-0.06	-0.05	0.10	0.02	-0.14	0.02	-0.06	-0.15	0.05	-0.18	0.00		1.38
19Host economic size	-0.10	-0.15	-0.10	-0.16	-0.07	-0.09	-0.28	0.11	0.06	-0.09	0.18	0.24	0.07	0.09	-0.19		1.82
20Host economic development	-0.06	-0.07	-0.06	-0.08	-0.17	-0.18	-0.29	-0.03	-0.04	-0.15	0.20	0.07	0.14	-0.05	-0.34		1.52
21Host minority shareholder protection	0.00	0.01	0.00	0.01	0.06	0.02	-0.07	0.05	0.04	-0.02	0.10	0.08	0.07	0.15	-0.12		1.91
22Acquirer-target industry relatedness	0.05	0.07	0.07	0.07	0.04	0.08	-0.05	-0.09	0.15	-0.09	0.08	0.08	-0.08	0.06	0.05	1.97	1.94
23Control entry (>50%)	-0.04	-0.02	-0.03	-0.01	-0.08	-0.07	-0.23	-0.01	0.07	-0.17	0.15	0.07	0.00	-0.04	-0.13	1.53	1.55
24Economic distance	-0.11	-0.20	-0.13	-0.22	-0.15	-0.11	-0.52	0.09	0.10	-0.32	0.15	0.20	0.05	-0.03	-0.15	1.54	1.39
25Demographic distance	0.10	0.07	0.10	0.07	0.22	0.16	0.13	-0.06	0.05	0.01	0.23	0.18	0.29	0.01	-0.06	1.24	1.28
26Cultural distance	0.08	0.07	0.08	0.07	0.04	-0.05	-0.15	-0.10	0.06	-0.15	0.05	0.07	0.15	0.02	-0.12	1.18	1.21
27Minority shareholder protection distance	0.03	-0.07	0.03	-0.07	0.09	0.13	0.02	-0.06	0.05	-0.12	0.24	-0.10	0.54	-0.10	0.10	1.81	1.77
28Post-acquisition ST (1-2 years)	0.06	0.08	0.06	0.08	-0.01	0.02	0.01	-0.03	0.06	-0.07	0.05	0.05	-0.02	0.00	-0.01	3.90	4.32
29Post-acquisition LT (3+ years)	0.03	0.11	0.07	0.13	-0.02	-0.01	-0.05	-0.04	0.10	-0.03	0.07	0.11	-0.01	0.04	0.01	4.86	5.35
30Post-acquisition	0.07	0.16	0.10	0.18	-0.03	0.00	-0.03	-0.05	0.13	-0.08	0.10	0.14	-0.02	0.04	0.01	2.16	2.22
Mean	6.60	5.18	6.46	5.00	3.63	9.44	2.08	1.03	0.60	0.93	6.79	3.28	0.94	1.61	7.48	1.98	1.88
SD	3.71	3.35	3.83	3.43	3.02	2.82	0.53	4.00	0.47	0.15	1.47	0.65	1.08	2.44	3.04		

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	VIF (Eq. 1)	VIF (Eq. 2)
16Target firm size	1.00																1.43
17Host RD intensity	-0.13	1.00															1.28
18Host industry competition	0.25	-0.36	1.00														1.38
19Host economic size	-0.26	0.34	-0.29	1.00													1.82
20Host economic development	-0.16	0.09	0.11	0.39	1.00												1.52
21Host minority shareholder protection	-0.15	0.14	-0.07	0.41	0.19	1.00											1.91
22Acquirer-target industry relatedness	-0.04	0.07	-0.02	0.09	0.08	-0.04	1.00									1.97	1.94
23Control entry (>50%)	-0.24	0.05	-0.02	0.18	0.21	0.05	0.40	1.00								1.53	1.55
24Economic distance	-0.39	0.10	-0.21	0.21	0.21	0.06	0.04	0.19	1.00							1.54	1.39
25Demographic distance	0.14	0.05	0.08	0.08	0.22	0.18	-0.06	-0.10	-0.01	1.00						1.24	1.28
26Cultural distance	-0.06	0.09	0.03	-0.08	0.15	0.11	-0.08	0.01	0.23	0.14	1.00					1.18	1.21
27Minority shareholder protection distance	0.08	-0.09	0.12	-0.31	-0.04	-0.58	-0.01	-0.04	-0.06	0.13	0.02	1.00				1.81	1.77
28Post-acquisition ST (1-2 years)	-0.03	0.04	-0.01	0.03	0.02	0.00	0.35	0.28	0.04	-0.04	0.02	0.00	1.00			3.90	4.32
29Post-acquisition LT (3+ years)	-0.06	0.05	0.01	0.09	0.08	0.00	0.46	0.33	0.03	-0.01	0.01	0.01	-0.27	1.00		4.86	5.35
30Post-acquisition	-0.08	0.07	0.00	0.10	0.09	0.00	0.57	0.51	0.06	-0.04	0.02	0.01			1.00	2.16	2.22
Mean	1.71	0.37	0.93	6.30	2.63	0.75	0.23	0.16	4.33	2.80	5.61	0.06	0.17	0.26	0.43	1.98	1.88
SD	0.59	0.46	0.14	1.28	1.09	1.29	0.39	0.37	2.32	0.88	1.00	0.67	0.38	0.44	0.50		

[1] Correlations above |0.03| are statistically significant at $p<0.05$. [2] N=2,718. [3] Correlations are omitted for pairs that do not appear in the same regressions.

Table 4. CMP Regression Results for Main Models

	1	2	3	Eq 1 vs. Eq 2. equality t-tests	
				2	3
Eq. 1 DV: Acquirer R&D					
Acquirer lagged R&D	0.59***	0.59***	0.59***		
	(0.01)	(0.02)	(0.02)		
Acquirer lagged R&D × Post-acquisition (H1a:-)		-0.02	-0.03+	(H2) ***	
		(0.03)	(0.01)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition) (H3a:+)			0.03***	(H4)	
			(0.01)		
Target lagged R&D (Post-acquisition)	0.01	0.01	0.20***		
	(0.02)	(0.03)	(0.05)		
Acquirer firm-specific initial conditions	0.03	0.03	0.03		
	(0.02)	(0.02)	(0.02)		
Acquirer firm assets	0.12***	0.12***	0.11***		
	(0.03)	(0.03)	(0.03)		
Acquirer firm size	0.15	0.15	0.25+		
	(0.14)	(0.14)	(0.14)		
Acquirer prior M&A experiences	0.04**	0.04**	0.04*		
	(0.01)	(0.01)	(0.01)		
Home industry-specific R&D intensity	1.52***	1.52***	1.47***		
	(0.13)	(0.13)	(0.13)		
Home industry competition	-0.69	-0.69	-0.67		
	(0.48)	(0.48)	(0.48)		
Home economic size	0.80	0.82	0.69		
	(0.92)	(0.92)	(0.92)		
Home economic development	-0.93	-0.94	-0.76		
	(1.16)	(1.16)	(1.16)		
Home minority shareholder protection	-0.20	-0.20	-0.19		
	(0.14)	(0.14)	(0.14)		
Post-acquisition	-0.20	-0.10	0.80*		
	(0.24)	(0.30)	(0.36)		
Acquirer-target industry relatedness (Post-acquisition)	0.05	0.04	0.07		
	(0.18)	(0.18)	(0.18)		
Control entry (>50%) (Post-acquisition)	-0.13	-0.14	-0.14		
	(0.16)	(0.16)	(0.16)		

Economic distance (Post-acquisition)	-0.02	-0.02	-0.02	
	(0.03)	(0.03)	(0.03)	
Demographic distance (Post-acquisition)	0.08	0.08	0.09	
	(0.07)	(0.07)	(0.07)	
Cultural distance (Post-acquisition)	0.18*	0.18*	0.19*	
	(0.08)	(0.08)	(0.08)	
Minority shareholder protection distance (Post-acquisition)	0.22*	0.22*	0.23*	
	(0.11)	(0.11)	(0.11)	
Constant	-3.00	-3.04	-3.21	
	(2.78)	(2.79)	(2.78)	
Eq 2. DV: Target R&D				
Target lagged R&D	0.51***	0.56***	0.56***	
	(0.02)	(0.02)	(0.02)	
Target lagged R&D × Post-acquisition (H1b:-)		-0.13***	-0.16**	(H2) ***
		(0.03)	(0.05)	
Target lagged R&D × Acquirer lagged R&D (Post-acquisition) (H3b:+)			0.02+	(H4)
			(0.01)	
Acquirer lagged R&D (Post-acquisition)	0.01	0.02	0.06	
	(0.02)	(0.02)	(0.04)	
Target firm-specific initial conditions	-0.02	-0.02	-0.02	
	(0.02)	(0.02)	(0.02)	
Target firm assets	0.10***	0.11***	0.11***	
	(0.02)	(0.02)	(0.02)	
Target firm size	0.06	0.05	0.07	
	(0.12)	(0.12)	(0.12)	
Acquirer prior M&A experiences (Post-acquisition)	-0.03	-0.04+	-0.04+	
	(0.02)	(0.02)	(0.02)	
Host industry-specific R&D intensity	0.43***	0.45***	0.44***	
	(0.13)	(0.13)	(0.13)	
Host industry competition	0.39	0.39	0.41	
	(0.43)	(0.42)	(0.42)	
Host economic size	-0.46	-0.54	-0.54	
	(0.51)	(0.50)	(0.50)	
Host economic development	0.38	0.51	0.53	
	(0.66)	(0.66)	(0.66)	
Host minority shareholder protection (Post-acquisition)	-0.20**	-0.20**	-0.21**	
	(0.07)	(0.07)	(0.07)	
Post-acquisition	0.31	1.01***	1.11**	

	(0.24)	(0.29)	(0.35)
Acquirer-target industry relatedness (Post-acquisition)	-0.03	-0.10	-0.09
	(0.18)	(0.18)	(0.17)
Control entry (>50%) (Post-acquisition)	-0.22	-0.30+	-0.30+
	(0.16)	(0.16)	(0.16)
Economic distance (Post-acquisition)	-0.06+	-0.07*	-0.07*
	(0.03)	(0.03)	(0.03)
Demographic distance (Post-acquisition)	0.21*	0.20*	0.20*
	(0.09)	(0.08)	(0.08)
Cultural distance (Post-acquisition)	0.17*	0.16+	0.15+
	(0.08)	(0.08)	(0.08)
Minority shareholder protection distance (Post-acquisition)	-0.19+	-0.23*	-0.23*
	(0.11)	(0.11)	(0.11)
Constant	0.21	0.70	0.62
	(2.03)	(2.03)	(2.03)
Ln(Sigma1) constant	0.86***	0.86***	0.85***
	(0.01)	(0.01)	(0.01)
Ln(Sigma2) constant	0.83***	0.83***	0.83***
	(0.01)	(0.01)	(0.01)
Inverse hyperbolic tangent of rho12	0.14***	0.14***	0.13***
	(0.02)	(0.02)	(0.02)
N	2718	2718	2718
Left-censored N in equation 1	371	371	371
Left-censored N in equation 2	472	472	472
$\chi 2$	4043.28	4060.55	4079.91
$\Delta \chi 2$ of interactive terms		17.27	36.63

[1] Clustered standard errors in parentheses.
[2] + p<.1, * p<.05, ** p<.01, ***p<.001
[3] All $\chi 2$s and $\Delta \chi 2$s are statistically significant at p<0.05.
[4] (Post-acquisition) suggests that the moderating variable values were censored to zeros before acquisitions.
[5] We have controlled for home, host, SIC2, and year dummies.

Table 5. CMP Regression Results for Robustness Checks

	4	5	Eq 1 vs. Eq 2. equality t-tests	
			4	5
Eq 1. DV: Acquirer R&D				
Acquirer lagged R&D	0.59***	0.59***		
	(0.02)	(0.02)		
Acquirer lagged R&D × Post-acquisition ST	-0.12***	-0.04*		
	(0.04)	(0.01)		
Acquirer lagged R&D × Post-acquisition LT	0.08*	0.07+	***	***
	(0.03)	(0.04)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition ST)		0.03***	+	+
		(0.01)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition LT)		0.02***		
		(0.01)		
Target lagged R&D (Post-acquisition)	0.01	0.20***		
	(0.03)	(0.05)		
Acquirer firm-specific initial conditions	0.03	0.03		
	(0.02)	(0.02)		
Acquirer firm assets	0.12***	0.11***		
	(0.03)	(0.03)		
Acquirer firm size	0.08	0.19		
	(0.14)	(0.14)		
Acquirer prior M&A experiences	0.04**	0.04*		
	(0.01)	(0.01)		
Home industry-specific R&D intensity	1.51***	1.46***		
	(0.13)	(0.13)		
Home industry competition	-0.73	-0.71		
	(0.48)	(0.48)		
Home economic size	0.69	0.57		
	(0.92)	(0.91)		
Home economic development	-0.82	-0.65		
	(1.16)	(1.16)		
Home minority shareholder protection	-0.23	-0.22		
	(0.14)	(0.14)		
Post-acquisition ST (1-2 years)	0.77*	1.67***		

	-0.35	(0.40)		
Post-acquisition LT (3+ years)	-0.60+	0.22		
	-0.32	(0.37)		
Acquirer-target industry relatedness (Post-acquisition)	0.02	0.05		
	(0.18)	(0.18)		
Control entry (>50%) (Post-acquisition)	-0.12	-0.12		
	(0.16)	(0.16)		
Economic distance (Post-acquisition)	-0.03	-0.02		
	(0.03)	(0.03)		
Demographic distance (Post-acquisition)	0.09	0.09		
	(0.07)	(0.07)		
Cultural distance (Post-acquisition)	0.19*	0.20**		
	(0.08)	(0.08)		
Minority shareholder protection distance (Post-acquisition)	0.23*	0.23*		
	(0.11)	(0.11)		
Constant	-2.46	-2.63		
	(2.78)	(2.77)		
Eq 2. DV: Target R&D				
Target lagged R&D	0.56***	0.56***		
	(0.02)	(0.02)		
Target lagged R&D × Post-acquisition ST	-0.13*	-0.19**		
	(0.04)	(0.07)		
Target lagged R&D × Post-acquisition LT	-0.13*	-0.20***	***	***
	(0.04)	(0.06)		
Target lagged R&D × Acquirer lagged R&D (Post-acquisition ST)		0.01+	+	+
		(0.01)		
Target lagged R&D × Acquirer lagged R&D (Post-acquisition LT)		0.02*		
		(0.01)		
Acquirer lagged R&D (Post-acquisition)	0.03	0.06		
	(0.02)	(0.04)		
Target firm-specific initial conditions	-0.02	-0.02		
	(0.02)	(0.02)		
Target firm assets	0.11***	0.11***		
	(0.02)	(0.02)		
Target firm size	0.07	0.08		
	(0.12)	(0.12)		
Acquirer prior M&A experiences (Post-acquisition)	-0.04	-0.04		
	(0.02)	(0.02)		

Host industry-specific R&D intensity	0.45***	0.44***
	(0.13)	(0.13)
Host industry competition	0.40	0.42
	(0.42)	(0.42)
Host economic size	-0.55	-0.54
	(0.50)	(0.50)
Host economic development	0.53	0.55
	(0.66)	(0.66)
Host minority shareholder protection (Post-acquisition)	-0.21**	-0.21**
	(0.07)	(0.07)
Post-acquisition ST (1-2 years)	1.06**	1.17**
	-0.34	(0.40)
Post-acquisition LT (3+ years)	0.97**	1.13**
	-0.3	(0.36)
Acquirer-target industry relatedness (Post-acquisition)	-0.08	-0.07
	(0.18)	(0.18)
Control entry (>50%) (Post-acquisition)	-0.30+	-0.30+
	(0.16)	(0.16)
Economic distance (Post-acquisition)	-0.07*	-0.07*
	(0.03)	(0.03)
Demographic distance (Post-acquisition)	0.20*	0.20*
	(0.08)	(0.08)
Cultural distance (Post-acquisition)	0.16+	0.15+
	(0.08)	(0.08)
Minority shareholder protection distance (Post-acquisition)	-0.23*	-0.23*
	(0.11)	(0.11)
Constant	0.67	0.56
	(2.03)	(2.03)
Ln(Sigma1) constant	0.85***	0.85***
	(0.01)	(0.01)
Ln(Sigma2) constant	0.83***	0.83***
	(0.01)	(0.01)
Inverse hyperbolic tangent of rho12	0.14***	0.14***
	(0.02)	(0.02)
N	2718	2718
Left-censored N in equation 1	371	371
Left-censored N in equation 2	472	472
$\chi 2$	4079.05	4104.2

Δ χ2 of interactive terms	35.77	60.92

[1] Clustered standard errors in parentheses

[2] + p<.1, * p<.05, ** p<.01, ***p<.001

[3] All χ2s and Δ χ2s are statistically significant at p<0.05.

[4] (Post-acquisition ST) suggests that the moderating variable values were censored to zeros other than post-acquisition ST (1-2 years).

[5] (Post-acquisition LT) suggests that the moderating variable values were censored to zeros other than post-acquisition ST (3+ years).

[6] We have controlled for home, host, SIC2, and year dummies.

Supplements

I. Table S1. Sample Distribution by Home and Host Markets (ISO2 Codes)

Host\Home	AT	AU	BE	BR	CH	CL	DE	DK	ES	FI	FR	GB	HK	IE	IN	IT	JP	KR	LU	MY	NL	NO	NZ	PL	PT	SE	SG	US	Total
AR				2(22)		2(22)			2(12)																				6(56)
AT							4(40)				1(10)					1(10)													6(60)
AU							2(13)	1(11)				4(37)	1(06)			1(11)	2(33)			2(21)							2(10)	2(11)	17(153)
BE	1(10)						1(08)				2(22)										1(11)							1(10)	6(61)
BR					1(11)		1(11)		1(08)		1(18)					1(08)	2(23)				1(11)				2(20)				10(110)
CA											1(10)	1(04)																9(71)	11(85)
CH			1(08)				1(11)				2(10)									1(16)									5(45)
CL									2(26)														1(17)						3(43)
CN													1(12)				1(11)		1(14)										3(37)
CZ							1(12)	1(11)													1(11)			1(15)		1(11)			5(60)
DE	5(35)		2(21)		5(38)				1(06)	1(11)	7(86)	2(22)		1(12)	1(10)	1(11)	1(11)		2(10)		5(46)					2(15)			36(334)
ES											1(20)					1(13)													2(33)
FI							1(11)																			2(12)			3(23)
FR	1(11)						5(67)					2(22)				3(21)	1(11)				2(25)					1(10)			15(167)
GB		1(11)									1(11)				1(11)					1(10)							1(17)	5(42)	10(102)
HK												1(11)					6(68)				1(10)						2(24)		10(113)
HR							2(10)																						2(10)
HU					1(10)						2(06)																		3(16)
ID													1(11)				2(22)			2(24)									5(57)
IN					4(56)		4(45)			1(11)	1(11)	2(22)		1(09)		1(11)	2(21)	1(05)			1(11)					2(18)			20(220)
IT							1(11)				1(23)	1(11)		1(08)															4(53)
JP											1(11)		2(07)					1(17)											4(35)

Host\Home	AT	AU	BE	BR	CH	CL	DE	DK	ES	FI	FR	GB	HK	IE	IN	IT	JP	KR	LU	MY	NL	NO	NZ	PL	PT	SE	SG	US	Total
KR					1(11)						1(15)						7(76)									1(11)			10(113)
MY							1(11)										3(33)										3(37)		7(81)
NL			1(12)		1(09)		1(07)				3(33)	2(21)																	8(82)
NO	1(15)											1(11)																1(10)	3(36)
NZ		2(17)																											2(17)
PH											1(22)						3(32)												4(54)
PL	1(11)						1(11)	1(11)			1(11)			1(09)		1(11)													6(64)
SE							1(11)			1(09)	1(06)	1(10)										1(09)	1(12)					1(10)	7(67)
SG											1(11)		1(15)		1(13)		1(11)			3(19)	1(11)	1(15)							9(95)
TH			1(22)								1(11)		2(25)		1(11)		1(11)			2(22)							2(28)		10(130)
TR										1(11)		1(09)												1(10)					3(30)
US		1(04)					2(18)			1(04)	3(18)	4(11)			1(01)	1(09)					1(05)					3(06)			17(76)
Total	9(82)	4(32)	5(63)	2(22)	13(135)	2(22)	29(297)	3(33)	6(52)	5(46)	33(365)	22(191)	8(76)	4(38)	5(46)	11(105)	32(363)	2(22)	3(24)	11(112)	14(141)	2(24)	2(29)	2(25)	2(20)	12(83)	10(116)	19(154)	272(2718)

Note: Number of deals are reported outside parentheses, and number of acquirer-target-year observations are reported in parentheses.

II. Trade-offs between post-acquisition R&D persistence decline and cross-firm R&D effects

Inserting our estimation results from Model 3, we have:

$$R\&D^{a}_{i,t} = (0.59-0.03+0.03R\&D^{t}_{i,t-1})\ R\&D^{a}_{i,t-1} + \sum K_{k=4}(a_k \cdot X_k)$$

$$R\&D^{t}_{i,t} = (0.56-0.16+0.02R\&D^{a}_{i,t-1})\ R\&D^{t}_{i,t-1} + \sum K_{k=4}(b_k \cdot X_k)$$

Solving the above equations, we conclude that the joint conditions for R&D persistence in both firms would be:

$$0.56+0.03R\&D^{t}_{i,t-1} \geq 1$$

$$0.4+0.02R\&D^{a}_{i,t-1} \geq 1$$

In addition, for R&D to take on meaningful values, we need also $R\&D^{a}_{i,t-1} \geq 0$ and $R\&D^{t}_{i,t-1} \geq 0$. Solving all the conditions we arrive at: $R\&D^{t}_{i,t-1} \geq 14.67$ and $R\&D^{a}_{i,t-1} \geq 30$. Since all our R&D values are in logarithms (of US$ thousands plus one), this solution means a level of US$2.35 billion R&D spending in the target and US$$1.07\times10^{4}$$ trillion in the acquirer respectively! Both numbers are unrealistic in the real-world, suggesting that we hardly would see R&D persistence.

III. Two cross-country-specific moderating variables

The cross-border context of the MDD arguments would suggest that the degree to which R&D expenditures will decline post-acquisition may depend on the short-term pressures as well as the difficulties in post-acquisition integration. Therefore, we further test two pathways that are suggested in the literature that may lead to stronger MDD and thus weaker R&D persistence. With respect to short-term pressures, for example, the argument that shareholders pressure companies to become more short-sighted in the post-acquisition period may differ across institutional contexts, as the structure of capital markets differs across countries (Capron & Guillén, 2009; Gedajlovic & Shapiro, 2002; Marginson & McAulay, 2008). It would suggest that minority public shareholders tend to be relatively short-term oriented (Andrews & Tomasic, 2007; Morck & Yeung, 2004). Therefore, legal protection of *home* minority shareholder rights increases the ability of minority public shareholders to pressure management to focus on short-term returns after a cross-border acquisition and divert resources away from long-term investments such as R&D. Since we focus on the acquirer's shareholders we would expect that the quality of home minority shareholder protection to capture the degree to which minority shareholder interests will be material.

With respect to difficulties in post-acquisition integration, cultural distance can increase the costs of post-acquisition integration and can impact the performance of both the target and acquirer in cross-border acquisitions. Nevertheless, there is remarkably little evidence in complete support of the notion that national cultural differences always result in poor post-acquisition performance. While there are a few studies (Morosini, Shane, & Singh, 1998) that suggest a positive effect, the majority of studies are more nuanced and tend to argue that although cultural distance can indeed increase integration costs and foster internal conflict, there are possibly offsetting contextual factors that might limit its negative impact (Björkman, Stahl, & Vaara, 2007; Reus & Lamont, 2009; Slangen, 2006; Stahl & Voigt,

2008). For instance, employing a global sample of CBAs by British firms during 2000-2004, Ahammad, Tarba, Liu, & Glaister (2016) found no statistically significant relationship between national cultural distance and reported two-way knowledge transfer. Importantly, there is little agreement over the possibility that national cultural differences can increase the types of costs that we have associated with MDD and R&D, notably difficulties in the short-term in integration of complex tasks [a point illustrated by Lee, Kim, and Park (2015) in their case study of Volvo and Samsung] including technological innovation. Indeed in their meta-analysis Tihanyi, Griffith, and Russell (2005) find a negative relationship between cultural distance and MNE performance in high-technology industries, while Bauer, Matzler, and Wolf (2016) suggest that cultural similarity enhances innovation outcomes of acquisitions. We speculate that differences in national cultures between home and host country firms may increase integration difficulties in the short term, thus diverting managerial attention away from long-term investments such as R&D.

As Table S2 reports, we included in Model 1 *Home minority shareholder protection* after acquisition as a moderator, which reported a positive and statistically significant impact (0.02, $p<0.1$) on the R&D persistence of the acquirers and a negative and statistically significant impact (-0.02, $p<0.1$) on the targets. This asymmetry is also statistically significant according to t-test of coefficient equality ($p<0.01$). These results are consistent with our main results. These results further support the main results. That is, the MDD effects due to minority shareholder pressures are mainly transmitted to the target. In Model 2, we included *Cultural distance* after acquisition as a moderator. The results suggest that cultural distance has a positive but statistically insignificant impact on acquirers (0.01, $p>0.1$) but a negative impact on the targets (-0.03, $p<0.001$). Again, R&D decline due to cultural distance in the targets is more salient and statistically significant ($p<0.1$ for coefficient equality test). These findings further support our main results. In Model 3, we included all moderators

simultaneously and received highly consistent results, except that the asymmetry in the main moderating impact of Post-acquisition dummy on R&D persistence becomes statistically insignificant. Overall, the increase in $\chi 2$ as an indicator of explanatory power of newly added moderators in every step is consistently statistically significant ($p<0.05$).

We also replicated the above two moderating tests in our robustness checks using post-acquisition ST vs. LT dummies. Results are reported in Table S3. Consistent with the main findings, Model 4 in Table 2S suggests that an acquirer market's minority shareholder pressure only caused a decline (-0.02, $p<0.1$) in R&D persistence in the targets. Whereas, such pressure seems to increase moderately the R&D persistence in the acquirers in the short term (0.02, $p<0.1$). In the long term after acquisition, the moderating effects become statistically insignificant in both acquirers and targets. Consistent with these results, the asymmetry is only statistically significant ($p<0.01$) in the short term. These findings support the view that the impact of shareholder pressures is short-term only, and it is mainly transmitted to the target firms.

Model 5 reports results for cultural distance as a moderator in two periods after acquisition. Results suggest a moderate negative impact in the short term (-0.03, $p<0.1$) and no statistically significant impact in the long run (-0.02, $p>0.1$) on the acquirers, suggesting weak evidence of restructuring in the acquirers due to cultural distance. Such effects are however statistically highly significant in the targets in the short term (-0.03, $p<0.001$) and moderately significant in the long term (-0.03, $p<0.1$). Asymmetry tests report statistically significant results ($p<0.1$) only in the long-term period, suggesting that cultural distance effects are relatively symmetric in the short-term but they remain more salient in the target firms. We reason this may be due to the long-term effects of new governance and likely leadership in the target after a cross-border acquisition, whereas the leadership typically remains unchanged in the parent firm. Results remain basically consistent in Model 6, in

which we included all the moderators at the same time. Overall, the increase in $\chi 2$ as an indicator of explanatory power of newly added moderators is consistently statistically significant ($p<0.05$).

Table S2. Home Minority Shareholder Protection and Cultural Distance as Moderators

	1	2	3	Equality t-tests	
				First introduced	3
Acquirer R&D					
Acquirer lagged R&D	0.60***	0.59***	0.59***		
	(0.02)	(0.02)	(0.02)		
Acquirer lagged R&D × Post-acquisition	-0.04	-0.03+	-0.04	***	
	(0.03)	(0.01)	(0.08)		
Acquirer lagged R&D × Home minority shareholder protection (Post-acquisition)	0.02+		0.03*	**	***
	(0.01)		(0.01)		
Acquirer lagged R&D × Cultural distance (Post-acquisition)		0.01	0.01	+	+
		(0.03)	(0.03)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition)			0.03***		
			(0.01)		
Target lagged R&D (Post-acquisition)	0.00	0.01	0.21***		
	(0.03)	(0.03)	(0.05)		
Acquirer firm-specific initial conditions	0.03	0.03	0.03		
	(0.02)	(0.02)	(0.02)		
Acquirer firm assets	0.12***	0.12***	0.12***		
	(0.03)	(0.03)	(0.03)		
Acquirer firm size	0.14	0.15	0.24+		
	(0.14)	(0.14)	(0.14)		
Acquirer prior M&A experiences	0.04**	0.04**	0.04**		
	(0.01)	(0.01)	(0.01)		
Home industry-specific R&D intensity	1.51***	1.51***	1.46***		
	(0.13)	(0.13)	(0.13)		
Home industry competition	-0.72	-0.69	-0.70		
	(0.48)	(0.48)	(0.48)		
Home economic size	0.83	0.86	0.76		
	(0.92)	(0.92)	(0.91)		
Home economic development	-0.91	-1.03	-0.82		
	(1.16)	(1.16)	(1.16)		
Home minority shareholder protection	-0.25+	-0.19	-0.27+		
	(0.15)	(0.14)	(0.14)		
Post-acquisition	-0.08	0.08	0.77*		
	(0.30)	(0.30)	(0.36)		
Acquirer-target industry relatedness (Post-acquisition)	0.07	-0.02	0.05		
	(0.18)	(0.18)	(0.18)		
Control acquisition (>50%) (Post-acquisition)	-0.14	-0.13	-0.13		
	(0.16)	(0.16)	(0.16)		
Economic distance (Post-acquisition)	-0.02	-0.03	-0.02		
	(0.03)	(0.03)	(0.03)		
Demographic distance (Post-acquisition)	0.09	0.08	0.09		
	(0.07)	(0.07)	(0.07)		
Cultural distance (Post-acquisition)	0.18*	0.26**	0.29***		
	(0.08)	(0.09)	(0.09)		
Minority shareholder protection distance (Post-acquisition)	0.22*	0.21*	0.22*		
	(0.11)	(0.11)	(0.11)		
Constant	-3.11	-3.54	-3.93		
	(2.79)	(2.80)	(2.78)		
Target R&D					
Target lagged R&D	0.55***	0.55***	0.56***		
	(0.02)	(0.02)	(0.02)		
Target lagged R&D × Post-acquisition	-0.12***	-0.10*	-0.10*	***	
	(0.03)	(0.04)	(0.04)		
Target lagged R&D × Home minority shareholder protection (Post-acquisition)	-0.02+		-0.02+	**	
	(0.01)		(0.01)		
Target lagged R&D × Cultural distance (Post-acquisition)		-0.03***	-0.03***+		
		(0.01)	(0.01)		
Target lagged R&D × Acquirer lagged R&D (Post-acquisition)			0.02+		
			(0.01)		
Acquirer lagged R&D (Post-acquisition)	0.03	0.03	0.06		
	(0.02)	(0.02)	(0.04)		
Target firm-specific initial conditions	-0.02	-0.02	-0.02		
	(0.02)	(0.02)	(0.02)		
Target firm assets	0.11***	0.11***	0.11***		
	(0.02)	(0.02)	(0.02)		
Target firm size	0.05	0.05	0.07		
	(0.12)	(0.12)	(0.12)		
Acquirer prior M&A experiences (Post-acquisition)	-0.04+	-0.04+	-0.04+		

	(0.02)	(0.02)	(0.02)
Host industry-specific R&D intensity	0.45***	0.45***	0.44***
	(0.13)	(0.13)	(0.13)
Host industry competition	0.41	0.36	0.40
	(0.42)	(0.42)	(0.42)
Host economic size	-0.52	-0.56	-0.53
	(0.50)	(0.50)	(0.50)
Host economic development	0.49	0.54	0.54
	(0.66)	(0.66)	(0.66)
Host minority shareholder protection (Post-acquisition)	-0.18*	-0.21**	-0.19*
	(0.08)	(0.07)	(0.08)
Post-acquisition	1.01***	1.05***	1.13**
	(0.29)	(0.29)	(0.35)
Acquirer-target industry relatedness (Post-acquisition)	-0.13	-0.14	-0.16
	(0.18)	(0.18)	(0.18)
Control acquisition (>50%) (Post-acquisition)	-0.30+	-0.29+	-0.29+
	(0.16)	(0.16)	(0.16)
Economic distance (Post-acquisition)	-0.07*	-0.08*	-0.08*
	(0.03)	(0.03)	(0.03)
Demographic distance (Post-acquisition)	0.20*	0.20*	0.20*
	(0.08)	(0.08)	(0.08)
Cultural distance (Post-acquisition)	0.15+	0.20*	0.19*
	(0.08)	(0.09)	(0.09)
Minority shareholder protection distance (Post-acquisition)	-0.15	-0.23*	-0.16
	(0.12)	(0.11)	(0.12)
Constant	0.53	0.41	0.21
	(2.03)	(2.04)	(2.04)
Ln(Sigma1) constant	0.86***	0.86***	0.85***
	(0.01)	(0.01)	(0.01)
Ln(Sigma2) constant	0.83***	0.83***	0.83***
	(0.01)	(0.01)	(0.01)
Inverse hyperbolic tangent of rho12	0.14***	0.14***	0.13***
	(0.02)	(0.02)	(0.02)
N	2718	2718	2718
Left-censored N in equation 1	371	371	371
Left-censored N in equation 2	472	472	472
$\chi 2$	4064.38	4065.23	4091.17
$\Delta \chi 2$ of interactive terms	21.1	21.95	47.89

[1] Clustered standard errors in parentheses
[2] + p<.1, * p<.05, ** p<.01, ***p<.001
[3] All $\chi 2$ and $\Delta \chi 2$ are statistically significant at p<0.05.
[4] suggests that the moderating variable values were censored to zeros before acquisitions.
[5] We have controlled for home, host, SIC2, and year dummies.

Table S3. Home Minority Shareholder Protection and Cultural Distance as Moderators in Robustness Checks

	4	5	6	Equality t-tests	
				First introduced	6
Acquirer R&D					
Acquirer lagged R&D	0.60***	0.59***	0.59***		
	(0.02)	(0.02)	(0.02)		
Acquirer lagged R&D × Post-acquisition ST	-0.14***	-0.08*	-0.04*		
	(0.01)	(0.03)	(0.01)		
Acquirer lagged R&D × Post-acquisition LT	0.07+	0.17*	0.07+	***	***
	(0.04)	(0.08)	(0.04)		
Acquirer lagged R&D × Home minority shareholder protection (Post-acquisition ST)	0.02+		0.03+	**	***
	(0.01)		(0.01)		
Acquirer lagged R&D × Home minority shareholder protection (Post-acquisition LT)	0.02		0.02+		+
	(0.01)		(0.01)		
Acquirer lagged R&D × Cultural distance (Post-acquisition ST)		-0.03+	-0.03+		
		(0.01)	(0.01)		
Acquirer lagged R&D × Cultural distance (Post-acquisition LT)		-0.02	-0.02+	+	
		(0.01)	(0.01)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition ST)			0.04***	+	+
			(0.01)		
Acquirer lagged R&D × Target lagged R&D (Post-acquisition LT)			0.03***		
			(0.01)		
Target lagged R&D (Post-acquisition)	0.00	0.01	0.21***		
	(0.03)	(0.03)	(0.05)		
Acquirer firm-specific initial conditions	0.03	0.03	0.03		
	(0.02)	(0.02)	(0.02)		
Acquirer firm assets	0.12***	0.12***	0.12***		
	(0.03)	(0.03)	(0.03)		
Acquirer firm size	0.07	0.08	0.18		
	(0.14)	(0.14)	(0.14)		
Acquirer prior M&A experiences	0.04**	0.04**	0.04**		
	(0.01)	(0.01)	(0.01)		
Home industry-specific R&D intensity	1.50***	1.51***	1.45***		
	(0.13)	(0.13)	(0.13)		
Home industry competition	-0.75	-0.73	-0.73		
	(0.48)	(0.48)	(0.48)		
Home economic size	0.71	0.72	0.63		
	(0.91)	(0.91)	(0.91)		
Home economic development	-0.79	-0.90	-0.69		
	(1.16)	(1.16)	(1.15)		
Home minority shareholder protection	-0.28+	-0.21	-0.29*		
	(0.15)	(0.14)	(0.15)		
Post-acquisition ST (1-2 years)	0.74*	0.78*	1.67***		
	-0.35	(0.35)	(0.40)		
Post-acquisition LT (3+ years)	-0.62*	-0.60+	0.21		
	-0.32	(0.32)	(0.37)		
Acquirer-target industry relatedness (Post-acquisition)	0.05	-0.05	0.02		
	(0.18)	(0.18)	(0.18)		
Control acquisition (>50%) (Post-acquisition)	-0.12	-0.11	-0.12		
	(0.16)	(0.16)	(0.16)		
Economic distance (Post-acquisition)	-0.03	-0.03	-0.03		
	(0.03)	(0.03)	(0.03)		
Demographic distance (Post-acquisition)	0.09	0.08	0.09		
	(0.07)	(0.07)	(0.07)		
Cultural distance (Post-acquisition)	0.19*	0.27**	0.30***		
	(0.08)	(0.09)	(0.09)		
Minority shareholder protection distance (Post-acquisition)	0.23*	0.22*	0.23*		
	(0.11)	(0.11)	(0.11)		
Constant	-2.54	-2.95	-3.34		
	(2.78)	(2.79)	(2.78)		
Target R&D					
Target lagged R&D	0.55***	0.55***	0.56***		
	(0.02)	(0.02)	(0.02)		
Target lagged R&D × Post-acquisition ST	-0.12*	-0.04+	-0.04+		
	(0.04)	(0.02)	(0.02)		
Target lagged R&D × Post-acquisition LT	-0.12*	-0.20**	-0.12*	***	***

	(0.04)	(0.07)	(0.04)		
Target lagged R&D × Home minority shareholder protection (Post-acquisition ST)	-0.02+		-0.02+	**	***
	(0.01)		(0.01)		
Target lagged R&D × Home minority shareholder protection (Post-acquisition LT)	-0.01		-0.01		+
	(0.02)		(0.02)		
Target lagged R&D × Cultural distance (Post-acquisition ST)		-0.03***	-0.03***		
		(0.01)	(0.01)		
Target lagged R&D × Cultural distance (Post-acquisition LT)		-0.03+	-0.03+	+	
		(0.01)	(0.01)		
Target lagged R&D × Acquirer lagged R&D (Post-acquisition ST)			0.01+	+	+
			(0.01)		
Target lagged R&D × Acquirer lagged R&D (Post-acquisition LT)			0.02*		
			(0.01)		
Acquirer lagged R&D (Post-acquisition)	0.03	0.03	0.06		
	(0.02)	(0.02)	(0.04)		
Target firm-specific initial conditions	-0.02	-0.02	-0.02		
	(0.02)	(0.02)	(0.02)		
Target firm assets	0.11***	0.11***	0.11***		
	(0.02)	(0.02)	(0.02)		
Target firm size	0.06	0.06	0.07		
	(0.12)	(0.12)	(0.12)		
Acquirer prior M&A experiences (Post-acquisition)	-0.04	-0.04+	-0.04+		
	(0.02)	(0.02)	(0.02)		
Host industry-specific R&D intensity	0.45***	0.45***	0.44***		
	(0.13)	(0.13)	(0.13)		
Host industry competition	0.41	0.37	0.41		
	(0.42)	(0.42)	(0.42)		
Host economic size	-0.52	-0.56	-0.53		
	(0.50)	(0.50)	(0.50)		
Host economic development	0.51	0.55	0.55		
	(0.66)	(0.66)	(0.66)		
Host minority shareholder protection (Post-acquisition)	-0.19*	-0.21**	-0.19*		
	(0.08)	(0.07)	(0.08)		
Post-acquisition ST (1-2 years)	1.07**	1.08**	1.20**		
	-0.34	(0.34)	(0.40)		
Post-acquisition LT (3+ years)	0.97**	0.99**	1.15**		
	-0.3	(0.31)	(0.36)		
Acquirer-target industry relatedness (Post-acquisition)	-0.12	-0.13	-0.14		
	(0.18)	(0.18)	(0.18)		
Control acquisition (>50%) (Post-acquisition)	-0.30+	-0.30+	-0.30+		
	(0.16)	(0.16)	(0.16)		
Economic distance (Post-acquisition)	-0.07*	-0.08*	-0.08*		
	(0.03)	(0.03)	(0.03)		
Demographic distance (Post-acquisition)	0.20*	0.20*	0.20*		
	(0.08)	(0.08)	(0.08)		
Cultural distance (Post-acquisition)	0.15+	0.20*	0.19*		
	(0.08)	(0.09)	(0.09)		
Minority shareholder protection distance (Post-acquisition)	-0.15	-0.23*	-0.16		
	(0.12)	(0.11)	(0.12)		
Constant	0.49	0.38	0.16		
	(2.03)	(2.04)	(2.04)		
Ln(Sigma1) constant	0.85***	0.85***	0.85***		
	(0.01)	(0.01)	(0.01)		
Ln(Sigma2) constant	0.83***	0.83***	0.83***		
	(0.01)	(0.01)	(0.01)		
Inverse hyperbolic tangent of rho12	0.14***	0.14***	0.14***		
	(0.02)	(0.02)	(0.02)		
N	2718	2718	2718		
Left-censored N in equation 1	371	371	371		
Left-censored N in equation 2	472	472	472		
$\chi 2$	4082.64	4084.1	4115		
$\Delta \chi 2$ of interactive terms	39.36	40.82	71.72		

[1] Clustered standard errors in parentheses

[2] + p<.1, * p<.05, ** p<.01, ***p<.001

[3] All $\chi 2$ and $\Delta \chi 2$ are statistically significant at p<0.05.

[4] (Post-acquisition ST) suggests that the moderating variable values were censored to zeros other than post-acquisition ST (1-2 years).

[5] (Post-acquisition LT) suggests that the moderating variable values were censored to zeros other than post-acquisition ST (3+ years).

[6] We have controlled for home, host, SIC2, and year dummies

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