The limits of relational governance:
Sales force strategies in the U.S. medical device industry

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Research Summary: We explore how inter-organizational relationships shape firm boundary decisions. Using data on 545 U.S. medical device manufacturers' product portfolios and sales-governance choices (i.e., internal or external sales forces) from 1983 to 1996, we find relational capital between manufacturers and external sales forces influences future firm boundary decisions. Relational capital lowers the likelihood of integrating the sales function, but only when firms remain focused on the same product market. Further, launching an innovative product has a nuanced effect. For firms lacking relational capital, innovation increases the likelihood of sales integration. This pattern reverses as relational capital accumulates, but only when innovations are in the firm's existing focal product market. Our findings suggest important limits on the effect of relational governance on firm strategy.

Managerial Abstract: Choosing between in-house or external sales is a key strategic decision. In the medical device industry, this decision is particularly important because sales people are conduits between R&D and customers. For firms who initially choose external sales, the trade-off between maintaining existing links (via external sales) and developing new, direct relationships (by bringing sales in-house) can change significantly as product portfolios change. Analyzing 545 U.S. medical device manufacturers from 1983 to 1996, we find that existing relationships with external sales forces reduce the likelihood of bringing sales in-house, but only when firms remain in the same product market, such as orthopedic implants. When firms launch products in new markets, especially innovations, they are more likely to bring sales in-house.

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INTRODUCTION

Organizations involved in economic exchange develop relationships over time. Trust, shared norms, and routines—the core aspects of relational governance—emerge via repeated exchange, and help to coordinate activity, incentivize investment in relationship-specific resources, and encourage the development and transfer of valuable knowledge (Hoetker and Mellewigt, 2009; Kotabe, Martin, and Domoto, 2003; Poppo and Zenger, 2002). Prior research links established inter-organizational relationships with both future partnering choices and performance (Elfenbein and Zenger, 2013; Gulati, 1995; Holloway and Parmigiani, 2016). Firms tend to choose the same external partners instead of identifying new ones (Holloway and Parmigiani, 2016; Mayer, Somaya, and Williamson, 2012), and surprisingly, firms even pay a premium to partner with familiar organizations (Elfenbein and Zenger, 2013).

Despite these insights into relational governance, remarkably little empirical research has explored how and when pre-existing relationships between firms influence ongoing firm boundary decisions.[1] Yet, as their product portfolios change, firms may periodically re-evaluate the choice between continuing to use external partners and integrating key activities. In doing so, firms weigh the demands of new products and new markets against accumulated relational capital. New requirements, such as the need for new types of knowledge, emerge as firms change downstream markets or innovate, i.e. launch new to the world products. Under these conditions, the benefits of bringing an activity in-house may outweigh existing relational capital. This logic

[1] Outside mainstream strategy research, organizational economics has developed formal theory exploring the related question of how relational contracts (i.e. self-reinforcing agreements in repeated games) differ if they take place within or between firms, including how integration (as compared to exchange) affects the temptation to renege in relational contracts (Baker, Gibbons, and Murphy, 2002). There has been some limited empirical work in this area (e.g., Gil and Zanarone, 2018), but it has focused on the determinants, prevalence, and characteristics of relational contracts rather than on the role of relationships in ongoing firm boundaries.

implies an important open question for strategy scholars: How do pre-existing relationships between firms affect future choices to integrate activities when product portfolios change?

In this paper, we attempt to address this question. We build theory to demonstrate the importance as well as the limits of relational governance.[2] We explore when and how pre-existing inter-organizational relationships influence subsequent firm boundary decisions, specifically examining the ongoing choice of medical device firms to integrate (or not) their sales function.

Building from prior work, we expect that firms will be less likely to integrate as they develop relational capital, which is comprised of the relationship-specific assets that underpin relational governance (Elfenbein and Zenger, 2013; Poppo, Zhou, and Zenger, 2008). Our primary argument is that relational capital is most relevant and valuable when partnering organizations remain working together in the same product market. Changes to the firm's downstream product market (e.g., for medical device firms, moving from selling primarily orthopedic to primarily cardiology devices) diminish the influence of pre-existing relationships on integration. Broadly, we argue that relational capital is embedded in the particular contexts in which it develops, and is therefore more consequential within those contexts.

We also examine how relational capital attenuates the positive relationship between integration and innovation, which we define as the introduction of new-to-the-world products by the focal firm. Prior work in transaction-cost economics has theorized and demonstrated that having innovative products affects the initial decision to integrate, i.e. to initially develop an internal sales force (Anderson, 1985; Weiss and Anderson, 1992). However, the relational

[2] Relational governance refers to inter-firm exchanges that include and rely on significant relationship-specific assets (Zaheer and Venkatraman, 1995), otherwise known as relational capital. The latent value of relational capital comes from social connections, norms, trust, and expectations of exchange continuity (Elfenbein and Zenger, 2013).

governance literature argues that a pre-existing relationship with an external sales force will moderate the push toward integrating sales if and when firms innovate. We argue the influence of relational capital on the sales integration decision is limited when a firm attempts to launch an innovation. Specifically, relational capital will only play a role if the innovation is in the firm's focal downstream market.

To test these ideas, we construct a dataset of 545 U.S. medical device manufacturers that enter the industry using external sales forces. Starting from their initial entry, we track their mode of sales—that is, whether they integrate or continue to use external sales—as well their product portfolios, including any innovative products, and other firm characteristics over time. We find evidence consistent with our theoretical predictions. Specifically, the likelihood of sales integration decreases with time using external sales provided firms do not change their focal downstream market, whereas the likelihood of integration does not decrease for firms that change downstream markets. For instance, a hypothetical firm that sells cardiology products through an external sales force is less likely to integrate sales over time provided they remain focused in cardiology. Further, we find relational capital attenuates the positive relationship between launching an innovative product and sales integration. However, this attenuation is strongest when the innovative product is in the firm's existing focal downstream market. In other words, if a hypothetical cardiovascular firm launches an innovative orthopedic implant, relational capital makes little difference in mitigating its effect on integration.

Our paper makes several contributions. First, we contribute to the literature on relational governance by building and testing theories for when pre-existing inter-firm relationships influence firm boundary decisions. By considering the role of pre-existing relationships in shaping decisions between external partnerships and integration (i.e., change in firm boundaries), we complement and extend the extant relational governance literature, which has primarily focused on choices across different external partners. Although we find that relationships may mitigate pressures to integrate, we also find important limits to this influence, specifically, when firms change downstream focal markets. We therefore provide initial evidence on the context embeddedness of relational capital, a finding not observed in prior studies. Understanding the limits to relational capital is important both for further research and for managers implementing integration and partnering strategy. Second, by focusing on how relational capital can mitigate the push towards integration, not just how it affects the choice between new or current external partners, we reintegrate relational governance into the larger literature on boundaries of the firm.

Our work also contributes to the literature that explores how innovation affects the boundaries of the firm (Kaul, 2012; Teece, 1986). We illuminate how the impact of novel innovation on the management of complementary downstream activities is contingent on existing relationships when the firm launches the innovation. Specifically, innovation increases integration likelihood only when relationships have not yet developed. By extension, our findings provide some explanation for the lack of firm boundary changes generally observed in prior research (Kapoor, 2013; Qian, Agarwal, and Hoetker, 2012). Even when innovation increases the need to develop and transfer new, product-specific knowledge across firm boundaries, established relationships appear to have a role in mitigating the push toward integration, although it is a more limited role than prior theory predicts.

CONTEXT: MEDICAL DEVICE SALES

This section briefly outlines some key features of the U.S. medical device industry and the sales function to preface our theoretical development. The U.S. medical device industry includes the producers of medical devices and diagnostic tests regulated by the U.S. Food and Drug

Administration (FDA),[3] as well as other related medical product suppliers. Medical devices generally fall into discrete medical specialty areas, reflecting distinct customer markets (i.e., physician specialties), including, for example, cardiovascular (devices such as artificial hearts and pacemakers) and orthopedics (e.g., replacement joints), among other specialty groups. We use this relatively clean partitioning to identify and differentiate the focal downstream markets of the firms in our analyses.

Within this context, our paper focuses on the role of relational capital in ongoing firm boundary decisions, specifically exploring the sales function and integration. We focus on sales for several reasons. First, in general, sales is an important strategic function. Firms spend 10%–40% of their revenue on sales (Sinha and Zoltners, 2001), which is often more than they spend on research and development, a subject of considerable inquiry in strategic management (e.g., (Ahuja, Lampert, and Tandon, 2008)). Second, and more specific to our theorizing, prior work suggests the choice of sales strategy is of key importance in settings where the ongoing transfer of knowledge to and from users is crucial for value creation and value capture (Danneels, 2002; Grant, 1991, 1996), a key feature of the medical device industry (Chatterji et al., 2008; Chatterji and Fabrizio, 2014). Third, prior research has shown the sales function is particularly important for capturing value from innovative medical devices (Martin, 1984; Mitchell, 1989; Teece, 1986). For example, in his foundational paper on complementary assets, Teece (1986) suggested ownership of sales and distribution networks helped General Electric, a technological follower,

[3] The FDA definition of a medical device is "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is: (1) recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them, (2) intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or (3) intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes" (FDA - CDRH, 2013).

to capture the market for CT scanners from the pioneering innovator EMI, which lacked sales assets. Similarly, in the case of cardiac pacemakers—an “easy to imitate” technology—firms with in-house, specialized sales capabilities performed better than those without (Teece, 1986). Overall, the governance of the sales function in medical devices offers an interesting and fitting window into understanding the role of relational capital in firm boundary decisions.

THEORY

Strategy research has long recognized the challenges inherent in coordinating activity across firm boundaries (Chandler, 1962; Grant, 1991; Williamson, 1971). The prevailing wisdom suggests that when new, specific investments are required, or when uncertainty about demand or technical aspects of a product looms large, firms should vertically integrate R&D, manufacturing, sales, and other complementary activities (Teece, 1986; Williamson, 1971).

However, recent theorizing suggests inter-organizational relationships that develop between partners can approximate features of vertical integration (Elfenbein and Zenger, 2013; Gibbons and Henderson, 2012; Poppo and Zenger, 2002; Poppo et al., 2008). Over time, separate and distinct firms can build trust, develop shared norms that dictate acceptable behavior and facilitate coordination, and create and hone routines that enable efficient actions. These features, collectively labeled “relational capital,” facilitate the development and transfer of relationship-specific knowledge across firm boundaries (Poppo and Zenger, 2002) and therefore underpin effective relational governance (Elfenbein and Zenger, 2013; Zaheer and Venkatraman, 1995). Based on past experiences and expectations of continued future exchange, partnering firms make investments in developing knowledge and other assets specific to their relationship.

The existing literature has explored the impact of relationships by estimating the effects of repeated partnering on future *external* partner choice (Elfenbein and Zenger, 2013; Mayer et al., 2012). For example, researchers have shown bridge builders repeatedly partner with the same subcontractors (Holloway and Parmigiani, 2016), and Fortune 500 firms in technology-based industries repeatedly use the same patent attorneys to file for patents (Mayer et al., 2012).

However, the relational governance literature has generally ignored another viable alternative to either current or new external partners: bringing the activity in-house. The relationships that develop over time between firms likely influence the choice to integrate, but prior work offers little explicit guidance as to how and when. In the following section, we develop theory on when relational capital influences integration. In doing so, we identify two key variables that will influence the relationship between relational capital and integration: (1) Whether the firm remains focused on the same downstream product market, and (2) Whether the firm is commercializing an innovation. We further explore the interaction of the two by parsing the downstream market of the innovation.

THE LIMITS OF RELATIONAL GOVERNANCE

Relational capital comprises three main elements: shared trust, routines, and norms (Elfenbein and Zenger, 2013; Poppo and Zenger, 2002; Schepker et al., 2014). Each of these elements develops between partners over time through repeated exchange. In inter-firm relationships, these core features emerge to coordinate activity, safeguard both partners against opportunistic behaviors, and facilitate jointly beneficial knowledge exchange in the absence of a centralized, joint corporate structure.

First, *shared trust* in exchange relationships is a set of informed beliefs about the behavior of a specific person or organization, built up from repeated, successful interactions (Adler, 2001; Bottazzi, Rin, and Hellmann, 2016).[4] Having shared trust means an organization is

[4] This concept contrasts with general trust, which is a context-level construct (e.g., How much do I trust a random person or organization?). In addition to the role of past experiences in influencing trust, some have argued for an

willing to accept risk and undertake costly actions based on the expectation that another organization will act in a favorable, mutually beneficial way, and vice versa (Rousseau et al., 1998; Zaheer, McEvily, and Perrone, 1998). For shared trust to emerge and influence behavior, some risk of deviation and thereby implicit demonstration of trustworthiness must be present (Rousseau et al., 1998). Such trust-building risk is a key feature of exchange between firms.

Prior work suggests that, similar to shared trust, *inter-firm routines*—routines that cross firm boundaries—develop over time as products are developed, bought, and sold and know-how is transferred between the various actors involved (Dyer and Singh, 1998; Feldman and Pentland, 2003; Zheng and Yang, 2015). Greater experience working with the same partner firm on the same activities translates into measurable performance benefits (Zollo, Reuer, and Singh, 2002). This logic implies that, like shared trust, the effect of inter-firm routines on the decision to integrate will increase over time, i.e., integration will become less likely as inter-firm routines develop.

Finally, repeated exchange also leads to the creation of *shared norms* of behavior—for example, shared language and patterns of communication, and mutual understanding of what constitutes appropriate actions—that underpin effective exchange (Ring and Van De Ven, 1994). Emergent norms that support exchange include mutual expectations of flexibility, solidarity, joint responsibility, mutual accommodation, and other behaviors that facilitate ongoing exchange activities between separate partners (Cannon, Achrol, and Gundlach, 2000; Macneil, 1980). In sum, shared trust, routines, and norms—relational capital—develop over time and through repeated exchange, lowering the risk of opportunistic behavior and easing the development and transfer of relationship-specific knowledge.

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additional basis for trust: calculative trust, based on the expectation of rewards and penalties, i.e., for trust as a forward-looking construct (Poppo, Zhou, and Li, 2016).

Context embeddedness of relational capital

The very features that ensure the development of relational capital—repeated exchanges between the same individuals within the same markets (enabling trust, routines, and norms)—may limit its value outside the context in which it is developed. If the context changes significantly, even for the same firm, the relevance and value of relational capital will be diminished. For example, firms may enter a new market or abandon a legacy market, and in doing so interrupt the development and decrease the relevance of valuable sales relationships and thus lessen the effect of pre-existing relationships on integration. This boundary condition is an important one not considered in prior work

In our context of medical device sales, relationships develop through repeated exchange between the manufacturing firm and sales forces (often focused on narrow medical specialties), *as well as* between sales forces and end customers, who typically specialize within single markets (i.e., physicians within medical specialties). The manufacturer–sales force and sales force–customer relationships develop in parallel. Specifically, as relational capital develops and facilitates the flow of knowledge between manufacturers and sales forces, it also develops between the sales representatives selling the manufacturer's products and their physician customers in the manufacturer's key specialty areas (e.g., orthopedic surgeons or cardiologists). Supporting this logic, our discussions with industry experts, supplemented by articles in the trade and popular press, suggest physicians highly value maintaining their ties to particular sales representatives.[5] Sales representative–physician relationships become "deep personal

[5] Further, the ongoing connection between manufacturers and physicians has been anecdotally described as highly dependent on the sales representative–physician relationship. For example, Norman Dann, a former venture capitalist and Medtronic executive who started his career in sales, described an experience in which one of the manufacturers he sold products for ended its relationship with his sales company (from the *Minnesota Star Tribune*): "[Dann's] reps had to go to docs and explain that they would no longer be handling a main product line. According to Dann, their response? 'We don't care, you're still going to be taking care of us, right?'"

relationships" over time, built on "the trust level that the physician, the physician's office and the hospital have with the individual rep" (Snowbeck, 2008).[6] Trusted sales representatives facilitate knowledge transfer to physicians about how products are intended to be used, and, conversely, transfer that valuable knowledge back to manufacturers. Similarly, surgeons rely on a trusted, technically knowledgeable sales representative to attend and observe relevant procedures, during which their "special product expertise enhances patient safety" by ensuring new devices are used correctly.[7] Knowledgeable, trusted sales representatives also enable efficiency in surgeries.[8]

When a device manufacturing firm switches its focal downstream market, it changes the set of physicians and other health professionals it is selling to, and thereby reduces the relevance and value of its existing relational capital. This change will interrupt the development of each feature of relational capital. This change will also pervade both parts of the overall sales relationship. In terms of the manufacturer–sales force relationship, given the tendency of sales representatives to focus one or two narrow specialties, such a change will interrupt the ongoing development of trust, routines, and norms. With respect to the sales force–end customer relationship, physician-customers in the new specialty could have little to no history of working with the sales force or the manufacturer. Therefore, they will have a weak foundation for building shared trust and will lack inter-organizational routines and shared norms of communication to facilitate knowledge transfer.

In sum, our argument is that by interrupting the development of relational capital, changing the focal downstream market will attenuate the expected negative relationship between

[6] From medical device industry analyst Thomas Gunderson, about a legal case in which medical device firm Ev3 was suing Cardiovascular Systems Inc. for poaching its specialized sales reps.
[7] Per Medtronic spokesperson Charles Grothaus (Hilzenrath, 2009).
[8] Stryker CEO Kevin Lobo suggests the detailed knowledge of devices that specialized sales forces hold is "an engine of growth" for the company (Saxena, 2015), and that without sales representatives' product- and context-specific specialized knowledge, "operating rooms just don't flow effectively and efficiently" (Johnson, 2015).

the length of time using an external salesforce and the likelihood of sales integration. Alternatively, for firms that remain focused on the same downstream market (i.e., the same specialty), the length of time using external sales further builds and reinforces relational capital and decreases the likelihood of integration. Therefore, we predict the following:

> **H1a:** The likelihood of integration decreases with the length of time using external sales if a firm remains focused on the same focal downstream market.
> **H1b:** The likelihood of integration does not decrease with the length of time using external sales if a firm changes its focus to a different downstream market.

Next, we explore how relational capital influences integration choices when the development and transfer of new knowledge becomes essential, as is the case when a firm innovates, i.e. launches a product that is new-to-the-world. Prior literature suggests competing hypotheses for how innovation will shape firm boundary choices. However, reconciling the seemingly opposing predictions offers us the chance to tighten our logic about the influence of relational capital on integration.

On the one hand, a transaction-cost view would imply innovation—which increases in the need for the development and transfer of relationship-specific knowledge—is a potential driver of integration (Macher, 2006; Williamson, 1993). Introducing and commercializing an innovative product requires the development and transfer of new, specific knowledge about how to use and sell the product. Novel innovation therefore requires both the manufacturer-innovator and sales force to make such investments, and for each to rely on the commitment of the other to transfer knowledge. A classic transaction-cost argument would suggest that as the need for specific investments increases, the risk of opportunism in inter-firm transactions also increases (Anderson, 1985; Argyres and Zenger, 2012; Williamson, 1971). Following such logic, we would expect that introducing an innovative product will increase the likelihood of integration.

On the other hand, a relational governance approach suggests innovation increases the value of accumulated relational capital, thereby further inhibiting integration (Elfenbein and Zenger, 2013). Specifically, the relational governance literature suggests that when the need for knowledge development and exchange increases, relational capital will have an even higher value for exchange partners (Elfenbein, 2007). Therefore, prior research in this tradition argues that innovation lowers the likelihood of changing external partners. In our context this logic implies that when a (medical device) firm has relational capital with an external sales firm, innovation should decrease the likelihood of integration.

To reconcile these perspectives, we build from the idea that relational capital builds up through repeated exchange over time. Therefore, if relational capital matters, we should therefore expect the relationship between innovation and integration to change over time. Following the transaction-cost logic, we hypothesize that adding an innovative product early in the firm's early days in using external sales, that is, when the firm has accumulated little relational capital, will increase a firm's likelihood of integration. Similarly, if a firm adds an innovative product after a few years of using external sales, that is, once it has already developed relational capital with its external sales partner, this change will decrease the firm's likelihood of integration. Therefore, we formulate two additional hypotheses:

> **H2a:** For firms *without* relational capital, i.e. those that have used external sales for a relatively short period of time, the likelihood of integration increases when they launch an innovation.
>
> **H2b:** For firms *with* relational capital, i.e. those who have used external sales for a relatively long period of time, the likelihood of integration decreases when they launch an innovation.

Further, building from our arguments in Hypothesis 1*,* we argue that the value of relational capital in moderating the impact of innovation on the decision to integrate will depend on the whether the innovation is in the firm's focal downstream market. This additional nuance stems from the context-dependent value of relational capital described above. That is, whether the length of time using external sales moderates the relationship between innovation and integration will depend on whether the requisite knowledge to effectively sell the innovation can be created and transferred within the established sales channel. For example, consider a cardiology-focused firm introducing either an innovative cardiac catheter or an innovative dialysis catheter (used by endocrinologists). If the required knowledge of how to use and sell the innovative product is likely accessible within the existing sales channel since the device is within its existing focal downstream market (i.e., the cardiovascular device), relational capital will decrease the likelihood of integration. Firms can use the relationships they have with their sales force and customers to effectively sell and distribute these innovations. However, if the required knowledge is not accessible within the existing channel (i.e., for the endocrine device), the relevance of the firm's existing relational capital will be lower and the likelihood of integration post-innovation will be higher. Thus, we predict the following:

> **H3a:** The likelihood of integration for firms with relational capital, i.e. those that have used external sales for a relatively long period of time, decreases when they launch an innovation *within* their focal downstream market.
>
> **H3b:** The likelihood of integration for firms with relational capital, i.e. those that have used external sales for a relatively long period of time, increases when they launch an innovation *outside* their focal downstream market.

DATA AND EMPIRICAL APPROACH

We test our hypotheses by looking at a panel of firm divisions in the U.S. medical device industry. To build our sample, we use the Medical Device Register (MDR) directory for the years 1983-1996. The MDR is a directory of U.S. medical device manufacturers (Cecchino, 2010; Medical Device Register, 2012; Prasek, 1999). It includes a listing of the types of products sold by each manufacturer (at the division level) in each year, the medical specialties for each product (e.g., Cardiovascular), and, at the firm-division level (e.g., 3M Imaging Systems), the mode of sales, number of employees, and other descriptive information. We use the yearly MDR directories to create a firm-division-year panel of medical devices marketed and sales mode used (i.e., external sales or internal sales). Thus, our unit of analysis is year-firm division. We observe all firm divisions entering in 1984 or later for which we know the full history of products and sales relationships. For our main analyses we use the 545 firm divisions that start out using an external sales force.

Along with the MDR, we employ FDA medical device classification data. We use the standardized, generic product name listed in the MDR (e.g., "Prosthesis, Shoulder") to link to FDA data at the product level.[9]. We categorize products that entered the market during the first approval year for their respective FDA product category as "innovative products."[10] Overall, we consider innovative products to signify devices that require new, product-specific, tacit information about their use to be transferred via the manufacturer–sales force and sales force–customer interfaces. To test Hypotheses 1a and 1b*,* we need to identify a firm's focal downstream market. We define the focal downstream market of each firm division (in each year) as the medical specialty in which it has the largest number of products. Relatedly, to test Hypotheses 3a and 3b, we segment innovative products as either within or outside the existing

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[9] In linking the FDA and MDR products, if and when the full MDR product names did not exactly match the FDA product names, we used shortened versions of device names to match and infer device class and product classification values. If the shortened version of names had multiple associated device classifications, we chose the lowest device class (e.g., if both II and III are listed, we assigned class II to the product).

[10] Information on FDA product classifications can be found on the FDA website: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPCD/classification.cfm. Product categories (there are ~6000) are akin to the generic name of products listed in the MDR, e.g., "Implant, Fixation Device, Spinal" or "Graft, Vascular, Synthetic/Biologic Composite." We used the FDA product-approvals databases to flag the first year of product approval for each category as the first year a product was approved in that category. For example, the first "Implant, Fixation Device, Spinal," code JDN, was approved in 1987.

focal downstream market (specialty) of the firm. The MDR data also list the corporate parent of each firm division (if any) in each year. Using this information, we create corporate-level firm-year measures, including the share of co-divisions with internal sales forces, and document any changes to ownership of firm divisions over time.

To generate our final analytical sample of 545 firm divisions that start out using external sales, we first drop those firm divisions that did not have information on our key measures.[11] Because many of our explanatory and control variables are lagged year-over-year changes, and our dependent variable is forward looking, we also omit a small number of firm divisions for which we have limited time series. Finally, we drop from our main sample firms that initially use internal sales forces (internal-first manufacturers). We use this internal-first sample (1,070 firms) in supplementary analyses to correct for initial sales mode selection (described in detail below). Firm divisions enter our analytical sample in the year they first market a product. Those that integrate leave our analytical sample in the year of integration. Those that retain external sales leave our analysis either the year of firm-division exit, or in 1996 (the end of our observation window). In our main analyses we follow 545 "external-first" firm divisions for an average of five years (2,798 firm-division years), including 102 integration events.[12]

We estimate the relationship between product changes in year *t* and integration events in year *t+1*. In other words, we are not modeling the relationship between concurrent firm

[11] The raw MDR data contains information for 5,768 firm divisions. Our main analysis includes only firms that enter using external sales (approximately 1/3rd of all firms). We necessarily include only firms that entered in 1984 or after. We also drop firm divisions from our sample that had no products, or no sales/distribution information, or those outside the United States. Because our analyses are focused on innovation and sales, we drop those that only distribute products for other firms, and, firm divisions that manufacture products for others but do not develop new products. Finally, we drop firm divisions without key control variables, e.g., employees, and those in our sample for 3 years or less, because we use lagged variables and have a forward-looking dependent variable.

[12] These numbers are for the full analytical sample. In the IPW analysis (described below), we trim divisions due to non-overlapping propensity scores, i.e. their estimated likelihood of being internal-first was lower than any of the internal-first sample (10 firms and 41 observations). The internal-first sample used only to construct the propensity-score weighting, is 1,070 firm divisions (5,032 firm-division years) and 59 outsourcing events.

characteristics and sales-force types, but instead the relationship between product changes and the likelihood of subsequent integration. We did so to reduce the potential for reverse causality, as prior literature has suggested complementary activities, including sales, can shape both the likelihood of innovation and firm outcomes (Dosi, 1982; Helfat and Raubitschek, 2000).

Importantly for our theory, during our sample period (1983-1996), physicians had significant freedom to make purchasing decisions (Anderson, 2012; Makower, Yock, and Zenios, 2010; Schafer, 2013), and, correspondingly, device firms cultivated close relationships with key physicians (Chatterji et al., 2008; Chatterji and Fabrizio, 2014).[13] Building on that point, our conversations with medical device sales managers confirmed the importance of sales-force continuity for maintaining important manufacturer–customer relationships. Last, the market for external distributors of medical devices was relatively competitive during our analysis period (Cohen, 1999), suggesting the availability of distributors did not constrain the choice between internal and external sales, leaving room for manufacturers to freely choose their sales strategy.[14]

Measures

Dependent variable

Our dependent variable is an event variable that takes the value of 0 for all years the firm division uses external sales, and a value of 1 if and when it integrates sales.[15] Because we are

[13] In more recent years, administrators with a cost-minimization focus have been increasingly making device-purchasing decisions at a hospital or hospital-systems level, not physicians at the individual or practice level.

[14] Although hybrid forms of sales governance have become more popular since the early 2000s in medical devices as well as other industries (Zoltners, Sinha, and Lorimer, 2004), hybrid sales forces—the simultaneous use of both internal and external sales— were rare during our window of analysis. They are also rare in our data set because we are looking at sales governance at the firm-division level, allowing for heterogeneity among divisions within the same firm. Because of the layer of complication that hybrids add theoretically (Krzeminska, Hoetker, and Mellewigt, 2013; Parmigiani, 2007), and because we do not have access to more recent data, we leave exploration of hybrid modes to future studies. We discuss our empirical approach for dealing with the few hybrids that emerge in our data in the results section.

[15] To construct this measure, we group MDR distribution types into external sales (distributor, manufacturer through distributor, dealer, manufacturer through dealer) and internal sales (manufacturer direct, direct, sold direct, manufacturer through manufacturer reps).

running event-history analyses (described below), we drop the firm divisions from the analytical sample for the years after integration, because they are no longer at risk. Firm divisions that never integrate sales are 0 for all years they remain in the sample until either firm exit or 1996. Variables and data sources are described below (and in Table 1).

INSERT TABLE 1 HERE

Key explanatory variables

Following prior literature, we use length of time as a proxy measure for relational capital (Elfenbein and Zenger, 2013; Kotabe et al., 2003). Concretely, we use *years using external sales* (in 2-year bands). As argued in Hypothesis 1a, we expect time using external to be negatively related to integration for firms that maintain the same focal downstream market. However, we don't expect this negative relationship for firms that change their focal downstream market (Hypothesis 1b). A change in a firm's focal downstream market is defined as a change in its focal medical specialty (e.g., from Cardiovascular to General Surgery).

To test Hypotheses 2, we explore how time using external sales moderates the relationship between innovation and the likelihood of integration. We use innovative product introductions to represent changes in the need for the development and sharing of new, relationship-specific knowledge. To further explore the moderating effect of time using external sales, and to test Hypotheses 3a and 3b, we look at how innovation within the focal downstream market (focal medical specialty) versus outside the focal downstream market differs in terms of the consequences for the likelihood of integration.

Control variables

To isolate the relationship between our key predictors and the likelihood of integration, we control for other relevant firm-division, corporate, and specialty-level factors. To account for firm-division growth, which may contribute to the feasibility of integration, we control for lagged changes in the number of firm-division employees. We expect the relationship between growth and likelihood of integration to be positive. Further, we control for changes to the number of products sold by the firm (changes in size) and changes in the number of specialties (changes in scope), both of which shape the marginal costs of having internal versus external sales (Chandler and Hikino, 1994). We expect increases in size to have a positive relationship with integration, and we expect the reverse to be true for increases in scope (controlling for size). We also control for several corporate-level changes and characteristics, including the share of other medical device subsidiaries of the same corporation with internal sales, *share internal,* which we expect to have a positive relationship with integration at the firm-division level. Finally, we account for any changes to ownership of the firm division.

To control for variations in the supply of external sales, we include location (region) dummies. We also include two dummies for diagnostic-focused firm divisions—laboratory diagnostic and radiology specialties—because these specialties involve the development of, respectively, tests used in clinical labs, or large capital purchases purchased at the hospital level, and are therefore sold differently than single-use tools and implantable devices. We include a dummy for post-1990 years to act as a control for aggregate-level changes in the supply of external sales forces over time.[16] We also control for changes in the number of competitor firms focused in the same specialty (*# competitors*) as a measure of changes in demand for external sales and other changes to the competitive environment of the firm using the full MDR data.

Lastly, we control for measures of the firm product and technology portfolio at the time of entry, including the initial counts of products, specialties, innovative products, and filed patent

[16] Results are robust to more disaggregated specialties and additional year controls, although lack of events in certain specialties and years means some observations are dropped.

applications. To obtain information on patents, we used the Harvard Patent Network Dataverse patent data set (Lai et al., 2011), which covers USPTO patents granted from 1975 to 2010. We linked the firm divisions to patent-assignee names. We counted only medical device patents (identified based on USPTO classifications). Because of knowledge development and transfer needs, we expect that firms with external sales that enter with patents (i.e., the antecedent of innovative products) or innovative products may be more likely to integrate in the future.

Econometric analysis of events

Since we use discrete, annual data to explore our hypotheses relating relationships and product changes to sales-related integration, we employ discrete event history analysis (EHA) techniques. EHA methods predict the conditional probability of an event occurring given that it has yet to happen within a population at risk of the event (Allison, 1984; Singer and Willett, 2003). In our case, discrete EHA is preferable to continuous-time methods because we do not know the precise timing of sales integration within each year, and because we have numerous simultaneous events or ties (i.e., more than one event in each year) (Allison, 2010; Franco *et al.*, 2009). For the population under study, the conditional probability of the event using discrete EHA is

$$P_{it} = Pr[T_i = t | \, T_i \geq t, \mathbf{x}_{it}],$$

where T is the discrete time of event occurrence and x is a vector of explanatory and control variables predicting event occurrence. EHA allows us to identify factors associated with change events. Discrete EHA can be estimated using maximum likelihood methods (Allison, 1984; Singer and Willett, 2003); for our main analyses, we used a complementary log-log model[17] and lagged our explanatory and control variables:

[17] The complementary log-log model is recommended when modeling events (or non-events) that are rare, because the function is asymmetrical. We also ran all models using a logit model (Allison, 2010), and our results were the

$$\Pr\ (Integration_i = 1 \mid \boldsymbol{x}_{it-1}) = 1 - exp(-\exp(\boldsymbol{x}_{it-1}\beta)).$$

Self-selection into sales mode at entry

An important potential source of bias in our estimates comes from the fact that firm divisions are not randomly assigned into their initial sales-governance mode. Firm divisions will vary in their likelihood of choosing integrated or external sales when they first enter, depending on initial transaction costs, capabilities, and the market for knowledgeable sales representatives at the time. In other words, observable factors, such as firm-division size and scope, whether the firm has an innovative product (or the foundational idea for an innovative product, i.e. a patent), its focal specialty, location, the size of its parent firm, and when it enters, will likely shape this initial choice. Failing to control for initial selection may pollute our estimates of the influence of both relational capital and innovation on the likelihood of integration. To control for self-selection on observables, we estimate firms' propensity to have integrated sales at entry based on the above listed observable characteristics at entry, and both balance and re-weight our data using inverse propensity scores (Bennett, 2013; Hirano and Imbens, 2001). We describe and document this process in detail in the related results section below as well as in the Appendix. All analyses are run in Stata 14.

RESULTS

Over the full period of our analyses, we find sales integration is a relatively rare event with just a 3.5% baseline annual likelihood of integration throughout our sample period.[18]

same qualitatively and in terms of statistical significance. Further, given the events are relatively rare, to supplement the logistic regressions, we also estimated firth logit models, and again our results were the same qualitatively and in terms of statistical significance (available from authors).

[18] Notably, outsourcing by firms who enter using internal sales is even less common than integration (annually 1.1%). As an aside, most medical device firms enter using internal sales (66%).

Our main regression results are provided in Tables 2 and 3 (and corresponding average marginal effects in Tables 4a and 4b and Figures 1 and 2). Table 2 details our main tests for Hypotheses 1a and 1b. As a baseline (column 1), we see that, compared to the reference category of one to two years using external sales, firms are less likely to integrate the longer they use external sales. The relationship isn't linear: the average marginal decrease in the likelihood of integration compared to the likelihood in the first two years is 2.8% in years 3 and 4, 2.7% in years 5 and 6, and 1.7% in years 7 or more. In column 3, we explore Hypotheses 1a and 1b by interacting time using external sales and focal specialty change in predicting the likelihood of integration. We expect time using external sales to have a negative relationship with integration likelihood only for those firms that don't change their focal specialties, because changing downstream market focus inhibits the development of relational capital. The regression results indicate support for our hypotheses, because the baseline coefficients on time remain negative (for firms without a specialty change). Because we estimate a nonlinear regression, true interaction effects are best described via average marginal effects. As summarized in Table 4a (and Figure 1), firms that don't change their focal specialty have an average marginal decrease in the likelihood of integration of 3.4% in years 3 to 4 and 3.0% in years 5 to 6 as compared to the first two years. By contrast, for firms that do change their focal specialty, we find no evidence of a significant decrease in the likelihood of integration over time using external sales.

INSERT TABLE 2 & FIGURE 1 HERE

In Table 3, we test Hypotheses 2a and 2b by exploring the association between innovation and the likelihood of integration, and we evaluate how this relationship varies across time using external sales. We predict that innovating when little to no relational capital exists will increase the likelihood of integration (Hypothesis 2a), whereas innovating when relational capital has developed will decrease the likelihood of integration (Hypothesis 2b). Consistent with Hypothesis 2a, and with a standard TCE logic, adding an innovative product is associated with an increase in likelihood of integration on average (by 2.8%), but only if the product is added in early on in the use of external sales. Specifically (Table 4b), in year 1 or 2, adding such a product increases the likelihood of integration by 9.7%, whereas adding such a product later on has no relationship with integration likelihood in later years (0.6% in years 3-4, -0.2% in years 5-6, 1.4% in years 7 or more), which is consistent with Hypothesis 2b.

INSERT TABLE 3 HERE

To test Hypotheses 3a and 3b, we separate innovative products into within versus outside specialty. We see that innovative products within the focal specialty drive our overall results (Table 3); however, we also see innovative products outside the focal specialty are not associated with an increased likelihood of integration (Hypothesis 3b). Table 4b and Figure 2 highlight the differences in marginal effects for within versus outside focal specialty innovations.

INSERT TABLES 4A AND 4B and FIGURES 1 AND 2 HERE

Controlling for initial sales self-selection

As mentioned above, the firms in our samples select whether to enter the industry using an internal or external sales force. Therefore, the above analyses estimate the likelihood of integration among those firm divisions that first chose to use external sales. A potential concern with such analyses is that firms that first choose external sales likely do so based on performance expectations, and as such, are both unlikely to integrate for reasons other than relational capital and are also more likely to remain in the sample (and not exit). A popular method to control for selection in strategy research is the Heckman method (Shaver, 1998). However, it was designed for use in linear regression models (i.e. OLS) and our main analysis uses a non-linear survival model (cloglog). Therefore, we instead use the inverse propensity weight (IPW) method to control for selection based on baseline observables. In estimating the likelihood of integration, the IPW method down-weights those firms that have a high propensity to be external-first, where propensity is estimated based on entry characteristics. Table 5 describes the balance between the external and internal first samples pre- and post-trimming and after propensity weights are applied. Further, the Appendix describes the IPW method in more detail, and Appendix Tables A1 and Figures A1 and A2 detail the analysis for estimating and evaluating the weights. The IPW versions of our main results are generally consistent with our findings without controlling for initial selection (see Tables 2 and 3, columns labelled "Inverse propensity weighted").

INSERT TABLE 5 HERE

Competing risks model to control for exiting firms

To further check the robustness of our main findings, we ran supplementary analyses that include the likelihood of firm exit as a competing potential outcome. Some firms in our sample exit during our study period. Therefore, we want to ensure our findings are driven by comparing firms that integrate sales with those that survive but do not integrate, and not by comparing firms that change sales with failing (or acquired) firms. Appendix Tables A2 and A3 provide the results from multinomial logit discrete event hazard regressions with three outcomes: survive but don't integrate sales (our reference category), survive and integrate sales (the event of interest), and exit (the competing event). These results are consistent with our main findings.

Alternative explanations and robustness checks

In our analyses, we do not observe the external sales firm used by the focal manufacturer firm. We only see the focal firm's mode of sales over time. Yet firms may change their external sales partner (e.g., from sales company X to sales company Y). Although prior relational governance research and sales-governance studies suggest switching from one external partner to another is uncommon in part due to the significant switching costs involved (Elfenbein and Zenger, 2013; Holloway and Parmigiani, 2016; Weiss and Anderson, 1992), we cannot rule out such changes. If firms do change external sales partners, our measure of relational capital (i.e., time using external sales) will be an overestimate. Helpfully, this mismeasurement biases us against finding a negative relationship between time using external sales and integration likelihood. However, we hope future research can include both external partner choice and integration to fully characterize how relational capital shapes governance-mode choices over time.

Given that we infer relational capital from time using external sales, a further potential concern is that our measure captures other features that develop over time and might affect the choice to integrate, including, notably, governance capabilities (Aggarwal and Hsu, 2009). Our results are, however, not consistent with a straightforward governance capabilities logic. First, we find firms that change specialties (but continue to use external sales) are not less likely to integrate over time, which suggests the effects we are identifying are more narrowly defined than firm-level capabilities. Second, if we run our same analyses on internal-first firms, we find no evidence that firms using internal sales are less likely to outsource over time, suggesting time using a particular sales mode provides a poor proxy for integrative (i.e. mode-specific governance) capabilities (results available from authors).[19]

In our analyses, we implicitly assume the degree to which firms have a choice to integrate is independent of scale. An alternative view would be that very small firms cannot feasibly integrate (e.g., because of prohibitive setup costs), and thus some of our sample is not at risk of

[19] We also explore how time using internal sales relates to the likelihood of outsourcing for organizations that are (1) new divisions of existing firms compared to (2) organizations that are new, standalone firms. If new divisions of existing firms with integrated sales are more likely to already have an integrative capability they may bias us against finding a result. However, controlling for these issues did not affect our results.

integration. Several descriptive facts suggest this is not an issue. First, if we look at the initial choices of sales-governance mode and compare the size of firms with internal versus external sales at entry, we find firms with more products are less likely to choose internal sales at entry (average size of product portfolio for internal-first firms is 6 versus 8 for external-first firms, Table 5). Second, division size has no significant relationship with either initial sales choice or likelihood of later integration (results available from authors).

Later in our sample period, firm divisions that use both external and internal sales—or hybrid sales forces—emerge, suggesting some firm divisions go from using purely external sales to partial integration. In our analyses, we treat these occurrences (6 events, or ~6% of the total) as if they represent full integration. We also ran analyses dropping the firm divisions that adopt hybrid sales forces, and our results do not change (results available from authors). Unfortunately, given the rare occurrence of this sales governance mode, we can’t separately explore the drivers of the partial integration of sales, and leave that to future research.

DISCUSSION

In this paper, we explore how relational governance influences firm boundaries. Our context is the strategic decision to integrate, or keep external, the sales function among U.S. medical device firms. This decision shapes the ongoing transfer of knowledge between product manufacturers and users and is therefore relevant both for value creation and value capture (Chatterji et al., 2008; Chatterji and Fabrizio, 2014; Danneels, 2002; Grant, 1991, 1996). Our findings clarify the influence and limits of relational capital in shaping the choice to integrate sales. Firms that do not change their focal downstream market are less likely to integrate the longer they use external sales, whereas we don’t see the same pattern for firms that change their focal downstream market. Further, relational capital limits the push toward integration for innovating firms.

Our study offers a number of contributions. First, this study contributes to work on the role of inter-organizational relationships in firm strategy. Existing relational governance research focuses on whether relational governance substitutes for or complements formal contracts (Poppo and Zenger, 2002), finding nuanced results, i.e. shared trust leads to less hierarchy (Gulati and Nickerson, 2008), while contracts between experienced partners are more formal (Ryall and Sampson, 2009). Another strand of relational governance research focuses on why firms to repeatedly choose the same external partners versus others (Elfenbein and Zenger, 2013; Holloway and Parmigiani, 2016), but implicitly ignores integration as an option. Our paper fills a gap by focusing on how relational capital can mitigate the push towards integration. In doing so, this research reintegrates relational governance into the large literature on boundaries of the firm.

Second, we theorize and empirically test for the *limits* of relational capital. Specifically, we propose that relational capital is embedded within narrow product markets and find empirical support for this theoretical proposition by demonstrating when relational capital shapes firm boundary decisions. Our paper therefore suggests the explanatory power of relational governance is context dependent. Relational capital's context embeddedness may provide an important narrative to describe firm performance differences and the consequences of planned changes in organizational design (Joseph *et al.*, Forthcoming).

Additionally, our paper partly reconciles the largely theoretical literature that suggests innovation sparks changes in firm boundaries (e.g., (Kaul, 2012; Teece, 1986)) with the dearth of firm boundary changes observed empirically (Kapoor, 2013; Qian et al., 2012) by highlighting the mitigating role of relational capital. We also add to the surprisingly limited scholarly work on corporate strategy and sales (Kleinbaum and Stuart, 2014) a strategic function on which firms spend considerable resources and one that is crucial to value creation and capture (Danneels, 2002; Grant, 1991, 1996). To our knowledge, we are the first to track firms' sales-boundary choices over time and explore relational capital, innovation, and sales governance in tandem.

Our study has some specific empirical limitations. First, although we structure our analysis to mitigate reverse causality, our key independent variables—including both relational capital and innovation—are the outcome of firm strategy. Thus, we cannot fully rule out endogeneity concerns stemming from an omitted variable driving both firm boundary choices and our key explanatory variables. For example, firms that are more agile may be more likely to both innovate and change sales strategies over time. Further, innovation can be customer driven (von Hippel, 1976), which may mean that relational capital is a mechanism driving innovation. We are unable to tease out apart these explanations, but we hope future research can. A second limitation is that we infer rather than directly measure relationships. If firms change external partners during our analysis, we may be overestimating the amount of relational capital. However, given prior research that suggests firms are unlikely to change external partners (Elfenbein and Zenger, 2013; Holloway and Parmigiani, 2016), as well as our discussions with industry experts that confirm such changes are unlikely, we believe such mismeasurement is rare. Further, this mismeasurement should bias us against finding any differential effects.

Our setting has some idiosyncratic features, which suggest opportunities for future research. In medical devices, new-product life cycles are relatively short (i.e., 2 years or less; (Kahn, 1991), customers are knowledgeable and expect close sales relationships, and products require specific, technical know-how to use. However, in industries with longer product life cycles, innovating firms may be more likely to integrate because they have more time to develop new relationships. Further, in industries where products do not require ongoing knowledge transfer between manufacturers, sales, and customers, sales would likely be less important for value capture. Studies focusing on industries with longer product cycles (e.g. agricultural biotechnology (Moeen, 2017)) or on firm-boundaries other than sales (for instance, component supply in automobiles or aircrafts) would help illuminate how salient the specific features of our context are in explaining the impact of relational capital on firm boundaries.

Our results advance understanding of the context embedded role of relational governance in firm boundary decisions. We hope future research will build on our study to delve deeper into the mechanisms by which inter-firm relationships shape firm boundaries and firm strategy.

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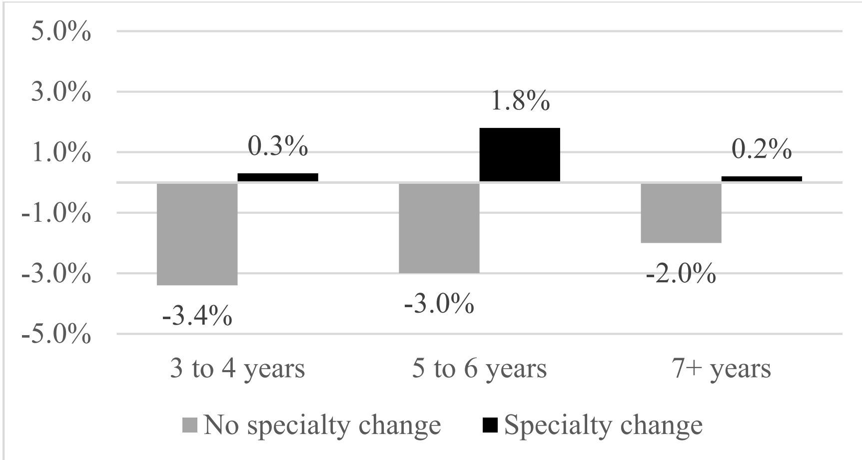

Figure 1: Marginal change in likelihood of integration (relative to 1 to 2 years) using external sales

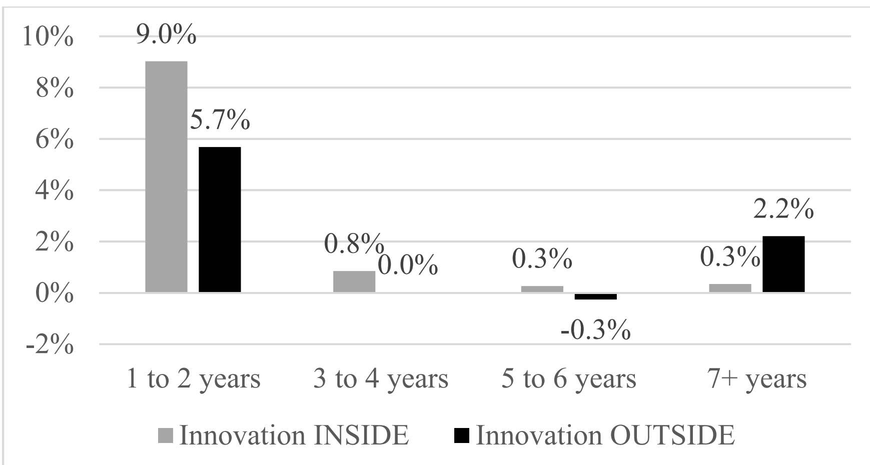

Figure 2: Marginal change in likelihood of integration associated with innovation

Table 1: Description of variables, measures, data sources used in main analysis

Covariates	***Measures***	***Data Sources***
Dependent variable		
Integration	Event: *external-first sample*=0 for all years from entry into data set for which a firm division used external; =1 if integrated sales.	Medical Device Register (MDR)
Key explanatory variables		
Years using external sales	4 categories: (1) if firm division has been using external sales for 1-2 years (ref. category), 3-4 years, 5-6 years, or 7 or more years. (t-1)	MDR
Specialty (Δ)	=1 if firm-division changes their main specialty from (t-2) to (t-1). A firm's main specialty is the medical specialty within which the firm has the most products in each year.[a]	MDR
Innovative product (Δ)	Increase (or decrease) in the count of innovative products sold by the firm division. Innovative products are those launched by the firm in the year such products are first approved by the FDA (t-1) – (t-2).	MDR; FDA Medical Device Product Classification Database
Controls – firm-division level		
# products (Δ)	Change in count of products sold by the firm-division (t-1) – (t-2).	MDR
# specialties (Δ)	Change in count of specialties in which the firm division currently sells products (t-1) – (t-2).	MDR
# division employees (Δ)	Change in number of employees (000s) (t-1) – (t-2).	MDR
# products at entry	Count of products sold by the firm division its entry year.	MDR
# specialties at entry	Count of specialties in which the firm division markets products in its entry year.	MDR
# patents at entry	Count of filed USPTO patent applications at entry.	USPTO
# Innovations at entry	Count of innovative products (as defined above) in the product portfolio of the firm division in entry year.	MDR; FDA
Region	U.S. Census Region based on state of firm division; Northeast, Midwest, South, and West.	MDR
Controls – corporate level		
Share of integrated sales (of co-divisions with same parent)	Number of firm divisions with the same corporate parent that have integrated sales (t-1).	MDR
Firm size (# divisions) (Δ)	Change in count of divisions of the parent firm from (t-2) to (t-1).	MDR
Ownership change (Δ)	=1 if parent firm changed (t-1).	MDR

[a] For example, J&J Cardiovascular's main specialty throughout the analysis is Cardiovascular

Table 2: Time using external sales, change in focal downstream market (specialty), and likelihood of integration

				Inverse propensity-score weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
Main Variables						
Years using external (3-4)	-0.781	-0.787	-0.944	-1.002	-1.009	-1.141
	(0.313)	(0.315)	(0.348)	(0.376)	(0.378)	(0.423)
Years using external (5-6)	-0.747	-0.756	-0.764	-0.553	-0.572	-0.549
	(0.336)	(0.336)	(0.344)	(0.415)	(0.410)	(0.420)
Years using external (7+)	-0.391	-0.387	-0.452	-0.525	-0.513	-0.584
	(0.289)	(0.289)	(0.310)	(0.366)	(0.363)	(0.391)
Specialty Change (Δ)		-0.267	-0.608		-0.684	-0.970
		(0.305)	(0.491)		(0.360)	(0.575)
Specialty (Δ) * Years (3-4)			1.033			1.064
			(0.803)			(0.889)
Specialty (Δ) * Years (5-6)			-0.070			-0.790
			(1.161)			(1.223)
Specialty (Δ) * Years (7+)			0.523			0.645
			(0.693)			(0.796)
Controls						
# products (Δ)	0.055	0.056	0.057	0.057	0.061	0.060
	(0.026)	(0.026)	(0.026)	(0.034)	(0.036)	(0.036)
# specialties (Δ)	-0.528	-0.550	-0.570	-0.364	-0.388	-0.378
	(0.204)	(0.213)	(0.223)	(0.361)	(0.405)	(0.420)
# division employees (Δ)	-0.039	-0.040	-0.034	-0.003	-0.013	-0.003
	(0.026)	(0.027)	(0.028)	(0.030)	(0.035)	(0.038)
Firm size (# divisions) (Δ)	-0.010	-0.010	-0.012	0.108	0.108	0.104
	(0.074)	(0.074)	(0.073)	(0.132)	(0.129)	(0.129)
Share internal (corporate level)	0.414	0.417	0.428	0.372	0.413	0.425
	(0.292)	(0.294)	(0.293)	(0.360)	(0.358)	(0.357)
Ownership change	-0.023	-0.022	-0.010	-1.062	-1.005	-1.010
	(0.497)	(0.496)	(0.496)	(0.991)	(0.955)	(0.968)
# competitors (Δ)	-0.008	-0.008	-0.008	-0.009	-0.009	-0.009
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
# products at entry	-0.030	-0.033	-0.034	-0.030	-0.041	-0.042
	(0.013)	(0.015)	(0.015)	(0.019)	(0.025)	(0.025)
# specialties at entry	0.061	0.078	0.082	-0.003	0.058	0.063
	(0.082)	(0.086)	(0.086)	(0.094)	(0.106)	(0.106)
# patents at entry	0.076	0.074	0.073	0.061	0.055	0.054
	(0.031)	(0.031)	(0.030)	(0.028)	(0.027)	(0.027)
# Innovations at entry	0.098	0.096	0.095	0.138	0.136	0.138
	(0.055)	(0.056)	(0.055)	(0.066)	(0.065)	(0.065)
Year, region, specialty controls	Y	Y	Y	Y	Y	Y
N (firm-division years)	2798	2798	2798	2739	2739	2739
n (firm divisions)	545	545	545	534	534	534
Events	102	102	102	101	101	101
LL	-415.2	-414.8	-413.9	-1302	-1294	-1290
Chi2 (p)	72.49	72.55	73.52	71.82	78.88	81.07

Note: All RHS variables are lagged by one period. All models also include controls for diagnostic specialties (lab and radiology separately), region fixed effects, and a variable for years after 1990.
Robust standard errors (clustered at the parent firm level) in parentheses

Table 3: Time using external sales, innovation, and likelihood of integration

					Inverse propensity-score weighted			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Main Variables								
Years using external (3-4)	-0.776	-0.723	-0.779	-0.735	-0.997	-0.961	-1.001	-0.964
	(0.312)	(0.317)	(0.314)	(0.315)	(0.376)	(0.383)	(0.378)	(0.381)
Years using external (5-6)	-0.763	-0.711	-0.755	-0.717	-0.564	-0.524	-0.560	-0.524
	(0.338)	(0.338)	(0.337)	(0.335)	(0.415)	(0.417)	(0.415)	(0.416)
Years using external (7+)	-0.392	-0.371	-0.390	-0.372	-0.527	-0.508	-0.525	-0.507
	(0.289)	(0.290)	(0.288)	(0.288)	(0.366)	(0.368)	(0.365)	(0.367)
Innovation (Δ)	1.206	1.921			1.332	1.973		
	(0.461)	(0.598)			(0.552)	(0.662)		
Innovation * Years (3-4)		-1.681				-1.686		
		(0.658)				(0.775)		
Innovation * Years (5-6)		-2.032				-1.901		
		(0.659)				(0.708)		
Innovation * Years (7+)		-1.493				-1.634		
		(0.733)				(0.763)		
Innovation within (Δ)			1.255	1.779			1.482	2.123
			(0.620)	(0.772)			(0.718)	(0.791)
Inno within * Years (3-4)				-1.433				-1.663
				(0.873)				(0.994)
Inno within * Years (5-6)				-1.671				-1.911
				(0.824)				(0.828)
Inno within * Years (7+)				-1.660				-2.042
				(0.953)				(0.927)
Innovation outside (Δ)			0.623	1.131			0.333	0.726
			(0.656)	(1.114)			(0.603)	(0.938)
Inno outside * Years (3-4)				-1.129				-0.976
				(1.156)				(1.024)
Inno outside * Years (5-6)				-1.246				-0.712
				(1.201)				(1.061)
Inno outside * Years (7+)				-0.493				-0.179
				(1.221)				(1.001)
Controls								
# products (Δ)	0.053	0.050	0.052	0.050	0.045	0.034	0.042	0.032
	(0.026)	(0.026)	(0.026)	(0.026)	(0.037)	(0.040)	(0.038)	(0.041)
# specialties (Δ)	-0.543	-0.543	-0.538	-0.542	-0.358	-0.344	-0.354	-0.340
	(0.204)	(0.202)	(0.203)	(0.201)	(0.370)	(0.368)	(0.368)	(0.366)
# division employees (Δ)	-0.040	-0.040	-0.039	-0.039	-0.003	-0.003	-0.003	-0.002
	(0.026)	(0.027)	(0.026)	(0.026)	(0.031)	(0.031)	(0.031)	(0.030)
# products at entry	-0.032	-0.035	-0.032	-0.035	-0.033	-0.035	-0.033	-0.036
	(0.013)	(0.013)	(0.013)	(0.013)	(0.020)	(0.020)	(0.019)	(0.019)
# specialties at entry	0.060	0.065	0.064	0.069	-0.003	0.005	-0.001	0.007
	(0.083)	(0.082)	(0.080)	(0.079)	(0.096)	(0.096)	(0.094)	(0.093)
# patents at entry	0.076	0.079	0.077	0.078	0.062	0.063	0.062	0.063
	(0.031)	(0.031)	(0.031)	(0.031)	(0.028)	(0.028)	(0.028)	(0.028)
# Innovations at entry	0.100	0.105	0.095	0.100	0.142	0.146	0.139	0.146
	(0.055)	(0.055)	(0.055)	(0.055)	(0.067)	(0.068)	(0.068)	(0.069)
Firm, Competition, Year, region, specialty controls	Y	Y	Y	Y	Y	Y	Y	Y
N (firm-division years)	2798	2798	2798	2798	2739	2739	2739	2739
Chi2 (p)	74.68	79.84	74.95	82.61	75.29	83.92	76.97	92.76

Note: Robust standard errors (clustered at the firm level) in parentheses

Table 4a: Marginal effects of years using external sales and moderating effect of a change in specialty, on integration likelihood (average marginal effects (ref: Years since entry=1-2)

	External	**Specialty Change =0**	**Specialty Change=1**
Years using external (3-4)	-0.028	-0.034	0.003
	(0.010)	(0.011)	(0.024)
Years using external (5-6)	-0.027	-0.030	0.018
	(0.012)	(0.013)	(0.021)
Years using external (7+)	-0.017	-0.020	0.002
	(0.012)	(0.014)	(0.021)

Note: Robust standard errors in parentheses

Table 4b: Marginal effect of innovative product launches, on integration likelihood across categories of years using external sales (average marginal effects)

	All innovations	**Inside innovation**	**Outside innovation**
Years using external (1-2)	0.097	0.090	0.057
	(0.032)	(0.039)	(0.056)
Years using external (3-4)	0.006	0.008	0.000
	(0.005)	(0.007)	(0.005)
Years using external (5-6)	-0.002	0.003	-0.003
	(0.006)	(0.007)	(0.011)
Years using external (7+)	0.014	0.003	0.022
	(0.013)	(0.018)	(0.017)

Note: Robust standard errors in parentheses

Table 5: Characteristics at entry for the external-first sample and internal-first sample

	Pre-match, pre-trim sample N=1615 (545 external-first, 1,070 internal-first)				Post-match, post-trim sample N=1598 (534 external-first, 1,064 internal-first)			
	External First	*Internal First*	*%bias*	*p-val (ttest)*	*External First*	*Internal First*	*%bias*	*p-val (ttest)*
# patents	0.52	1.03	9.50	0.11	0.77	0.72	-1.90	0.70
# products	8.11	5.89	-18.00	0.00	6.36	5.86	-4.20	0.26
# specialties	2.45	2.08	-20.70	0.00	2.14	2.08	-3.80	0.34
# Innovative products	0.79	0.51	-12.20	0.02	0.51	0.51	0.00	0.99
Firm size (# divisions)	3.49	3.39	-1.70	0.74	3.17	3.39	3.80	0.35
Region								
Northeast	0.45	0.33	-23.60	0.00	0.32	0.33	3.40	0.42
Midwest	0.24	0.21	-8.10	0.12	0.19	0.21	4.20	0.31
West	0.17	0.28	27.20	0.00	0.31	0.28	-7.60	0.11
South	0.15	0.18	9.60	0.07	0.19	0.18	-0.60	0.90
Specialty								
Anesthesiology / Pul Med	0.05	0.04	-3.50	0.50	0.05	0.04	-0.90	0.83
Cardiovascular	0.04	0.08	15.80	0.00	0.11	0.08	-14.50	0.01
Dental	0.03	0.04	4.70	0.38	0.07	0.04	-12.30	0.02
Ear, Nose, and Throat	0.02	0.01	-5.10	0.32	0.01	0.01	5.30	0.11
Gastro / Urology	0.02	0.04	12.40	0.03	0.03	0.04	6.60	0.17
General	0.38	0.35	-6.30	0.23	0.32	0.35	5.90	0.17
Lab Diagnostics	0.23	0.18	-13.80	0.01	0.19	0.18	-3.60	0.39
Neurology	0.01	0.01	-5.40	0.29	0.01	0.01	-1.90	0.63
Obstetrics	0.03	0.01	-13.30	0.01	0.01	0.01	-0.70	0.85
Ophthalmology	0.04	0.05	6.60	0.22	0.03	0.05	9.40	0.03
Orthopedics	0.02	0.02	-5.00	0.33	0.02	0.02	-3.40	0.42
Physical Med	0.05	0.04	-8.60	0.09	0.03	0.04	0.90	0.82
Radiology	0.04	0.08	18.00	0.00	0.08	0.08	0.30	0.95
Surgery	0.03	0.06	13.90	0.01	0.04	0.05	7.10	0.13
Propensity Score (propensity internal-first)	0.56	0.71			0.66	0.66		
Standardized Bias (mean)	**11.0**				**4.8**			

Standardized bias: the % difference of the sample means in the treated and non-treated subsamples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups. A bias score below 5 is a typical rule of thumb (Caliendo and Kopeinig, 2008).

ONLINE APPENDIX

Inverse propensity weighting to control for self-selection on observables

To control for observed differences across firms that select into external-first sales that may drive integration decisions, we use propensity scores to trim and re-weight our data (Bennett, 2013; Hirano and Imbeds, 2001). Specifically, for all firm divisions (including those that enter with an integrated sales force), we estimate the likelihood of integrating sales at entry. This analysis assigns each firm a propensity or likelihood of initially choosing integrated sales (Table A1). Figure A1 shows the kernel density plot of the propensity scores, highlighting the ex-ante differences between those that initially integrated sales and those that chose external sales at entry. We use the estimated propensity score to trim and re-weight our sample to account for selection. First, we drop firm divisions that have non-overlapping propensity scores (i.e., external-first with too low propensity scores). To account for selection on observables, we then weight our main external-first sample as ($1/1-\hat{p}$), where $\hat{p}$ is the propensity to be initially integrated, following Hirano and Imbens (2001). This process allows us to control for observable differences across the samples that drive the initial sales-force choice. Figure A2 depicts the kernel density of the trimmed and weighted samples and demonstrates similarity in propensity distributions of each sample.[20]

[20] Table 5 provides further evidence of balance across the internal- and external-first samples from the propensity-weighting procedure. It includes the mean values of product and firm characteristics at entry both for the raw sample (pre-matched, pre-trimmed) and the trimmed and weighted sample, and provides estimates of decreases in bias (from 11.4 to 4.8, where <5 is typically used as a guideline for balance (Caliendo and Kopeinig, 2008).

Figure A1: Propensity to be internal-first, by actual sales boundary at entry (*before *trimming and weighting)

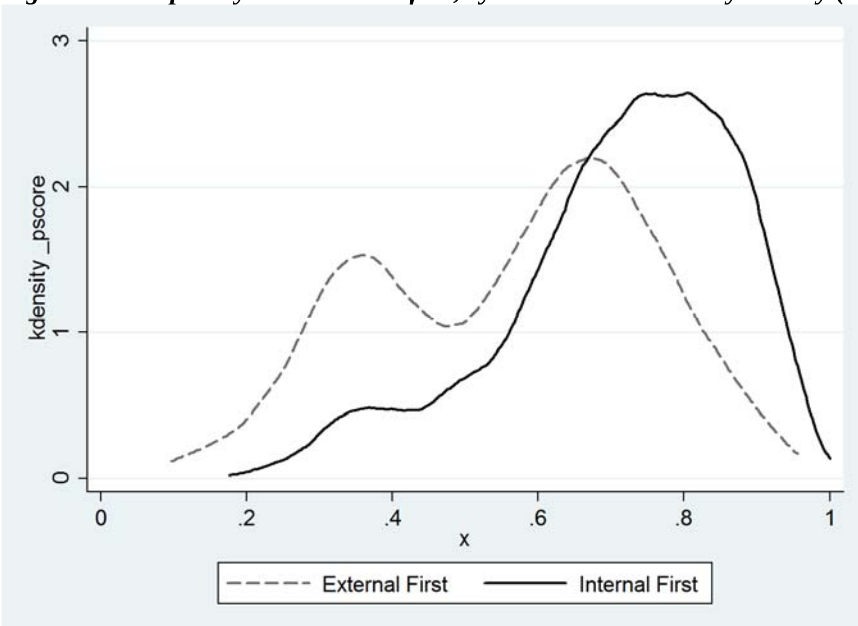

Figure A2: Propensity to be internal-first, by actual sales boundary at entry (*after *trimming and weighting)

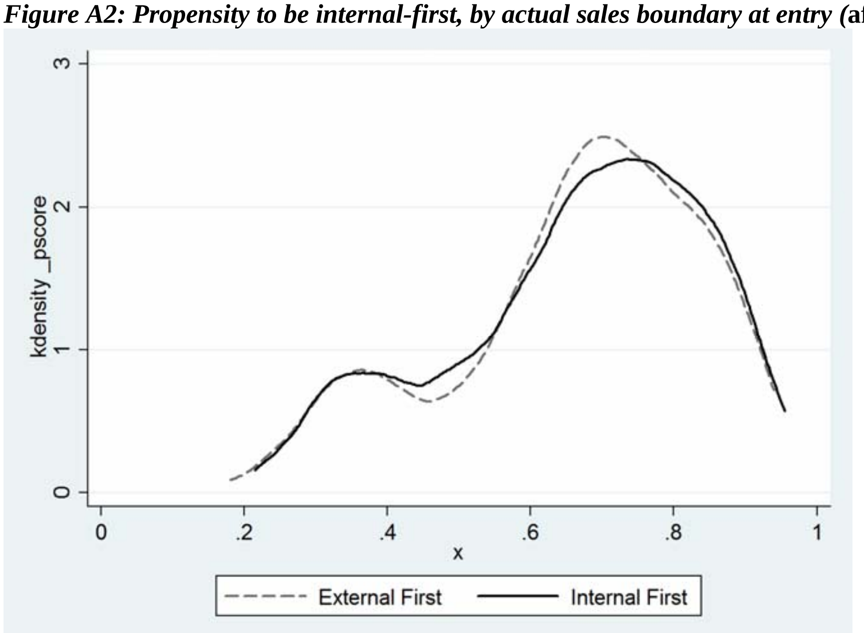

Table A1: Likelihood of being internal-first at entry (probit)

	Coefficient	Avg marginal effects
# patents	0.023	0.007
	(0.013)	(0.004)
# products	-0.013	-0.004
	(0.005)	(0.002)
# specialties	-0.065	-0.021
	(0.030)	(0.009)
Innovative products	0.098	0.031
	(0.023)	(0.007)
Firm size (# divisions)	-0.006	-0.002
	(0.006)	(0.002)
Specialty		
Cardiovascular	0.344	0.110
	(0.210)	(0.067)
Dental	0.331	0.105
	(0.235)	(0.075)
Ear, Nose, and Throat	-0.410	-0.131
	(0.311)	(0.099)
Gastro / Urology	0.611	0.195
	(0.271)	(0.086)
General	-0.181	-0.058
	(0.163)	(0.052)
Lab Diagnostics	-0.028	-0.009
	(0.171)	(0.054)
Neurology	-0.327	-0.104
	(0.370)	(0.118)
Obstetrics	-0.657	-0.210
	(0.282)	(0.089)
Ophthalmology	0.147	0.047
	(0.225)	(0.072)
Orthopedics	-0.197	-0.063
	(0.282)	(0.090)
Physical Med	-0.481	-0.153
	(0.223)	(0.071)
Radiology	0.409	0.130
	(0.212)	(0.067)
Surgery	0.487	0.155
	(0.237)	(0.075)
Region dummies	Y (4)	Y (4)
Entry year dummies	Y (12)	Y (12)
Constant	0.042	
	(0.190)	
n (firm-divisions)	1615	
r2	0.120	
ll	-909.0	
chi2 (p<0.001)	247.1	

Standard errors in parentheses

Table A2: Competing risk model (MNL): Sales integration, firm-division exit, and continue as external sales (ref. category)

	Time			Specialty Change		
	Integrate	Exit	Integrate	Exit	Integrate	Exit
Main Variables						
Years using external (3-4)	-0.778	0.238	-0.785	0.235	-0.938	0.286
	(0.318)	(0.181)	(0.320)	(0.181)	(0.354)	(0.199)
Years using external (5-6)	-0.728	0.335	-0.738	0.330	-0.738	0.387
	(0.346)	(0.190)	(0.346)	(0.189)	(0.355)	(0.204)
Years using external (7+)	-0.384	0.203	-0.379	0.203	-0.445	0.218
	(0.299)	(0.200)	(0.299)	(0.200)	(0.322)	(0.220)
Specialty Change (Δ)			-0.283	-0.119	-0.613	0.066
			(0.314)	(0.170)	(0.506)	(0.310)
Specialty (Δ) * Years (3-4)					1.010	-0.363
					(0.821)	(0.519)
Specialty (Δ) * Years (5-6)					-0.131	-0.453
					(1.183)	(0.550)
Specialty (Δ) * Years (7+)					0.522	-0.098
					(0.710)	(0.447)
Controls						
# products (Δ)	0.055	-0.044	0.056	-0.045	0.057	-0.045
	(0.031)	(0.028)	(0.032)	(0.028)	(0.032)	(0.028)
# specialties (Δ)	-0.541	0.001	-0.561	0.003	-0.581	0.006
	(0.214)	(0.135)	(0.222)	(0.136)	(0.231)	(0.134)
# division employees (Δ)	-0.053	-0.071	-0.053	-0.072	-0.047	-0.071
	(0.035)	(0.066)	(0.034)	(0.066)	(0.035)	(0.066)
Firm size (# divisions) (Δ)	-0.028	-0.102	-0.028	-0.102	-0.030	-0.103
	(0.079)	(0.037)	(0.079)	(0.037)	(0.079)	(0.037)
Share internal (corporate)	0.426	-0.024	0.427	-0.025	0.437	-0.024
	(0.304)	(0.235)	(0.306)	(0.236)	(0.305)	(0.237)
Ownership change	0.051	0.650	0.052	0.650	0.063	0.645
	(0.512)	(0.269)	(0.512)	(0.269)	(0.513)	(0.269)
# competitors (Δ)	-0.009	-0.003	-0.009	-0.003	-0.009	-0.003
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
# products at entry	-0.030	-0.002	-0.034	-0.003	-0.034	-0.003
	(0.014)	(0.009)	(0.015)	(0.009)	(0.015)	(0.009)
# specialties at entry	0.072	0.071	0.090	0.076	0.093	0.076
	(0.085)	(0.049)	(0.089)	(0.049)	(0.089)	(0.050)
# patents at entry	0.073	-0.053	0.070	-0.053	0.069	-0.053
	(0.033)	(0.041)	(0.033)	(0.041)	(0.033)	(0.041)
# Innovations at entry	0.097	-0.017	0.095	-0.017	0.095	-0.017
	(0.058)	(0.038)	(0.059)	(0.038)	(0.058)	(0.039)
Year, region, specialty controls	Y	Y	Y	Y	Y	Y
N (firm-division years)	2798		2798		2798	
LL	-1289		-1289		-1287	
Chi2 (p<0.001)	163.7		163.5		167.0	

Table A3: Competing risk model (MNL): Sales integration, division exit, and continue as external sales (ref. category)

	(1)		(2)		(3)		(4)	
	Integrate	Exit	Integrate	Exit	Integrate	Exit	Integrate	Exit
Main Variables								
Years using external (3-4)	-0.771	0.238	-0.721	0.243	-0.774	0.237	-0.734	0.204
	(0.318)	(0.180)	(0.323)	(0.181)	(0.319)	(0.182)	(0.321)	(0.183)
Years using external (5-6)	-0.741	0.336	-0.691	0.337	-0.732	0.344	-0.692	0.306
	(0.348)	(0.190)	(0.348)	(0.191)	(0.347)	(0.190)	(0.346)	(0.193)
Years using external (7+)	-0.381	0.203	-0.363	0.198	-0.378	0.209	-0.362	0.190
	(0.299)	(0.200)	(0.300)	(0.200)	(0.298)	(0.201)	(0.299)	(0.201)
Innovation (Δ)	1.222	-0.040	2.009	0.735				
	(0.474)	(0.447)	(0.624)	(0.437)				
Innovation * Years (3-4)			-1.788	-0.989				
			(0.676)	(0.855)				
Innovation * Years (5-6)			-2.247	-1.439				
			(0.695)	(1.061)				
Innovation * Years (7+)			-1.669	-1.515				
			(0.762)	(0.949)				
Innovation within (Δ)					1.200	-0.702	1.865	0.788
					(0.629)	(0.605)	(0.772)	(0.589)
Inno within * Years (3-4)							-1.680	-2.318
							(0.876)	(1.027)
Inno within * Years (5-6)							-2.353	-3.767
							(0.877)	(1.003)
Inno within * Years (7+)							-1.671	-0.448
							(1.004)	(0.714)
Innovation outside (Δ)					0.741	0.635	1.322	0.468
					(0.701)	(0.418)	(1.213)	(0.612)
Inno outside * Years (3-4)							-1.194	0.616
							(1.263)	(0.850)
Inno outside * Years (5-6)							-1.012	1.461
							(1.395)	(1.095)
Inno outside * Years (7+)							-0.878	-2.019
							(1.323)	(1.242)
Controls								
# products (Δ)	0.053	-0.045	0.050	-0.046	0.053	-0.040	0.050	-0.038
	(0.030)	(0.028)	(0.030)	(0.029)	(0.030)	(0.028)	(0.030)	(0.028)
# specialties (Δ)	-0.553	0.001	-0.553	-0.001	-0.549	-0.004	-0.550	-0.008
	(0.215)	(0.134)	(0.213)	(0.135)	(0.214)	(0.138)	(0.212)	(0.139)
# division employees (Δ)	-0.053	-0.071	-0.053	-0.071	-0.053	-0.071	-0.053	-0.070
	(0.035)	(0.066)	(0.036)	(0.066)	(0.035)	(0.067)	(0.036)	(0.067)
# products at entry	-0.033	-0.002	-0.035	-0.002	-0.033	-0.003	-0.036	-0.004
	(0.014)	(0.009)	(0.014)	(0.009)	(0.013)	(0.008)	(0.013)	(0.008)
# specialties at entry	0.072	0.071	0.075	0.069	0.076	0.073	0.083	0.077
	(0.086)	(0.049)	(0.085)	(0.049)	(0.083)	(0.048)	(0.083)	(0.048)
# patents at entry	0.073	-0.053	0.076	-0.053	0.073	-0.052	0.075	-0.059
	(0.033)	(0.041)	(0.033)	(0.041)	(0.033)	(0.042)	(0.033)	(0.043)
# Innovations at entry	0.098	-0.017	0.103	-0.015	0.094	-0.015	0.098	-0.016
	(0.058)	(0.038)	(0.058)	(0.037)	(0.058)	(0.038)	(0.058)	(0.038)
Firm-level, Comp., Year, region, specialty controls	Y	Y	Y	Y	Y	Y	Y	Y
N (firm-division years)	2870		2870		2870		2870	
LL	-1471		-1469		-1470		-1464	