ORGANIZING FOR INNOVATION: MANAGING THE COORDINATION-AUTONOMY DILEMMA IN TECHNOLOGY ACQUISITIONS

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Large, established firms acquiring small, technology-based firms must manage them so as to both exploit their capabilities and technologies in a coordinated way and foster their exploration capacity by preserving their autonomy. We suggest that acquirers can resolve this coordination-autonomy dilemma by recognizing that the effect of structural form on innovation outcomes depends on the developmental stage of acquired firms’ innovation trajectories. Structural integration decreases the likelihood of introducing new products for firms that have not launched products before being acquired and for all firms immediately after acquisition, but these effects disappear as innovation trajectories evolve.

The ability to produce multiple product innovations in quick succession is critical in high-velocity environments (Brown & Eisenhardt, 1997). Many companies adopt external development strategies in order to avoid the time-consuming, path-dependent, and uncertain processes of internally accumulating capabilities for producing streams of innovation (Dierickx & Cool, 1989; Leonard-Barton, 1995). Technology acquisitions—acquisitions of small, technology-based firms by large, established firms made so that the larger firms can “graft” acquired technological capabilities onto their own resource bases (Huber, 1991; Puranam, 2001)—are an important external source of innovation streams (Doz, 1988; Graebner, 2004; Granstrand & Sjolander, 1990; Ranft & Lord, 2002). Yet the management of such acquisitions poses an organizational dilemma. Acquirers must integrate acquired firms in order to commercialize their technologies in a coordinated manner; at the same time, they must preserve organizational autonomy for acquired firms in order to avoid disrupting their capacity for continued innovation (Haspeslagh & Jemison, 1991; Puranam, 2001; Ranft & Lord, 2002).

How does the coordination-autonomy dilemma affect innovation outcomes in technology acquisitions? In this article, we draw on the concepts of exploration and exploitation in organizational learning (March, 1991) and research on postmerger integration (Haspeslagh & Jemison, 1991) to answer this question. The key to successfully generating a sequence of innovations is ongoing exploration and exploitation (Benner & Tushman, 2003; Brown & Eisenhardt, 1997; March, 1991). However, basic choices about postacquisition structural form are discrete and emphasize either exploration or exploitation. Structural integration of an acquired firm enables the acquirer to exploit its technological developments through enhanced coordination, but organizational autonomy through structural separation preserves the acquisition’s capacity for continued exploration. Our key contribution is the argument that the conflicting effects of structural form on coordination and autonomy need not always offset each other.

Technological innovations often follow a “trajectory”—a related stream of technological developments (Dosi, 1982, 1984; Winter, 1984). Continuous exploration and continuous exploitation are both necessary for a firm to progress along a technological trajectory. Viewed longitudinally, however, an
acquired firm’s technological trajectory has stages that are more exploration-intensive—stages when exploration activity is more critical than is exploitation for successful innovation. At such stages, structural forms that emphasize autonomy are likely to outperform structural forms that emphasize coordination. The implication is that acquirers can better manage the coordination-autonomy dilemma in technology acquisitions by taking into account the relative importance of exploration and exploitation when selecting the structural form of an acquisition.

To test our argument, we examined the impact of structural integration on the likelihood of introducing innovations to market at different stages of the innovation trajectories of acquired firms. Structural integration, and its converse, structural separation, represent two archetypes of postacquisition organizational structure; either a target firm is absorbed into the acquirer and loses its distinctive identity as an organizational unit, or it is preserved as a distinct organizational entity within the merged firm (Haskeslagh & Jemison, 1991). New-product launches are considered a key indicator of the performance of innovation processes (Brown & Eisenhardt, 1997; Eisenhardt & Tabrizi, 1995; Katila & Ahuja, 2002; Schoonhoven & Eisenhardt, 1990). We argue that the first innovation a firm launches and the first innovation launched after its acquisition are much more exploration-intensive than other innovations on its technology trajectory. Supporting our argument, we find that structural integration adversely affects the likelihood of launching these first innovations but has more favorable effects on the likelihood of launching other innovations from an acquired firm.

This study contributes to the literature on postmerger integration (Birkinshaw, Bresman, & Hakanson, 2000; Haskeslagh & Jemison, 1991; Pablo, 1994; Puranam, 2001; Ranft & Lord, 2002; Zollo & Singh, 2004). Prior work suggests that initial autonomy followed by eventual integration may be beneficial in acquisitions that confront the coordination-autonomy dilemma (Birkinshaw et al., 2000; Haskeslagh & Jemison, 1991; Ranft & Lord, 2002), but there is little theoretical development or large-sample evidence on the conditions under which the transition from autonomy to coordination is optimal. Our analysis suggests that the structural integration in technology acquisitions is optimal when it does not coincide with the most exploration-intensive phases in a sequence of innovations.

This study also contributes to the broader literature on the organizational challenges of balancing exploration and exploitation (Burns & Stalker, 1961; Ghemawat & Costa, 1993; March, 1991). Synchronizing changes in organizational arrangements with changes in the relative importance of exploration and exploitation may be an alternative to spatial separation (Tushman & O’Reilly, 1996), repeated cycling between organizational arrangements, and creating hybrid structures (Brown & Eisenhardt, 1997, 1998).

STRUCTURAL FORM, COORDINATION, AND AUTONOMY IN TECHNOLOGY ACQUISITIONS

Small, technology-based firms are attractive to acquirers as sources of innovation streams because of their organizational advantages at exploration (Brown & Eisenhardt, 1997; Burns & Stalker, 1961; Doz, 1988; Zenger, 1994). Acquirers can graft the innovation streams of acquired firms onto their own organizations (Huber, 1991; Puranam, 2001) and exploit the fruits of the acquired firms’ exploration in a coordinated manner by linking them to their own complementary assets in manufacturing, marketing, and distribution (Doz, 1988; Teece, 1986; Williamson, 1985). However, linking acquired innovations to an organization differs from internal development in an important regard: to accomplish the link, acquirers cannot rely on the preexisting coordination mechanisms (such as standard operating procedures, routines, and shared language and identification) yielded by comembership in a firm (Grant, 1996; Kogut & Zander, 1992, 1996) but instead must design and implement coordination mechanisms after the acquisition. Therein lies the importance of structural form.

Structural integration—as opposed to structural separation—is a fundamental design choice about the structural form of a combined organization (Haskeslagh & Jemison, 1991). As a formal design choice concerning the grouping of organizational units, structural integration precedes decisions about the use of linking mechanisms between organizational units (such as the alignment and standardization of processes and systems, common hierarchical control, cross-unit teams, and integrating managers) both temporally and in importance (Galbraith, 1977; Nadler & Tushman, 1997; Thompson, 1967). Scholars who study acquisition implementation have described the choice between complete absorption and preservation of autonomous organizational status as an important initial decision that shapes further fine-grained integration actions (Haskeslagh & Jemison, 1991; Pablo, 1994; Ranft & Lord, 2002; Zollo & Singh, 2004).

Structurally integrating an acquired firm into the acquirer’s organization creates organizational conditions that support the coordinated exploitation of the target firm’s technological breakthroughs by the
acquirer. Successful commercialization depends on extensive coordination across the various organizational units, such as R&D, manufacturing, and marketing, that play a role in converting an invention into an innovation (Brown & Eisenhardt, 1995; Zahra & Nielsen, 2002). By grouping organizational units within common administrative boundaries through structural integration, an acquirer can use common authority, incentives, systems, and processes to simplify coordination and facilitate mutual adaptation. In addition to impacting the formal systems and procedures of an organization, structural form also shapes the emergence over time of informal organizational processes that aid coordination, such as group conventions, common language, informal communication channels, and group identity (Camerer & Knez, 1996; Ibarra, 1993; Kogut & Zander, 1996).

However, structural integration has a darker side. Change can cause disruption, independent of any improvements brought about by a new configuration of organizational attributes (Amburgey, Kelley, & Barnett, 1993; Hannan & Freeman, 1984). Structural integration involves changes to the organizational processes and procedures of a target firm that make it similar to those of the acquirer into which it is being structurally integrated. Such changes can alter organizational routines in the target firm, and in doing so can undermine its innovative capacity (Benner & Tushman, 2003; Ranft & Lord, 2002). Arguments from agency theory suggest that structural integration also weakens the link between reward and effort. Grouping formerly distinct organizational units increases the possibility of free riding and precludes the use of sharp incentives (Baker, 2002). Talented employees with hard-to-measure skills and efforts are often attracted to small organizations because of their ability to offer high-powered incentives (Zenger, 1994). Such employees are likely to leave after their firm has been fully integrated into an acquirer, critically undermining the target firm’s innovation capacity (Ernst & Vitt, 2000). Even if these employees are retained via high-powered incentive systems, lowered intrinsic motivation owing to lowered task autonomy following structural integration can lead to similar results (Osterloh & Frey, 2000; Wageman, 1995).

The choice of structural form in technology acquisitions thus appears to be constrained by the difficulty of balancing autonomy (to promote exploration) and coordination (to promote exploitation). Although the coordination-autonomy dilemma exists in principle in all acquisitions, technology acquisitions are particularly susceptible to its adverse consequences. This is because producing a sequence of innovations requires organizations to cycle repeatedly through phases of exploration (product definition, conceptual design, prototyping, and testing) and exploitation (manufacturing, marketing, and distribution) in order to bring each innovation to market (Brown & Eisenhardt, 1995, 1997, 1998; Zahra & Nielsen, 2002). Indeed, if technological competition and turbulent industry conditions pose severe time constraints, the exploration and exploitation phases of successive products may significantly overlap (Brown & Eisenhardt, 1997, 1998; Eisenhardt & Tabrizi, 1995). Thus, a question with significant theoretical and managerial implications arises: if ongoing exploration and exploitation are both important to generate a stream of innovations, what is the impact on innovation outcomes of structural forms that emphasize either exploration or exploitation?

In the next section, we develop the argument that the effect of a structural form on innovation outcomes is contingent on the stage of development of the innovation trajectory of an acquired firm. We identify specific stages in the development of the acquired firm’s innovation trajectory when exploration is more important than exploitation and hypothesize that at such stages, structural forms that emphasize autonomy outperform structural forms that emphasize coordination.

HYPOTHESES

Although both exploration and exploitation are important to the success of a sequence of innovations, exploration and exploitation are not always equally important.1 Our basic proposition is that in technology acquisitions, there are stages in the development of the acquired firms’ technological trajectories when exploration is more important than exploitation. At these stages, we argue, the adverse impact of structural integration on exploration activity overwhelms the favorable impact on exploitation to create a net adverse impact on innovation outcomes. At other stages, the adverse and favorable consequence of structural integration may be more evenly balanced, or the latter may even dominate. We present hypotheses that focus on two distinct stages in an acquired firm’s technological trajectory when exploration is more important than exploitation. The first occurs when the firm’s innovation sequence is initiated. The second occurs in the immediate aftermath of the acquisition.

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1 More formally, we might say that the marginal rate of technical substitution between exploration and exploitation is different at different stages in an innovation sequence.
The initial innovation in a sequence of innovations is likely to involve the widest-ranging exploration of the technological opportunity space. Scholars have conceptualized the notion of a technology paradigm, which represents an early but formative innovation that focuses the direction of subsequent efforts. Such paradigms can describe both industry-level and firm-level technological development (Dosi, 1982, 1988; Nelson & Winter, 1982). Following an initial innovation, further innovations typically arise along the trajectory initiated by the original innovation, as it provides an exemplar as well as a set of heuristics about where and how to search for future innovations (Dosi, 1982, 1988; Winter, 1984). Thus, relative to the initial innovation, later innovations are likely to involve more local search (Rosenkopf & Almeida, 2003; Rosenkopf & Nerkar, 2001).

In a technology acquisition, the first innovation based on the technology of the acquired company establishes the paradigm within which its future innovations will arise (Dosi, 1982, 1988). When acquired firms have not yet launched their initial products, they are in a stage that emphasizes exploration. This is true even if their innovations are not “first to the world” but only “first to the firm.” Product specifications and designs may still be fluid, with development teams engaged in wide-ranging search among different technical opportunities (Chaudhuri & Tabrizi, 1999). Though structural integration is conducive to exploitation by enhancing coordination between acquired and acquiring firm, at this stage the adverse effects on innovation outcomes should be more salient, as turnover and disruption of organizational routines and motivation undermine exploratory activities (Amburagey et al., 1993; Ranft & Lord, 2002). Disruption results in significant obstacles to the launch of a product if acquirers need to replace members of development teams and take over development activities. Since subsequent innovations may not only build on the initial innovation, but also improve on and resolve defects in the initial product (Brown & Eisenhardt, 1998), a poor start can adversely affect the entire sequence of innovations emanating from the acquired firm.

However, if firms are acquired and structurally integrated after they have launched initial products, the disruptive effects are likely to be less adverse. Innovations at this stage are likely to involve narrower exploration than initial innovations, as the boundary conditions imposed by the first necessarily constrain them (Dosi, 1988; Nelson & Winter, 1982; Rosenkopf & Nerkar, 2001). Rather, a subsequent innovation is more likely to involve a search for improvements within parameters defined by the initial product. Put differently, a corresponding decline in exploratory activities is likely to affect later innovations much less than an initial innovation, because exploration contributes less to the success of later innovations. We therefore predict:

**Hypothesis 1a.** In technology acquisitions, structural integration has a negative impact on innovation outcomes for target firms that have not launched products prior to their acquisition.

**Hypothesis 1b.** In technology acquisitions, structural integration has a better impact on innovation outcomes for target firms that have launched products prior to their acquisition than it has on target firms that have not launched products prior to acquisition.

Even if the initial innovation after acquisition is not the first in the technological trajectory of a target firm, because it is the first after acquisition, the innovation’s organizational and technological context contains sufficient novelty to require a relatively wide-ranging search for improvements, and possibly a reevaluation of key design parameters. Novelty and the need for exploration in the immediate aftermath of acquisition arise from two sources. First, significant changes may be needed if technological synergies between the target and acquirer’s technologies and interoperability (Schilling, 2000) are to be achieved. Second, even without major alterations for synergy or interoperability considerations, target firms’ technologies may require modifications to be suitable for commercialization using the complementary assets of acquirers (Chaudhuri & Tabrizi, 1999; Ranft & Lord, 2002). For instance, target firms might be required to change design specifications and design techniques in order to conform to their acquirers’ design-forn-manufacture principles. As an illustration, consider Cisco Systems, a prolific and popular user of technology acquisitions. The period after a Cisco acquisition has typically involved significant adjustments to an acquired technology to make it compatible with and optimized for Cisco’s proprietary “internetworking operating system” (IOS) and to ensure that the prototype based on the acquired firm’s technology adheres to Cisco’s new product introduction process (Holloway, Kasper, Tempest, & Wheelwright, 1999; Paulson, 2001; Stauffer, 2000).

We therefore expect that in the period leading up to a target’s first innovation after acquisition, the disruption of productive routines, decline in motivation, and departure of key developers (and the
loss of their knowledge) will significantly hamper the acquirer’s efforts to achieve compatibility with and commercialize the acquired firm’s technology. Structural integration and disruption to the exploratory processes underlying technical developments at this stage can have adverse consequences that may overwhelm the benefits of coordination. However, once the initial innovation after acquisition has been launched, it resolves some of the uncertainty about the conditions under which future technological progress must take place in the merged organization. Fundamental changes to the technology to ensure technical interoperability will have occurred at the time of the initial postacquisition innovation. Similarly, development processes and procedures in the acquired organization will have been modified as a way to enable commercialization using the acquirer’s complementary assets. Once these changes have been made, these elements of the technology development process are likely to remain relatively stable over the course of future innovations. In this sense, the initial innovation after an acquisition defines a new technological paradigm that shapes further innovations, which incrementally enhance and elaborate on the first (Dosi, 1982, 1988). Therefore, the disruption of exploratory processes by structural integration should have less severe effects on subsequent innovations. We therefore predict:

**Hypothesis 2a.** In technology acquisitions, structural integration has a negative impact on innovation outcomes immediately following acquisition.

**Hypothesis 2b.** In technology acquisitions, structural integration has a better impact on subsequent innovation outcomes than it has on immediate innovation outcomes.

**METHODS**

**Sample and Data**

In keeping with prior research, we defined technology acquisitions as the acquisition of small, technology-based firms by large, established firms to gain access to the target firms’ technologies and capabilities (Doz, 1988; Graebner, 2004; Granstrand & Sjolander, 1990; Ranft & Lord, 2002). We chose our sample of acquirers from information technology hardware industries for two reasons. First, this sector has been frequently profiled in popular publications as being extremely active in technology acquisitions (e.g., Goldblatt, 1999; Reinhardt, 1999). Second, we were able to obtain access for extensive interviewing at three major firms in this sector—Intel, Cisco Systems, and Hewlett-Packard—which gave us a rich understanding of the context necessary for designing the large-sample study. At two of these firms, we were also able to obtain primary data with which to test the reliability and validity of our measures obtained from secondary sources.

Acquiring firms were selected from the SIC codes of manufacturing industries connected to information technology (IT; computing and communications). Our criteria for selecting large, established acquirers required them to have been listed continuously in COMPUSTAT between 1988 and 1998 and to have had more than 1,000 employees throughout the study period. The choice of the time window was driven by the availability of good public information on acquisitions and ex post performance measures (the data were collected in 2001).

We defined an established firm as one with continuous existence during the study window. The use of 1,000 employees as the cut-off point for large acquirers is consistent with prior research (Pavitt, Robson, & Townsend, 1987, 1989). We used the U.S. Small Business Administration definition of a small business (fewer than 500 employees) and identified acquisitions of such small firms through SDC Platinum’s M&A Database. Finally, we relied on media coverage at the time of the acquisitions to isolate those in which technology was reported as a key motivating factor (Ahuja & Katila, 2001). Though the acquirers were all from IT hardware industries, targets could be from other industries as well (software was the most frequent nonhardware industry represented). A total of 217 acquisitions by 49 acquirers met these criteria. Data availability reduced this sample to 207 acquisitions for 49 acquirers.

**Dependent variable.** We measured innovation outcomes as the hazard (instantaneous probability) of an acquirer launching a new product after an acquisition that has incorporated the acquired firm’s technology. In their review of product development research, Brown and Eisenhardt distinguished several different measures of innovation outcomes in the product development context: (1) process performance, defined as the speed and productivity of product development; (2) product effectiveness, defined as the fit of the product with
firm competencies and market needs; and (3) financial success, defined as revenue, profitability, and market share (1995: 366). Brown and Eisenhardt’s review revealed that the most robust empirical findings in the literature on product development have to do with process performance, rather than product effectiveness or financial success. The factors that seem to have a robust effect on process performance are essentially organizational (the amount and variety of problem solving, and the organization of information exchange).

Since our theoretical antecedents of innovation outcomes are organizational (the coordination-autonomy dilemma), we focus on innovation process performance—i.e. the speed and productivity of product development (Brown & Eisenhardt, 1995, 1997; Eisenhardt & Tabrizi, 1995; Katila & Ahuja, 2002; Schoonhoven & Eisenhardt, 1990). The hazard of new-product introduction incorporates both the number and timing of new-product launches (Allison, 2000; Morita & Lee, 1993). We obtained the counts and dates of new products introduced by an acquirer through three publicly available databases that aggregate news and press releases: Business and Industry, Dow Jones Interactive, and Lexis-Nexis. Data were generated by a search for new-product announcements by only the acquirers that mentioned their target firms as the sources of the technologies/products. Each acquisition was tracked from the date of announcement until the beginning of the study period (1 year of acquisition, as reflected in the disappear-ance or continued appearance of the acquired firms in CORPTECH in the year following acquisition). We report analyses with the measure obtained from CORPTECH. The results are qualitatively unaltered with either measure.

We created a dummy variable, target prior product, to record whether a target firm had introduced at least one product prior to acquisition (prior product = 1). This information was obtained from CORPTECH, which records annual numbers of products and sales. The data were supplemented and cross-checked with information from press releases at the time of the acquisition. We created a dummy variable, subsequent product, to distinguish the initial innovation after acquisition (subsequent product = 0) from subsequent innovation (subsequent product = 1).

Control variables. We controlled for several acquirer, target, and relational characteristics that could influence innovation outcomes and structural integration decisions.

From CORPTECH and SDC Platinum we obtained the number of employees in each target firm to measure target size, and for target age, we obtained data on age in years at the time of acquisition. The age and size of target firms may influence their innovation outcomes and also how acquirers treat their organizational autonomy (Pablo, 1994).

We included two variables as controls for the quality of the target firms. First, the amount paid per employee of the acquired firm, in millions of dollars (dollars paid per employee), was obtained from SDC Platinum and from press releases. Second, whether an acquired firm had filed one or more patents prior to the acquisition (target prepatenting), was obtained from the U.S. Patents and Trademarks Office Web site. It was coded 1 if a target firm had filed a patent before its acquisition and 0 otherwise. We included dummy variables for target industry. All acquirers were in the manufacturing (hardware) sector, but target firms could be in hardware or software industries. Differences in acquirers’ and targets’ industries could contribute to implementation difficulties. The variable, software target, was coded 1 if a target firm was in software and 0 otherwise.

Acquirer acquisition experience was a count of an acquirer’s prior technology acquisitions since the beginning of the study period (1 = “prior acquisition experience,” 0 = “no experience”). Acquisition experience has been shown to have sig-
significant effects on performance and integration decisions (Haleblian & Finkelstein, 1999; Zollo & Singh, 2004).

Investment in R&D as a percentage of sales for acquirers was calculated from data available from COMPUSTAT; the variable was called acquirer R&D intensity. R&D investments by acquirers could lead to superior innovation outcomes on their own, and could also build absorptive capacity, enabling successful utilization of external sources of knowledge (Ahuja & Katila, 2001).

We included a measure of the extent of technological relatedness between target and acquirer, assessing the overlap between the technology codes assigned to targets and acquirers by SDC Platinum. This database assigns three-digit technology codes to acquirers and targets on the basis of the technology and product lines of the firms. We calculated overlap as the number of codes common to acquirer and target divided by the total number of technology codes of the target firm.

**Analytical Techniques**

Since the dependent variable in this study was the hazard (the instantaneous probability) of an acquirer launching a new product after acquisition that incorporated an acquired firm’s technology, we used survival analysis techniques to model the hazards of new-product introduction. We constructed a longitudinal data set of the timing and number of product introductions by acquirers. An acquisition marked the beginning of an observation period, and introduction of a new product or our decision to terminate observation marked the end of an observation period. We observed each acquisition until January 1, 2001, leading to right-censoring of observations. Our basic estimation technique was the Cox proportional hazards model (Cox, 1972), a robust technique for hazard rate analysis that does not place restrictive assumptions about the precise nature of a hazard’s probability distributions. The basic model can be written as:

\[ h_i(t) = \lambda_0(t) \exp(\beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik}). \]

(1)

This formula states that the hazard (h) of product introduction for target firm i at time t is the product of a baseline hazard \( \lambda_0(t) \), which is left unspecified except that it must be nonnegative, and an exponentiated linear function of k fixed covariates. The advantage of this formulation is that differences in hazard rates across target firms depend only on the covariates, not on the baseline hazard, which is the same for all firms. The model is estimated by finding values of beta that maximize the partial likelihood of observing the data (Cox, 1972). The resulting estimates are consistent and asymptotically normal, though not efficient (Allison, 2000; Morita & Lee, 1993).

The data are best understood as being three-layered: the data capture, as time t, the time after acquisition when target firm j, acquired by acquirer firm i, introduces product k. The analysis of all three levels (repeated events on repeated events) introduces considerable complexity into the analysis. The usual conditional independence assumption used in the analysis of panel data is not tenable here, because one is in effect taking repeated measures on the same subject (target firm) for the same type of event (product introduction). A target firm was not at risk of introducing the \( k + 1 \)th product unless it had introduced the \( k \)th product, so that we needed to account for the ordering of events in our analysis.

We analyzed these data using the conditional risk set methodology (Prentice, Williams, & Peterson, 1981). In this technique, the conditional risk set for event \( k \) at time \( t \) is made up of all subjects that have had the event \( k - 1 \) by time \( t \). The baseline hazard therefore had to be allowed to differ across risk sets in our analyses. An important advantage of the Cox regression model was that it allowed us to model differing baseline hazards across different strata (i.e., subgroups) within the sample (Allison, 1996, 2000; Morita & Lee, 1993). We thus estimated Cox regressions with stratification on event order (Prentice et al., 1981). In Equation 1, this estimation implies that all first-product introductions have a unique baseline hazard, different from the hazard for all second-product introductions, which in turn differs from the hazard for all third-product introductions, and so on. The estimates of beta were therefore obtained after we controlled for the effect of event ordering. Finally, we adjusted the standard errors for nonindependence across multiple spells observed on the same target firm (Lin & Wei, 1989).

The effect of structural integration, a decision taken and implemented in the period immediately following the acquisition, was unlikely to be constant over the time periods over which we observed innovation outcomes. In fact, unless we could control for the simple maturation effects of structural integration, we could not accurately test Hypothesis 2b, as the hypothesized effects of structural integration on subsequent innovations might be confounded with its time-varying effects. A further advantage of the Cox regression model was that it allowed incorporation of time-varying effects of covariates (Allison, 2000; Morita & Lee, 1993).
modeling the effect of structural integration interacting with time, we ensured that our results controlled for simple maturation effects.

RESULTS

Descriptive Statistics

Table 1 shows the descriptive statistics and correlations for the principal variables used in the analysis. Our sample consisted of 207 acquisitions by 49 acquirers. The number of acquisitions varied from 1 (12 acquirers) to 26. In terms of structural form, about 51 percent of the target firms in the sample underwent structural integration after the acquisition. Target firms were small and young, on average (92 employees, eight years old at time of acquisition), though 63 of them had filed at least one patent prior to being acquired, and 181 of the targets had launched a product prior to being acquired.

An examination of the most significant correlations indicated that acquisition experience was associated with a higher degree of integration (0.30, \( p < .01 \)) and that larger acquirers and acquirers with greater R&D intensities had greater acquisition experience (0.43, \( p < .01 \) and 0.31, \( p < .01 \), respectively). Acquirers with high R&D intensity also tended to acquire target firms with related technologies (0.20, \( p < .01 \)).

Our data comprised 371 observational spells, in which each spell began after a product introduction (except for the first spell, which began with the acquisition) and ended with either another product introduction or censoring. The clock was reset after each product introduction, so that each spell began afresh (Amburgey et al., 1993; Prentice et al., 1981). In terms of products introduced (the dependent variable), of 207 acquisitions, 73 resulted in one or more new-product introductions. Of these, 27 were structurally integrated. The 73 acquisitions that introduced one or more products resulted in an average of 1.26 additional products (the range was 0–6 additional products). Since there were fewer than ten spells in the strata corresponding to the fifth, sixth, and seventh product introductions, we consolidated these into the fourth stratum. Although the number of products launched by an acquirer varied across its acquisitions, 21 acquirers did not launch any products from any of their acquired firms; only 13 acquirers managed to launch more than 3 products from any of their acquisitions; and only 6 acquirers managed to launch more than 4 products from any of their acquisitions. Eighteen out of 47 acquirers used only one or the other structural form (integration/separation), while all other acquirers used both in their acquisition portfolios.

Results of Hypothesis Testing

Table 2 presents results from conditional risk set Cox regressions (Prentice et al., 1981) in which the dependent variable is the hazard of new-product introductions. By stratification on product introduction order, we ensured that a target firm was not at risk of the \( k \)th new-product introduction until it had introduced the \( (k - 1) \)th product. The reported coefficients can be exponentiated \((e^\beta)\) to obtain haz-

<table>
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<tr>
<th>Variable</th>
<th>Mean</th>
<th>s.d.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>1. Structural integration</td>
<td>0.51</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
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<td></td>
<td></td>
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<td>2. Target prior product</td>
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<td>1</td>
<td>-15†</td>
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<td>3. Target age</td>
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<td>6.93</td>
<td>0</td>
<td>30</td>
<td>.00</td>
<td>.12†</td>
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<td>4. Target size</td>
<td>92.88</td>
<td>99.28</td>
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<td>500</td>
<td>-0.05</td>
<td>-0.2</td>
<td>.41**</td>
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<td>5. Dollars paid per employee(b)</td>
<td>2.52</td>
<td>4.35</td>
<td>0.02</td>
<td>32.5</td>
<td>.01</td>
<td>.07</td>
<td>.23**</td>
<td>-.32**</td>
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<td>.16*</td>
<td>.28**</td>
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<td>7. Technological relatedness</td>
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<td>0.11</td>
<td>0.06</td>
<td>0.6</td>
<td>31.4</td>
<td>.07</td>
<td>.11</td>
<td>-.08</td>
<td>-.07</td>
<td>-.02</td>
<td>.12†</td>
<td>.20**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Acquirer sales(b, c)</td>
<td>7.69</td>
<td>1.71</td>
<td>3.71</td>
<td>10.8</td>
<td>.08</td>
<td>-.08</td>
<td>-.17*</td>
<td>-.11</td>
<td>.24**</td>
<td>.10</td>
<td>-.02</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>10. Acquirer acquisition experience</td>
<td>3.90</td>
<td>5.07</td>
<td>0</td>
<td>25</td>
<td>.30**</td>
<td>.12</td>
<td>-.15*</td>
<td>-.11</td>
<td>.02</td>
<td>.02</td>
<td>.11</td>
<td>.31**</td>
<td>.43**</td>
</tr>
</tbody>
</table>

\( ^a \text{n = 207.} \)
\( ^b \text{In millions.} \)
\( ^c \text{Logarithm.} \)
\( ^† p < .10 \)
\( ^* p < .05 \)
\( ^** p < .01 \)
Results of Conditional Risk Set Cox Regression Analyses for the Hazard of New-Product Introduction

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural integration × subsequent innovations</td>
<td>0.15* (0.06)</td>
<td>0.15* (0.06)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural integration × prior product</td>
<td>0.26* (0.13)</td>
<td>0.26* (0.12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural integration</td>
<td>−0.03 (0.04)</td>
<td>−0.25* (0.12)</td>
<td>−0.12* (0.05)</td>
<td>−0.33** (0.11)</td>
<td></td>
</tr>
<tr>
<td>Target prior product</td>
<td>0.47 (0.35)</td>
<td>0.41 (0.36)</td>
<td>−0.23 (0.31)</td>
<td>0.36 (0.36)</td>
<td>0.25 (0.323)</td>
</tr>
<tr>
<td>Target size</td>
<td>0.00* (0.00)</td>
<td>0.00* (0.00)</td>
<td>0.00* (0.00)</td>
<td>0.00* (0.00)</td>
<td>0.00* (0.00)</td>
</tr>
<tr>
<td>Target age</td>
<td>−0.08** (0.02)</td>
<td>−0.08** (0.02)</td>
<td>−0.08** (0.02)</td>
<td>−0.08** (0.02)</td>
<td>−0.08** (0.02)</td>
</tr>
<tr>
<td>Dollars paid per employee&lt;sup&gt;b&lt;/sup&gt;</td>
<td>−0.01 (0.02)</td>
<td>−0.01 (0.02)</td>
<td>−0.01 (0.02)</td>
<td>−0.01 (0.02)</td>
<td>−0.01 (0.02)</td>
</tr>
<tr>
<td>Target prepatenting</td>
<td>0.31* (0.16)</td>
<td>0.27&lt;sup&gt;f&lt;/sup&gt; (0.16)</td>
<td>0.42** (0.16)</td>
<td>0.29&lt;sup&gt;f&lt;/sup&gt; (0.16)</td>
<td>0.44** (0.16)</td>
</tr>
<tr>
<td>Software target</td>
<td>−0.27&lt;sup&gt;f&lt;/sup&gt; (0.16)</td>
<td>−0.27&lt;sup&gt;f&lt;/sup&gt; (0.16)</td>
<td>−0.35* (0.17)</td>
<td>−0.30&lt;sup&gt;b&lt;/sup&gt; (0.15)</td>
<td>−0.37* (0.23)</td>
</tr>
<tr>
<td>Technological relatedness</td>
<td>0.37&lt;sup&gt;f&lt;/sup&gt; (0.23)</td>
<td>0.37&lt;sup&gt;f&lt;/sup&gt; (0.23)</td>
<td>0.42&lt;sup&gt;f&lt;/sup&gt; (0.23)</td>
<td>0.33 (0.23)</td>
<td>0.37 (0.23)</td>
</tr>
<tr>
<td>Acquirer R&amp;D intensity</td>
<td>0.16 (0.17)</td>
<td>0.16 (0.16)</td>
<td>0.15 (0.17)</td>
<td>0.16 (0.17)</td>
<td>0.15 (0.17)</td>
</tr>
<tr>
<td>Acquirer sales&lt;sup&gt;b, c&lt;/sup&gt;</td>
<td>0.14* (0.06)</td>
<td>0.14&lt;sup&gt;c&lt;/sup&gt; (0.06)</td>
<td>0.13&lt;sup&gt;c&lt;/sup&gt; (0.06)</td>
<td>0.15* (0.06)</td>
<td>0.14* (0.06)</td>
</tr>
<tr>
<td>Acquirer acquisition experience</td>
<td>−0.05* (0.02)</td>
<td>−0.04&lt;sup&gt;c&lt;/sup&gt; (0.02)</td>
<td>−0.04* (0.02)</td>
<td>−0.04* (0.02)</td>
<td>−0.05** (0.02)</td>
</tr>
<tr>
<td>Spells</td>
<td>371</td>
<td>371</td>
<td>371</td>
<td>371</td>
<td>371</td>
</tr>
<tr>
<td>Wald χ&lt;sup&gt;2&lt;/sup&gt;</td>
<td>59.37**</td>
<td>59.90**</td>
<td>65.82**</td>
<td>66.49**</td>
<td>73.21**</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>−683.35</td>
<td>−683.86</td>
<td>−680.50</td>
<td>−680.53</td>
<td>−677.20</td>
</tr>
<tr>
<td>df</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

<sup>a</sup> All models were estimated by stratification on order of product introduction. Hazard ratios can be obtained by exponentiating the coefficients reported for each variable. The coefficient of structural integration and its interactions are time-varying in all models. Numbers in brackets are standard errors corrected for heteroscedasticity and nonindependence of spells within target firms.

<sup>b</sup> In millions.

<sup>c</sup> Logarithm.

<sup>f</sup> p < .10

<sup>c</sup> p < .05

<sup>**</sup> p < .01

ard ratios, which are interpreted as the multipliers of the baseline hazard of new-product introduction when the variable increases by one unit (Allison, 2001). An increase in the hazard ratio can also be understood as shortened time to market, as the hazard of product introduction depends on the occurrence as well as the timing of product introduction. All standard errors reported were corrected for heteroscedasticity and nonindependence across observations on the same target firm (Lin & Wei, 1989).

All models in Table 2 are highly significant. Column 1 presents the results of the baseline model with control variables alone. Column 2 shows results of the regression with the time-varying effect of structural integration added. We estimated this model as an interaction between structural integration and the natural logarithm of the time in days since acquisition (Allison, 2000; Amburgey et al., 1993). We modeled the effect of structural integration as varying over time to avoid confounding maturation effects (such as deepening intraorganizational relationships following integration) with our theoretical argument, which rests on the qualitative difference between initial and subsequent innovations, and the consequently different impact of structural integration on them. The effect was insignificant, and we got similar results when structural integration was treated as time-invariant. This nonfinding was consistent with our theory, according to which both exploration and exploitation are important for generating a sequence of innovations. Structural integration’s adverse consequences for exploration thus appear to just offset the benefits from enhanced exploitation over the entire sequence of innovations. However, our hypotheses do not pertain to the main effect of structural integration on the typical innovation, but to its effects contingent on the relative importance of exploration and exploitation, which, we claim, is high for both initial innovations in a technology trajectory and the first innovation after acquisition.

To test Hypothesis 1, we entered the interaction between structural integration and the dummy variable, prior product. In this model, the term $e^{B(\text{structural integration})}$ represents the effect of structural integration on target firms that had not launched any products prior to acquisition. The difference in the effects of structural integration on target firms that did and did not have product launches prior to acquisition is $e^{B(\text{structural integration} \times \text{prior product})}$. Hypothesis 1a predicts that $e^{B(\text{structural integration})}$ will be less than one, and Hypothesis 1b predicts that $e^{B(\text{structural integration} \times \text{prior product})}$ will be more than one.

The results, reported in column 3, support both
hypotheses. The coefficient of structural integration is negative and significant at the 5 percent level, so that $e^{\beta_{\text{structural integration}}}$ is less than one. Further, the coefficient on the interaction term, structural integration times prior product, is positive and significant at the 5 percent level, so that $e^{\beta_{\text{structural integration} \times \text{prior product}}}$ is greater than one.

Therefore, both Hypotheses 1a and 1b are supported. We also depict our results graphically in Figure 1, which plots the multiplier effect of structural integration on the baseline hazard of launching a product after acquisition over time (Amburgey et al., 1993). For target firms with no prior products, the multiplier was less than zero, and it leveled off at about 0.22 by 12 months after the acquisition. Thus, for target firms with no prior products, structural integration lowered the likelihood (the hazard) of new-product launch by about 80 percent. However, for targets with prior products, the baseline hazard rate multiplier was statistically indistinct from one, indicating that the effect of structural integration was more than four times as favorable for acquired firms that had prior products than for those that did not have prior products.

To test Hypotheses 2a and 2b, we estimated a model in which we included the interaction between structural integration and the dummy variable identifying subsequent product introductions in addition to the main effect of structural integration. The results are reported in column 4. In this specification, the main effect of structural integration was interpreted as its effect on initial innovations. Hypothesis 2a predicts that $e^{\beta_{\text{structural integration}}}$ is less than one. The difference in the effects of structural integration for initial and subsequent innovations is given by the coefficient of the interaction term, and Hypothesis 2b predicts that $e^{\beta_{\text{structural integration} \times \text{subsequent}}}$ is greater than one.

The results in column 4 show that the coefficient on structural integration is negative and significant at the 5 percent level, so that $e^{\beta_{\text{structural integration}}}$ is greater than one. Further, the coefficient of the interaction term, structural integration multiplied by subsequent product introduction, is positive and significant at the 5 percent level, so that $e^{\beta_{\text{structural integration} \times \text{subsequent}}}$ is greater than one. Therefore, we concluded that Hypotheses 2a and 2b were also supported. We also depict our results graphically, in Figure 2. For first innovations after acquisition, the multiplier effect of structural integration on the baseline hazard leveled off at about 0.50 by the end of 12 months after acquisition. Thus, for the first innovation after acquisition, structural integration lowered the hazard of new-product launch by about 50 percent. However, for subsequent innovations, the baseline hazard rate multiplier was statistically indistinguishable from one, indicating that the effect of structural integration was about twice as favorable for subsequent innovations as for initial innovations.

In column 5, we show results from a full model that simultaneously included both interaction effects. All effects of interest continued to retain direction and significance. We concluded that the data support both our first and second sets of hypotheses (1a–1b and 2a–2b).
Control Variables

Several control variables had robust effects in multiple specifications presented in Table 2. The results indicated that older targets had lower hazards of new-product introduction (longer times-to-market), whereas larger target firms had greater hazards of product introduction (shorter times-to-market). Age may imply a parametric shift in the extent of disruption after an acquisition, with older targets suffering greater disruption because of organizational rigidity and inertia (Amburgey et al., 1993; Leonard-Barton, 1995). Larger target firms are likely to have more R&D personnel, and therefore greater human capital to contribute to the innovation process.

None of the target industry dummies were significant, except the dummy for the software industry. Presumably, differences between software and hardware industries contribute more to acquisition implementation difficulties than differences within hardware industries (all acquirers were hardware firms, but target firms could be making hardware or software). In order to conserve degrees of freedom, we retained only the software industry dummy in all models. If the target firm had filed one or more patents prior to being acquired, it was more likely to produce innovations later. This finding is intuitive and consistent with the idea that preacquisition patenting signals technological quality. Larger acquirers were more likely to introduce new products after acquisitions, perhaps because of their larger pool of complementary assets and resources (Teece, 1986). Acquisition experience appeared to lower the hazard of new-product introduction, in keeping with some prior research (e.g., Halebian & Finkelstein, 1999). However, it is also possible that experience was capturing other unobservable features of acquirers, a possibility we investigated further in our robustness checks.

Robustness of Inference to Alternative Explanations

Broadly speaking, our results on the contingent effects of structural integration on the hazard of product introduction at different stages in an innovation sequence could arise for reasons other than the ones we proposed if unobserved features of (1) acquirers (structure, culture, experience, leadership, etc.) and/or (2) a transaction (an acquired firm’s technological attributes, management team, structure, culture, etc.) influenced both choices of structural form and innovation outcomes. The salient results of our analyses meant to rule out such alternative explanations are reported in Table 3 and discussed briefly below.

Controlling for unobserved features of acquirers. A possible counterexplanation for our results is that unobserved features of acquirers—such as commercialization skills or ability to select “good” targets—accounted for observed success at introducing new innovations after acquisitions, rather than structural integration. If we found these unobserved features to be correlated with structural integration, then the reported results might even be spurious. In column 1 of Table 3, we report results from a fixed-effects model that accounts for acquirer-specific features that are unobservable, but stable over time, and their possible correlation with explanatory variables (Allison, 1996). The esti-
mates were obtained by stratification on acquirer, in addition to product introduction order. The basic pattern of results from Table 2 remains unchanged. Although the effect of the interaction of structural integration with prior product appears only marginally significant in a one-tailed test, this was because of collinearity with the main effect of prior product; the two effects are jointly significant ($p < .05$), though neither is individually. Further, fixed-effects estimates are known to be inefficient, possibly inflating standard errors (Allison, 1996). Therefore, we concluded that our results could not be attributed solely to spurious effects of stable but unobserved features of acquirers. We also note that the effect of acquisition experience, which was consistently negative in Table 2, becomes insignificant in the fixed-effects model, suggesting that experience was capturing other unobserved features of acquirers, such as knowledge articulation and codification processes (Zollo & Singh, 2004; Zollo & Winter, 2002).

Controlling for unobserved features of transactions. Like acquirers, the transactions could also have unobserved features—such as the preacquisition quality of the acquired firm, its technological attributes, and/or cultural compatibility between acquirer and target—that could correlate with structural integration decisions and also with innovation outcomes. If such correlation were present, estimates of the relationship between structural integration and innovation outcomes would be biased. Following Dolton, Makepeace, and Treble (1994), we estimated an accelerated failure time (AFT) model with treatment effects (Dolton et al., 1994; Wooldridge, 2003). AFT models, which rely on the assumption that the time to product introduction is distributed log-normally, are not as robust as the nonparametric Cox regression techniques (Allison, 1996, 2000; Morita & Lee, 1993), which is why we did not use them as the primary modeling platform for this study. However, as Dolton and colleagues noted, accelerated failure time is a useful model to use to incorporate corrections for self-selection into treatment groups (in this case, choices of structural form).

Column 2 of Table 3 reports results from an AFT specification that has the same variables as the Cox regression we estimated and report in column 5 of Table 2. Note that the coefficients are reversed in sign compared to the results of the Cox regressions, as the dependent variable is a function of time to product introduction rather than the hazard of product introduction. The results are qualitatively similar across these specifications, establishing the baseline AFT model and affirming that our basic results are qualitatively unchanged whether we treat the effects of structural integration as time-invariant or as varying with time. To correct for the biases arising from unobserved transaction features, we first estimated a probit model to predict the structural integration decision. The predicted probabilities from this model were used to construct a correction factor known as the inverse Mills ratio (IMR; Wooldridge, 2003). The values of the IMR are used in the accelerated failure time models reported in column 3 of Table 3. The results are qualitatively unchanged, though the negative, marginally significant coefficient on the IMR shows that unobserved factors that increase the likelihood of target firms being left unintegrated (such as high

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cox, Model 1</th>
<th>AFT, Model 2</th>
<th>AFT, Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural integration × prior product</td>
<td>0.16† (0.11)</td>
<td>−2.68** (1.00)</td>
<td>−2.75** (1.0)</td>
</tr>
<tr>
<td>Structural integration × subsequent product</td>
<td>0.27** (0.07)</td>
<td>−1.33* (0.53)</td>
<td>−1.41** (0.53)</td>
</tr>
<tr>
<td>Structural integration</td>
<td>−0.27** (0.10)</td>
<td>3.33** (0.94)</td>
<td>3.32** (0.43)</td>
</tr>
<tr>
<td>Controls: All variables in column 1, Table 3</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Inverse Mills ratio</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Product introduction order</td>
<td>Stratified</td>
<td>(Dummies)</td>
<td>(Dummies)</td>
</tr>
</tbody>
</table>

| Spells | 371 | 371 | 371 |
| Wald $\chi^2$ | 41.47** | 114.97** | 128.79** |
| $df$ | 13 | 16 | 17 |

*Model 1 is a Cox regression analysis, and models 2 and 3 are accelerated failure time models. Numbers in brackets are standard errors corrected for heteroscedasticity and nonindependence of spells within target firms.

† $p < .10$, one-tailed test
* $p < .05$, two-tailed test
** $p < .01$, two-tailed test

4 These results are not reported here in the interests of conserving space but are available from the authors.
quality, technological properties, or distinctive culture) are also likely to improve innovation performance by reducing time to product introduction. Thus, although there is some weak evidence that unobserved features of target firms influence structural integration decisions and innovation outcomes, this alternative explanation does not fully account for our results.

Finally, our results survive checks for outliers and influence points. We also assessed the extent of multicollinearity by calculating variance inflation factors for ordinary least squares models with the same independent variables as those used in the Cox models we reported (Allison, 2000). These were within acceptable limits for all models.

**DISCUSSION**

In this study, we sought to understand how the coordination-autonomy dilemma affects innovation outcomes in technology acquisitions. Drawing on the concepts of exploration and exploitation and existing literature on postmerger integration, we argued that the disruptive consequences of the loss of autonomy due to structural integration are particularly severe at stages of the innovation trajectory of the acquired firm in which exploration is more important than exploitation. We hypothesized that the initial innovation in a trajectory and the initial innovation after acquisition both represent stages in which exploration activities are more important than exploitation for innovation outcomes, and thus would suffer the most from the loss of autonomy implied by structural integration. Our results confirm that structural integration has the most adverse effect on innovation sequences from acquired firms that have not launched any products prior to acquisition, and on the first innovation after acquisition. These results are robust to a number of different estimation techniques and controls for alternative explanations. We discuss below the implications for theory and practice.

**Implications for Theory**

Our analysis extends the literature on M&A (mergers and acquisition) integration in particular and on the links between organizational form and innovation in general. Prior literature in the merger integration domain suggests that initial autonomy followed by eventual integration is a solution to the coordination-autonomy dilemma (for instance, see the discussion of the integration approach labeled “symbiosis” by Haspeslagh and Jemison [1991]). However, the conditions for optimal transition from autonomy to coordination remain underspeci-
integrating mechanisms (Lawrence & Lorsch, 1967). Unlike spatial separation, temporal separation minimizes the need for differentiating and integrating exploration and exploitation activity, as the same organizational unit takes on both types of activity at different times. However, the ability to alter organizational attributes fluidly and continuously is critical to this strategy (Brown & Eisenhardt, 1997, 1998). Hybrid arrangements appear to avoid the inconsistencies between exploration and exploitation by combining elements of formal and informal organization in a unique manner (see, for instance, Brown and Eisenhardt’s discussion of “semistructures” [1997, 1998]).

The strategies described above may not be available in technology acquisitions. Acquirers cannot count on preexisting integration mechanisms that are normally taken-for-granted inside a firm, such as standard operating procedures, routines, culture, and informal networks (Kogut & Zander, 1992, 1996), so coordination between explorative and exploitative processes must be achieved de novo through formal organization. Yet the choice of structural form, a basic element of the formal post-acquisition organization, may force a choice between exploration and exploitation. Further, structural integration is not an easily reversible decision, as the loss of key employees and changes to productive routines may be hard to rectify once they have occurred (Graebner, 2004; Ranft & Lord, 2002). Therefore, choices of structural form are not compatible with cycling between periods of exploration and exploitation. Nor can acquirers count on the existence of organizational hybrids such as semistructures, which “must be grown, not assembled at a single point in time” (Brown & Eisenhardt, 1997: 31).

Instead, this study suggests that synchronizing the shift in organizational emphasis with stages of technological development may avoid disrupting critical phases of exploration. Our results are similar in spirit to those of Siggelkow and Levinthal (2003), who concluded from simulations of adaptation on a “rugged landscape” that there are advantages to organizational forms that are initially decentralized but eventually centralized. The initial decentralization allows firms to escape low-level local peaks, and the coordinated local search that arises from eventual centralization yields a higher initial starting point from which to seek improvements. Siggelkow and Levinthal also argued that the optimal duration of the delay in centralization increases with the importance of autonomous exploration, which is consistent with our finding that structural forms that emphasize autonomy outperform structural forms that emphasize coordination during exploration-intensive stages of development.

Implications for Practice

The most obvious implications of our results for practice concern the choice of structural form in technology acquisitions. First, an acquirer needs to be aware of the trade-off between coordination and autonomy that underlies structural form choices. Second, the acquirer must also keep in mind that the effect of choice of structural form on innovation outcomes is contingent on the stage of development of the acquired firm’s innovation trajectory. This study suggests that, rather than choose between “quick” and “slow” integration approaches, acquirers should consider the relative importance of exploration and exploitation when selecting the structural forms of acquisitions.

Third, our results also have implications for choosing acquisition targets on the basis of their technological maturity at the time of acquisition. Our results direct acquirers to seek target firms that have already launched products and are on the verge of launching others, all other things being equal. Another strategic trade-off lurks here, as acquirers must balance the technological maturity of target firms against their age and possible organizational inflexibility. Indeed, our results consistently show that older target firms perform worse in terms of bringing innovations to market (Table 2). Cisco Systems is a firm that relied extensively on technology acquisitions to build its product portfolio during the dramatic growth of the networking industry in 1995–2000, though a subsequent sharp downturn in demand and drop in market capitalization has since slowed the pace of acquisitions at this company. At a time when Cisco Systems was routinely evaluating more than 100 acquisition candidates a year, it appeared to have been using rules-of-thumb about the technological maturity of acquisition targets that are quite consistent with the implications of our results. Quoted in an article in Fortune (Goldblatt, 1999), a manager from Cisco captured the logic behind these criteria when he commented on “that one sweet spot in the development of a start-up when it is old enough to have
a finished and tested product, yet young enough to be privately held and flexible in its ways.” Finally, although our focus in this study was not on acquirer-specific capability to manage postmerger integration or to select superior targets (e.g., Zollo & Singh, 2004), the insights generated here can help managers build such capabilities, since our results allow for a sophisticated understanding of the implications of structural form choices and of target attributes such as stage of technological development and age.

Limitations, Future Research, and Conclusions

This study is not without limitations. Some arise from the availability of data, and others from restrictions of scope chosen in order to maintain tractability. First, our theoretical and empirical focus was on technology acquisitions—acquisitions of small, technology-based firms by large, established firms. In our study, the disruptive effects of structural integration arise in part from the fundamental differences between the organizational contexts of small and large firms (Doz, 1986), and we would expect these differences to increase (though perhaps at a decreasing rate) as the difference between acquirer and target size increases. Therefore, we would expect our results to grow stronger for smaller target firms and larger acquirers. We do not expect our theoretical arguments to apply in all acquisition contexts, but we do expect that they will be relevant whenever the coordination-autonomy dilemma is salient, and whenever continuous exploration and exploitation are essential for acquisition success. For instance, we would not expect our present arguments and pattern of findings to hold for acquisitions conducted primarily for cost efficiency in the banking industry, but we would expect them to hold for acquisitions of small biotechnology firms by larger pharmaceutical firms, and perhaps in nontechnology settings such as the creative industries (e.g., acquisitions of small media, fashion design, and advertising companies by larger counterparts).

Second, in relying extensively on secondary data, our results are subject to possible measurement errors that we cannot accurately quantify and evaluate. For instance, if public reporting of structural integration and new-product introductions for particular target firms is subject to common biases, then the resulting correlation in measurement errors may have biased our estimates of the relationship between the two. We feel confident about the basic validity of our results despite the possible biases arising from this source because our robustness checks show that unobserved factors that correlate with structural integration decisions and innovation outcomes do not completely account for our estimates of the relationship between the two (Table 3, columns 1 and 3).

Another problem may arise from the possibility that public sources underreport new-product introductions from structurally integrated target firms. For instance, if the trade press underreported product introductions when target firms were fully integrated, our estimates of the relationship between structural integration and innovation outcomes for Hypotheses 1a and 2a would be biased (the bias would be conservative for Hypotheses 1b and 2b). We attempted to test for such reporting biases by using primary data for a subsample of about a fifth of our data. We obtained primary data through a short questionnaire on structural integration and innovation outcomes for all transactions conducted by two of the most prolific acquirers in our sample, which together accounted for 20 percent of the data (41 acquisitions). A senior M&A integration manager in each company completed our questionnaire. In this subsample, we found (1) 87 percent agreement between our archival measure of structural integration and the answers of our respondents, (2) 88 percent agreement between our respondents’ answers and data obtained from public sources on whether or not target firms had introduced at least one product after their acquisition, and (3) no significant difference in the accuracy of public reporting of product introductions for acquisitions that were structurally integrated and those that were not. We therefore concluded that our results are robust to reporting biases. However, there is no doubt that further research based on measures of innovation not subject to such reporting biases will help resolve this issue. Puranam and Srikanth’s (2004) analysis using patenting data (which is free of such reporting biases) is a step in this direction.

Third, our measurement of structural integration only guaranteed that structural form decisions announced at the time of acquisition were implemented by the end of the year. It was therefore possible that some of the product launches occurred prior to the completion of integration. We expect this measurement error to have imposed only a conservative bias, as it should have made it harder to detect hypothesized effects for structural integration. In an additional test, we reestimated all models without those spells that corresponded to initial product launches within a year from acquisition and in which the target firms were structurally integrated (20 spells). As expected, we found that the results were stronger without these observations.
Fourth, we measured innovation performance in terms of bringing innovations to market. Although this aspect of innovation performance is doubtless important, it is not the only one (Brown & Eisenhardt, 1995). The technological and economic performance of these innovations, once they are brought to market, was beyond the scope of our study, and we treated all innovations following acquisitions as identical except as to order of introduction. For instance, we did not distinguish between new products that relied entirely on an acquired firm’s technology and those that incorporated it as a component. Future research that addresses these distinctions would be interesting in its own right.

Fifth, we focused on only one aspect of postacquisition structural form, structural integration. Other formal mechanisms, such as integration managers, cross-unit teams, and alignment of procedures and processes across acquirers and targets, may not be subject to the constraints of discreteness and irreversibility. However, complementarities between organizational elements can limit the extent to which discreteness in organizational forms can be avoided (Gersick, 1991; Ghemawat & Costa, 1993; Milgrom & Roberts, 1990; Mintzberg, 1990; Williamson, 1991). Further, our arguments only require structural integration to shift the emphasis from autonomous exploration to coordinated exploitation and do not necessarily rule out exploration altogether. Nonetheless, we believe that further research that explores the limits of using process overlays and other formal coordination mechanisms to compensate for the discrete nature of organizational choices in acquisitions will prove valuable in understanding the issues in this study.

Despite its limitations, our work highlights the problems and opportunities that arise when firms seek to graft new capabilities via “step changes” such as acquisitions (Puranam, 2001). In doing so, this study highlights the continuing opportunities for deepening researchers’ understanding of coordination between and within firms, a topic that has been displaced from the agenda of organizational research by interest in how organizations are shaped by their environment, in the pattern of connections between organizations, and in the contractual hazards that can beset interfirm relationships (Camerer & Knez, 1998; Gulati, Lawrence, & Puranam, 2005; Heath & Staudenmayer, 2000). By analyzing the organizational dilemma of autonomy versus coordination, we hope to have suggested that much remains to be learned about the relationship between motivation and coordination, about the effects of formal coordination strategies on informal organization, and about the advantages and limitations of the different coordination mechanisms used within and between firms.

REFERENCES


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