THE BI-DIRECTIONAL RELATIONSHIP BETWEEN INTERFIRM COLLABORATION AND BUSINESS SALES IN ENTRANT AND INCUMBENT ALLIANCES

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ABSTRACT

This paper demonstrates the existence of bi-directional relationships between interfirm collaboration and business sales. Entry and post-entry collaboration often contribute to superior performance, which in turn attracts more partners. At the same time, though, collaboration may impose constraints on growth opportunities. The relationships vary across types of collaborators and collaborations – with differences among entrant and incumbent partners, between marketing and R&D partnerships, by partner size, and across time. Thus, successful firms may become entrenched in the industry, and will often enjoy preferred access to new partners with capabilities needed for continued growth and survival. The empirical analysis examines businesses that operated in the U.S. hospital software systems industry between 1961 and 1991. The results contribute to dynamic views of strategy.
Interfirm collaboration and firm performance have a complex relationship, each affecting the other. Extensive economics, organization, and strategy research argues that businesses often benefit from collaborative relationships (e.g., Burt, 1983; Coase, 1937; Dyer and Singh, 1998; Williamson, 1975, 1991), while recent empirical studies have identified some of the conditions under which collaborations are or are not beneficial (Baum, Calabrese and Silverman, 2000; Khanna, Gulati and Nohria, 1998; Singh, 1997; Singh and Mitchell, 1996). Nonetheless, the systematic nature of the relationship between collaboration and performance – in particular, for our discussion in this study, sales performance – is not clear. Several studies identify relationships between collaboration and greater sales, but do not establish whether greater business sales induce collaborative relationships or result from past collaboration. Instead, the studies tend to emphasize uni-directional relationships, in which either collaboration facilitates sales or sales facilitate collaboration. This paper argues that sales performance and collaboration most often are self-reinforcing forces but, under some circumstances, collaboration may impose constraints on growth opportunities.

The research has two goals. Our first goal is to explore the ways in which interfirm activities contribute to or constrain business performance and, in turn, arise from performance. Specifically, we investigate the relationship between interfirm collaboration and business sales, both during entry into an industry and after entry. In doing so, we distinguish among types of collaborators and collaborations. We consider marketing and R&D collaboration with entrants and with industry incumbents of varying size, predicting differences in the timing of collaboration benefits and differences in the presence of constraints depending on the partner. Prior research has identified some of the elements, but has not established a pattern of relationships. The results have implications for theories of long-term business success and failure, which have under-emphasized the complexities in the impact of collaboration.

Our second goal is primarily conceptual. We aim to contribute to the further development of a dynamic theory of business strategy and performance, with particular emphasis on the role of interfirm collaboration. We argue that a firm’s routines may span firm boundaries and may become embedded in interfirm routines and resources. This emphasis adds an interfirm
dimension to arguments concerning the importance of firm-specific routines and resources in shaping strategy and performance (e.g., Barney, 1986; Hannan and Freeman, 1989; Nelson and Winter, 1982; Penrose, 1959; Wernerfelt, 1984). In this view, the success or failure of interorganizational collaboration significantly influences firms’ future strategies and performance (Baum et al., 2000; Dyer and Singh, 1998; Mitchell and Singh, 1996; Teece, Pisano and Shuen, 1997). Therefore, a dynamic theory of strategy and performance must incorporate key characteristics of firms and partners and the nature of their relationships (Baum et al., 2000; Koza and Lewin, 1998). To contribute to dynamic perspectives of business alliances, we compare several collaboration strategies that a firm might adopt during and after entry to an industry. We then extend the results to a general discussion of the long-term evolution of interfirm collaboration.

Our argument that sales and collaboration are bi-directional forces applies to collaborative interfirm relationships that involve substantial ongoing interaction between legally autonomous organizations. Collaborative relationships contrast with independent approaches in which businesses carry out some functions themselves and other activities through hands-off relationships with third parties (Mitchell and Singh, 1996). The empirical analysis examines 938 businesses that operated in the U.S. hospital software systems industry between 1961 and 1991.

**BACKGROUND AND PREDICTIONS**

We first review research about the relationship between collaboration and business performance. We then develop predictions of the bi-directional relationships between collaboration and sales.

The summary conclusion from collaboration research is that businesses that collaborate often achieve superior performance, although with substantial variation in outcomes. Many analyses of collaborating businesses report above-average corporate-level profitability for businesses with collaborative links and above-average industry-level profitability for industries in which collaboration is common (Berg et al., 1982: 151-152; Burt, 1983; Hagedoorn and Schakenraad, 1994), although with frequent exceptions (Anand and Khanna, 2000; McConnell and Nantel, 1985). Several studies show that businesses are more likely to survive if they collaborate (Mitchell and Singh, 1996), even though many collaborative ventures themselves end (Dussauge, Garrette and Mitchell, 2000; Kogut, 1988). The prior studies suggest a resource-
access explanation for the observed performance improvements: collaborative relationships can provide access to a wider scale and scope of information, technology, manufacturing capabilities, financial resources, products, and markets than would be available if the firm operated independently. Collaboration benefits include sharing costs, acquiring tacit knowledge, commercializing complex technology, expanding into new markets, entering new industries, complementing product lines, and increasing market power (Arora and Gambardella, 1990; Baum et al., 2000; Dyer and Singh, 1998; Khanna et al., 1998; Oliver, 1990).

In parallel, though, collaboration may create substantial problems for collaborators. Risks include issues such as loss of proprietary information, dependence on a partner, and confusion during attempts to adapt (Hamel, Doz, and Prahalad, 1989; Williamson, 1991; Singh and Mitchell 1996). An intriguing challenge lies in determining when the benefits outweigh the costs and when the reverse is true.

We focus on business sales as a performance measure, for both conceptual and empirical reasons. Conceptually, business managers commonly focus on sales levels and growth as key performance metrics, both because higher sales may lead to higher profitability (Weiss, 1971) and because firms frequently value higher sales independent of profitability. Sales growth is particularly important when a firm enters an industry, when it is critical to achieve a substantial competitive position. Ongoing sales growth following entry also is important, as it demonstrates that the firm continues to be a successful competitor. Moreover, higher sales tend to contribute to greater business survival chances (Mitchell, 1994), which managers commonly value.

Empirically, sales provide a tractable performance measure for both research and managerial competitive analysis. Although competitors and researchers commonly cannot obtain profitability data for many businesses, either because they are private firms that do not report public data or because they are business units within larger corporations that do not report detailed unit-level profitability, sales information typically is available as a performance metric.

Business sales are important performance factors for collaboration, both as cause and as outcome. First, higher sales might lead to collaboration. Larger businesses may seek collaborative relationships if they need new resources to support continued growth or if the relationships will help them influence industry evolution. Other businesses often seek the resources and market presence of large partners. Consequently, large firms have more attractive
opportunities to collaborate. Second, operating efficiencies that result from collaboration may then reinforce existing sales levels and possibly lead to greater sales for the collaborating businesses. Thus, greater sales might both cause collaboration and result from collaboration.

A few large-scale studies report positive relationships between interfirm collaboration and business sales, measured either by sales levels or as sales growth. Hagedoorn and Schakenraad (1994) report a positive cross-sectional relationship between sales levels and the number of interfirm links of manufacturing firms, but do not investigate effects of collaboration on firm performance. Stearns, Hoffman, and Heide (1987) and Barnett (1994) suggest that collaboration causes business growth, using industry averages as indicators, but do not identify the aspects of collaboration that lead to increased growth. Several studies suggest that greater size causes collaboration but do not investigate whether past collaboration contributes to growth (Berg et al., 1982:124; Burt, 1983; Gulati, 1995a; Mitchell and Singh, 1992). We discuss this research in more detail when we develop the predictions.

An important conclusion from these empirical studies of sales and collaboration is that causality may be bi-directional. However, no studies have investigated the mutual impact of collaboration and size over time. The following predictions address key aspects of the bi-directional relationship between collaboration and sales. We discuss how collaboration at the time of entry into an industry might influence early sales and how post-entry collaboration may influence later sales growth. We then consider how business sales, sales growth, and past collaboration affect current collaboration. Figure 1 presents the key concepts and the hypothesized links between them, to guide our discussion and hypothesis development.

********** Figure 1 about here **********

**Impact Of Entry Collaboration On Initial Business Sales and Growth**

We first consider how collaboration when a business enters an industry will influence the business’s initial sales levels and growth. By initial sales levels, we mean sales during the first full year of operation in the industry. By initial sales growth, we mean growth during the years immediately following the first full year, which we measure as percentage sales growth during the second, third, and fourth years. We contrast the performances of entrants with and without collaboration on both of these measures. For entrants with collaborative ventures, we examine partnerships with other entrants and partnerships with incumbents. The entrant-incumbent
distinction is intrinsically important, because entrants play major roles in the emergence, change, and convergence of industries. However, there is limited agreement on the determinants of entrants’ performance in the context of interfirm collaboration.

We expect businesses that form collaborative relationships when they enter an industry to achieve greater initial sales and initial sales growth than entrants without collaborative relationships. Collaboration during industry entry provides a broader base of knowledge, technological skills, and market access than most entrants can achieve independently (Baum et al., 2000). In addition, collaboration can provide signaling and reputation advantages, and may provide new businesses with legitimacy among potential customers (Oliver, 1990). Businesses that enter industries with the assistance of collaborative ventures also enjoy access to resources and skills of their collaborators. Consequently, these firms are likely to achieve greater initial sales and sales growth.

Hypothesis 1a. Businesses that form collaborative relationships when they enter an industry will achieve greater initial sales levels than businesses that do not form collaborative relationships when they enter.

Hypothesis 1b. Businesses that form collaborative relationships when they enter an industry will achieve greater initial sales growth than businesses that do not form collaborative relationships when they enter.

We distinguish between entrants’ collaboration with industry incumbents and with other entrants. Industry incumbents are businesses that have an established position in an industry, while entrants are recent startup businesses, which we operationalize as businesses that entered the industry during the prior year. Baum et al. (2000) found that startups collaborating with incumbents in vertical relationships enjoyed greater revenue growth, while those collaborating with potential rivals suffered negative consequences. That study did not distinguish between early and later impact on sales growth, however, and did not evaluate entrant alliances. We expect that entrants that collaborate with incumbents will enjoy earlier sales gains than entrants that collaborate with other entrants. Incumbents possess technical and organizational capabilities, distribution systems, and reputations that may immediately contribute to their partners’ sales. In contrast, entrants often possess capabilities that have potential value but which will take longer to influence their partners’ sales. Thus, entry collaborations with industry incumbents are likely to have earlier impact on entrants’ sales than partnerships with other entrants.
Hypothesis 1c. Entry collaboration with industry incumbents will have earlier impact on an entrant’s sales than collaboration with other entrants.

In the longer term, though, collaboration with incumbents may constrain entrants’ sales growth. Although an incumbent may provide an entrant with quick access into a market, incumbents also will often limit the parts of the market in which entrants can operate. From an incumbent’s point of view, an entrant’s goods and services typically serve to fill niches that the incumbent does not serve. The incumbent has strong incentives to limit the entrant’s activities to such niches, rather than allow it to expand across the full market as a competitor. Incumbents can impose such limits through contractual terms, as well as through non-contractual constraints on access to technology and customers. By contrast, entrants that collaborate with other entrants may gain few of the immediate advantages of market access that collaboration with incumbents provides, but also will face few constraints on subsequent expansion.

Hypothesis 1d. Entry collaboration with industry incumbents will constrain an entrant’s longer-term sales compared to collaboration with other entrants.

We also address two empirical questions. First, we distinguish between marketing and R&D collaborations. Marketing collaborations typically sell existing products, while R&D collaborations involve developing new products. We do not develop specific hypotheses about whether marketing or R&D relationships will have greater influence on sales, but it seems likely that marketing relationships will have earlier impact because they allow immediate access to customers.

Second, it is useful to consider the impact of partner size on entrants’ sales. Larger partners might provide strong boosts to early sales, as they possess larger pools of resources and often have the slack to deploy resources quickly. Gulati (1995a) finds that firms that differ in size are more likely to form alliances. Alternatively, larger firms may collaborate in order to obtain a specialized range of capabilities or fill a narrow market niche, which would provide only a small initial sales boost for their partners. Moreover, larger firms may also collaborate primarily to learn from their partners (Dussauge, et al, 2000; Khanna et al., 1998), rather than to achieve immediate sales either for themselves or for their partners. If so, larger partner size would have no relationship or a negative impact on the early sales of industry entrants. Therefore, we treat the issue of whether larger partner size inhibits or contributes to entrants’ sales growth and levels
as an empirical question.

A question concerning the hypotheses is whether the strength of an entrant business that undertakes entry collaboration might cause both the superior sales performance and the collaboration. New businesses with strong capabilities – such as, in our empirical context, prior hardware or software skills – might be desirable partners when they enter an industry, so that their greater early sales might stem from their possession of superior capabilities rather than from the collaboration. For example, some large firms may diversify with the aid of collaboration, despite possessing sufficient strength to achieve high levels of performance independently (Mitchell and Singh, 1992), while other entrants may simply possess what subsequently prove to be good products. Therefore, we will use a two-stage statistical selection analysis that addresses business-level and market-level factors that might influence both collaboration formation and early sales. We note, though, that if entrants with stronger capabilities systematically choose to undertake collaborative entry, this would suggest that such entrants expect collaboration to offer advantages over independent entry, in particular, to gain greater sales than they would be able to achieve alone.

**Impact Of Post-Entry Collaboration On Sales Growth**

We next consider how collaborative relationships that businesses form after entering an industry influence sales growth. As with entry collaboration, post-entry collaboration provides access to capabilities and legitimacy that would be difficult, costly, or time-consuming to develop independently. Two studies indirectly suggest that businesses often achieve greater growth after forming post-entry relationships. Stearns et al. (1987) find greater market share growth among television stations with many interfirm links. Barnett (1994) finds that greater numbers of firms with linkages in the early telephone industry associated with increased growth rates among these companies, which he interprets as resulting from greater opportunities for the firms to coordinate activities.

Nonetheless, the prior studies provide only limited evidence, for two reasons. First, both studies provide only inferential evidence for the collaboration-sales link, as neither measured the formation of collaborative links. Second, none of the studies control for factors that caused the collaboration in the first place. For instance, if stronger incumbents are more likely to form collaborative relationships, as we argue below, then any observed relationship between post-entry
collaboration and performance might stem from the underlying business strength rather than from the collaboration itself.

Consistent with the implication of earlier studies, we expect sales growth to increase following the formation of post-entry collaborative linkages. As with our predictions on early sales, collaboration with incumbents is likely to have greater immediate impact on post-entry sales growth than collaboration with entrants, because of incumbents’ established capabilities.

Hypothesis 2a. Post-entry collaboration positively influences businesses’ annual sales growth.

Hypothesis 2b. Post-entry collaboration with other industry incumbents will have earlier impact on an incumbent’s initial sales growth than collaboration with industry entrants.

At the same time, though, it is possible that collaboration selection effects influence post-collaboration sales growth, just as in the case of initial sales levels and growth. Once again, therefore, we will use a two-stage selection approach in the post-entry sales growth analysis, where the first stage controls for influences on collaboration formation.

**Impact Of Sales And Past Collaboration On New Collaboration**

We now turn to the impact of business sales and past collaboration on the formation of collaborative relationships after a business enters an industry. We expect that businesses with large sales and businesses that have established many prior collaborative links will be more likely to collaborate in the future, thus reciprocating the impact of collaboration on sales.

Large businesses are desirable partners owing to the skills that underlie their market success. These firms are likely to attract more and better offers of collaboration, and therefore will have more opportunities to collaborate. Large businesses, in turn, have incentives to form new relationships in order to support additional growth. By contrast, while small firms also need collaboration to support growth, they offer different and fewer benefits to potential allies and so will have fewer opportunities to collaborate.

Studies of collaboration show that larger businesses and corporations are more likely to form relationships in a given period. Berg *et al.* (1982: 124) show that larger publicly traded U.S. manufacturing firms were more likely to create joint ventures. Mitchell and Singh (1992) find that larger industry incumbents are more likely than smaller incumbents to form interfirm relationships before they enter new industry subfields. Gulati (1995a) identifies a relationship between corporate assets and collaboration formation, although he does not examine business
sales. Thus, we expect firm size to influence collaboration formation.

Hypothesis 3a. The greater the sales of a business, the more likely the business will form a collaborative relationship.

We expect sales growth to have a positive impact on alliance formation. Growing businesses often are able to attract partners owing to their market success. Little empirical research has examined how growth influences collaboration. In the most closely related study, Gulati (1995b) finds no impact of corporate asset growth on the formation of collaborative relationships. To the extent that collaborative relationships are more likely to serve business-specific purposes rather than corporate ends, the business unit is the appropriate level of analysis in comparisons containing multi-business corporations. High business sales growth is an appropriate measure of business success. Growing businesses have incentives to form relationships in order to support continued growth, while prospective partners have incentives to form relationships in order to share their growth.

Hypothesis 3b. The greater the sales growth of a business, the more likely the business will form new collaborative relationships.

The number of collaborative links a business has formed in the past also is likely to play a role in the formation of new collaborations. Businesses that have established collaborative relationships will often internalize relationship management within their organizational routines and managerial expertise (Nelson and Winter, 1982) and will develop competence in forming and managing alliances (Anand and Khanna, 2000; Kale, Singh, and Perlmutter, 2000). The alliances that businesses establish also create a social structure that facilitates the establishment of new relationships by fostering trust, information exchange and partner evaluation (Gulati, 1995b). Businesses with partnerships are desirable allies because they become embedded in an industry network and offer substantial industry-specific information to their partners (Kogut et al., 1992; Singh, 1997). Two prior studies provide suggestive evidence, although they do not examine this question directly. Gulati (1995a) shows that the number of past relationships is a strong predictor of repeated relationship formation among existing partners. Ahuja (2000), meanwhile, shows that businesses that possess key resources tend to create more alliances.

Hypothesis 3c. The more collaborations a business has formed in the past, the more likely that it will form new collaborative relationships.
The analysis of collaboration formation will compare whether sales, sales growth, and past collaborations have differing impact on the formation of relationships with industry entrants and incumbents. Previous research has not explored this question. Large businesses, growing businesses, and businesses with many partners might tend to attract industry entrants as partners if the entrants seek immediate access to customers and relationships. Conversely, large, growing, or well-connected businesses might attract other incumbents if scale economies and market power are important goals. The answers to this question concerning differential impact on entrant and incumbent collaboration will have implications for our understanding of business evolution in an industry.

In summary, the predictions address the impact of collaboration on sales as well as the causes of collaboration. We expect entry collaboration to lead to greater initial sales levels and initial sales growth, and post-entry collaboration to lead to greater post-entry sales growth. We expect collaboration with industry incumbents to have earlier positive impact on sales than collaboration with industry entrants, coupled with longer-term constraints on growth. In turn, we expect greater sales, sales growth, and past collaboration to increase the likelihood that businesses will form new collaborative relationships. In the methods section, we will discuss other possible influences on sales and collaboration. In particular, we will introduce various business-level measures that address the possibility that heterogeneity of skills is the cause of sales and collaboration.

THE HOSPITAL SOFTWARE SYSTEMS INDUSTRY

We test the hypotheses by examining sales and collaboration of businesses operating in the U.S. hospital software systems industry between 1961 and 1991. The industry comprises businesses that develop applications software systems specifically designed to support administrative and clinical activities in community hospitals in the United States. The industry definition excludes software businesses that develop general-purpose applications such as word processing and spreadsheet software.

The first recorded entry of a hospital software system business occurred in 1961, when systems to automate patient management and financial operations became available. These software systems gradually extended to many departments and functions, such as in radiology and laboratory departments, and for patient management and records management. Appendix 1
lists the different types of systems.

The hospital software systems industry suits this study because businesses have used both collaborative and independent forms of organization to commercialize the systems during the full history of the industry. Many businesses in the industry formed collaborative relationships involving joint development, technology licensing agreements, marketing and distribution agreements, and other forms of interfirm cooperation. In addition, many businesses operate independently, either by relying on short-term market relationships or by internalizing key activities. Moreover, most of the firms in the industry are either single business companies or operate distinct hospital software systems businesses for which it is possible to track sales and collaborative activities. Thus, the industry provides a fruitful source of information concerning the relative success of businesses that engaged in collaborative relationships to commercialize goods and businesses that operated independently.

The data for the study comprise 938 businesses that commercialized software systems for American hospitals from 1961 to 1991, which includes almost all the businesses that have operated in the industry. The sample consists of 502 startup firms and 436 established companies that undertook diversifying entry into the industry. Some diversifying entrants had previous experience in other computer software industries and/or experience in manufacturing computer hardware, although many diversifying firms simply entered the industry in hopes of being able to develop relevant skills. The United States was the home market of almost all businesses in the study. We collected the data through an extensive search of the business press, corporate reports, government publications, and other public sources, augmented with interviews with participants in the industry. Singh and Mitchell (1996) provide more details concerning data collection procedures.

The criterion for recognizing a collaborative relationship was the formal announcement of an agreement in a published media. We identified 667 cases in which businesses operating in the industry announced marketing-oriented or development-oriented collaborative relationships, with such agreements being formed by 229 of the 938 firms in the sample. The set of 667 collaborative relationships omits ten cases in which businesses created free-standing joint ventures, which we defined as new businesses rather than as collaborations because the parents of the joint ventures ceased to participate in the industry. We believe that our search identified
most agreements.

The collaboration data have two limitations. First, we cannot control for the quality of collaboration. Second, we found that businesses were much less likely to report agreement termination than agreement creation. As noted earlier, our records report the cumulative number of interfirm agreements that each business created, rather than the number of agreements active in each year. This is similar to the approach in most longitudinal research of alliances.

METHODS

Table 1 describes the variables that we used in the statistical analysis, which we summarize in a table owing to the large number of variables. We deflated all financial variables by the U.S. 1982 base year Producer Price Index. Appendix 2 reports the summary statistics for the variables that we used in the different analyses.

********** Table 1 about here **********

Variables

We defined the following equations for Hypotheses 1a and 1c, concerning initial sales levels.

\[ S_1 = a_1 P_1 + f_{1b} P_{S0} + g_{1b} X_1 + h_{S1} \lambda_0 + e \]

\( S_1 \) (Initial Sales Level) recorded the sales revenue that each business obtained during its first full calendar year in the industry. \( P_1 \) is a set of partnership variables (Entrant Partner: Marketing; Entrant Partner: R&D; Incumbent Partner: Marketing; Incumbent Partner: R&D) that record whether a business had formed at least one collaborative relationship by the end of its first full calendar year of participation in the industry. The variables distinguish between entry relationships with other industry entrants and with incumbents, as well as between marketing and R&D relationships. Hypothesis 1a expects positive \( a_1 \) coefficients. Hypothesis 1c holds the “Incumbent Partner” effects will be greater than the “Entrant Partner” effects. \( P_{S0} \) denotes partner sales during the year before the firms created the partnership. \( X_1 \) is a set of control variables. \( \lambda_0 \) is the entry collaboration selection variable from the first collaboration selection equation (\( S_1 \)), as we discuss below, while \( e \) is a random error term.

We defined three equations for Hypotheses 1b and 1d, concerning initial sales growth.

\[ G_{12} = \ln(S_2/S_1) = b_{1a} P_1 + f_{2a} P_{S0} + g_{2a} X_2 + h_{S1} \lambda_0 + e \]

\[ G_{13} = \ln(S_3/S_1) = b_{1b} P_1 + f_{2b} P_{S0} + g_{2b} X_2 + h_{S1} \lambda_0 + e \]
The Initial Sales Growth variables, $G_{12}$, $G_{13}$, and $G_{14}$, record percentage change in sales for the 1-year, 2-year, and 3-year periods after entrants’ first full year in the industry. Percentage change in sales is the appropriate dependent variable for the growth analyses, following research showing that current size influences sales growth (Evans, 1987). Positive $b_1$ coefficients on the collaboration variables ($P_1$) would show a positive impact of collaboration on sales growth (Hypothesis 1b). We use the three-year growth window to test Hypothesis 1d, which expects greater longer-term benefits for collaboration with entrants relative to collaboration with incumbents. $PS_0$ again represents partner sales during the year before the firms created the partnership, while $X_2$ is a set of other influences and $\lambda_0$ is the entry collaboration selection variable created from equation S1.

Our primary independent variables in the initial sales and growth equations record whether a business collaborates with another firm during entry to the industry. As we noted earlier, though, there is a risk that we might attribute changes in sales to collaboration when, in fact, entry collaboration itself is an outcome of firm and market characteristics and those characteristics also cause sales growth. Thus, there is the potential of a selection bias, such that the coefficients in the growth-collaboration equations actually capture the effect of unmeasured variables.

Therefore, we follow Heckman’s (1979) two-stage sample selection estimation approach, which explicitly recognizes the conditional nature of the empirical relationships and allows for more meaningful interpretation of the coefficient estimates. We calculate a selection equation as a first stage in equations 1 and 2. We then use the estimates of the selection equation to create an entry collaboration selection variable for the sales models, based on the inverse Mills ratio. This approach addresses the correlation in error terms of the two equations. Shaver (1998) and Greene (2000) provide more complete descriptions of the benefits in using such techniques. The selection equation takes the form:

$$\begin{align*}
[2c] & \quad G_{14} = \ln(S_4/S_1) = b_1P_1 + f_2PS_0 + g_2X_2 + hS_1 \lambda_0 + e \\
\end{align*}$$

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$$\begin{align*}
[S1] & \quad P_1 = z_0W_0 + u \\
\end{align*}$$

$P_1$ is a 0-1 dummy variable that denotes whether a firm entered the industry with a collaborator. $W_0$ is a set of independent variables, including an intercept, while $z_0$ is a vector of associated coefficients. The $W_0$ matrix includes pre-entry firm-level measures (Private firm, Firm
age at entry, Previous hardware experience, Previous software experience, Diversify with no previous hardware experience) and a market level measure (Industry age) as factors that might influence entry collaboration.

We chose these selection instruments as indicators of capabilities and market conditions that might make it more or less likely that a business had incentives to form an entry relationship and also would be able to attract a partner. Private firms may find it difficult to attract collaborators because they are less visible and may also raise issues of unlimited financial risk. Older corporations may find it easier to attract collaborators when they undertake diversifying entry into a new industry because they are more visible and potential partners will be more familiar with their partnership styles. Diversifying entrants with previous computing hardware or software experience might find it easier to attract partners because of their complementary capabilities, but also might have less need of entry partnerships owing to the existing base of skills. In turn, diversifying entrants without computing experience might actively seek partnerships to help make up for the lack of skill. In addition, collaboration may be more common as an industry ages, because there will be a greater set of experiences on which to judge suitable partnerships. Clearly, these do not encompass all relevant influences on entry collaboration, but they define a meaningful set of factors.

We assume that the error term, u, has a normal distribution, which is consistent with a probit specification for the selection regression. We then use the output of the probit analysis to create the selection variable for the initial sales and initial sales growth equations. These “entry collaboration selection” variables attempt to eliminate the causes of collaboration as conflicting influences in the growth equations. Appendix 3 reports the results of the analysis of equation S1.

We defined the following equations to test Hypotheses 2a and 2b, concerning the influence of post-entry collaboration on sales growth.

\[ G_{t1} = \ln(S_{t+1}/S_t) = c_{1a} P_t + f_{3a} P_{St-1} + g_{3a} X_3 + h_{s2} \lambda_t + e \]
\[ G_{t2} = \ln(S_{t+2}/S_t) = c_{1b} P_t + f_{3b} P_{St-1} + g_{3b} X_3 + h_{s2} \lambda_t + e \]
\[ G_{t3} = \ln(S_{t+3}/S_t) = c_{1d} P_t + f_{3b} P_{St-1} + g_{3b} X_3 + h_{s2} \lambda_t + e \]

The Post-Entry Sales Growth variables, G_{t1}, G_{t2}, and G_{t3} recorded percentage change in sales for the 1-year, 2-year and 3-year periods after the first full year of participation in the industry. P_t is a matrix of dummy variables that denote whether firms formed new relationships.
during observation years after the entry year (as in the entry collaboration analysis – Entrant Partner: Marketing; Entrant Partner: R&D; Incumbent Partner: Marketing; Incumbent Partner: R&D). Positive coefficients for the $P_t$ variables would show a positive impact of collaboration on post-entry sales growth (hypothesis 2a). Hypothesis 2b expects incumbent relationships to have earlier impact than entrant relationships. $PS_{t-1}$ represents partner sales during the year before the firms created the partnership, while $X_3$ is a matrix of other influences and $\lambda_t$ is the selection variable from equation S2 below.

As in equations 1 and 2, we used a two-stage selection approach to calculate the post-entry growth equations, 3a, 3b, and 3c. The first-stage selection equation takes the form:

$$[S2] \quad P_t = z_{t-1}W_{t-1} + u$$

$P_t$ is a dummy variable denoting whether a business formed a new collaborative relationship in a given year. The $W$ matrix uses the independent variables from equations 4a and 4b (below) as predictors of collaboration formation, consistent with the hypotheses in the paper. We again assumed that the error term, $u$, has a normal distribution and calculated a probit estimate of the equation. We used the post-collaboration formation estimate to create the selection variable (Post-Entry Collaboration Selection) for the post-entry growth equations. This procedure addresses the potential endogeneity that would arise if we specified causes of collaboration directly as independent variables in the growth equations.

Finally, we defined two equations to test Hypotheses 3a-3c, concerning post-entry partnerships.

$$[4a] \quad P_{Et} = d_1\ln(S_{t-1}) + d_2\ln(S_{t-1}/S_{t-2}) + d_3Cum_{t-1} + g_{4a}X_{4} + e \quad (t>1)$$

$$[4b] \quad P_{It} = e_1\ln(S_{t-1}) + e_2\ln(S_{t-1}/S_{t-2}) + e_3Cum_{t-1} + g_{4b}X_{4} + e \quad (t>1)$$

$P_{Et}$ (Created Entrant Relationship) and $P_{It}$ (Created Incumbent Relationship) are dummy variables that denote whether firms formed new partnerships during observation years after the entry year. $P_{Et}$ and $P_{It}$ are equivalent to the Entrant Partner and Incumbent Partner measures that we use as independent variables in equations 3a-3c. Log Business Sales ($\ln S_{t-1}$) is the log of annual sales. We specified log of sales because the relationship between size and collaboration is likely to be non-linear. That is, the incentives to form links decline as business sales become particularly large (Kogut, Shan and Walker, 1992), because very large firms often have access to internal and external resources to support independent growth. Sales Growth ($\ln S_{t-1}/S_{t-2}$) is 1-
year percentage change in sales, lagged one year. Cumulative Total Partnerships (Cum_{t-1}) is the number of partnerships that businesses created before a given record year. Positive coefficients for the three independent variables would show that sales levels, sales growth, and collaboration experience positively influence partnership formation, consistent with the predictions. X4 is a matrix of other influences.

**Control Variables: Other Influences On Sales And Collaboration**

Table 1 lists several industry-level and business-level control variables that economic, organizational, and strategic studies suggest might influence business size and growth. Evans (1987) shows that business size and business age have negative influences on percentage increases in business employment among firms in the U.S. manufacturing sector. This result contrasts with the view of proportional business sales growth as independent of current size (see Scherer, 1980: 145-150). It is particularly important to control for business size in the sales growth models, to ensure that any relationship with collaboration does not in fact stem from variations in sales levels (e.g., firms that achieve initially lower sales might achieve greater subsequent proportional growth). Studies of business acquisitions suggest that the acquiring business gains increased sales, but the combined businesses often remain the same total size or lose market share (Ravenscraft and Scherer, 1987). In the organizational ecology literature, business density has shown both competitive and complementary effects on growth (see Barnett, 1994: 341-342). Barnett and Carroll (1987) and Barnett (1994) show a positive relationship between current and lagged business size in the early U.S. telephone industry, finding also that business age had a negative impact on business growth and that lagged business failures had a positive impact on growth. Both business failures and business density may be outcomes of market size and growth trends, with which they tend to correlate. In the strategy literature, several studies find that new ventures and established businesses achieve higher growth in growing markets (e.g., Eisenhardt and Schoonhoven, 1990). Many analyses also suggest that new ventures and established businesses with broader product lines will achieve greater growth (Barnett, 1994; Barnett and Carroll, 1987; Penrose, 1959). Thus, prior research has found business-level influences of size, age, product line breadth, business acquisition, and prior business experience, as well as industry-level influences of market growth, market size, density, and exits.

We test for these influences in the analyses of business growth. To be consistent with the
outcome measures, we use log values of financial variables (market size, market growth, partner sales, and business sales) for analyses of sales growth, and untransformed values for analyses of sales levels.

The analysis of collaboration formation also examines several control factors. Several studies suggest that older businesses will be desirable partners because they offer consumer brand recognition and credibility (Lieberman and Montgomery, 1988), and have greater accumulated experience (Harrigan, 1985; Mitchell and Singh, 1992). These age-related factors correlate with business size, however, so that whether business age has any effect net of size is an open issue. Indeed, businesses that age without becoming large might be unattractive partners owing to their demonstrated lack of market success. Singh and Mitchell (1996) argue that businesses have incentives to form new partnerships to replace lost capabilities, if existing partners shut down or form relationships with new partners. Startup firms are more likely than diversifying entrants to form partnerships, both at entry and during later participation in the industry, because of their smaller stock of internal corporate resources. Businesses with broad or growing product lines tend to form collaborative relationships in order to support their products. Therefore, we address the business-level influences of business age, partner dissolution, partners’ formation of new partnerships, prior business experience, and product line breadth and growth. We also address industry-level influences of market size and growth, because businesses are more likely to form relationships in large or growing markets in order to expand the scope of their activities. Together, these influences provide an unusually extensive set of control and exploratory factors.

Statistical Methods

We used linear regression to test the sales level and sales growth hypotheses. We used least squares regression for the analysis of business sales levels, following Eisenhardt and Schoonhoven (1990). White’s (1980) asymptotic variance-covariance matrix adjusted the standard errors of the coefficients for unknown forms of heteroscedasticity. We used least squares with White’s heteroscedastic-consistent standard errors for the sales growth analyses (Evans, 1987). We used maximum likelihood probit regression to test the collaboration formation hypotheses.
RESULTS

Initial Sales Levels and Growth

Table 2 presents results for Hypotheses 1a to 1d, which predicted greater initial sales and initial sales growth for businesses with entry collaboration. Column 1 reports the analysis of year 1 sales levels. Columns 2 through 4 then report the sales growth analyses. Columns 2 through 4 use natural logs of the values of the independent variables, because the dependent variable (growth) is in log form, while column 1 uses untransformed values for analyses of sales levels. The results support most predictions, while producing several intriguing refinements and extensions.

********** Table 2 about here **********

The results in column 1 of Table 2 support hypothesis 1a for incumbent marketing partners but do not support the predictions for incumbent R&D partners or for entrant partners. Counter to the entrant ally aspect of Hypothesis 1a, the Entrant Partner results show that entrants that ally with other entrants do not realize a significant impact on initial sales relative to entrants who do not collaborate. This result shows that collaborating entrants find it as difficult as independent businesses to gain sales for their new businesses. That is, any sales benefits of collaborating with a new business appear to take longer than the first year of operation to appear. This is consistent with Hypothesis 1c, which predicted later impact from entrant alliances than from incumbent alliances. We will discuss Hypothesis 1c below.

Consistent with Hypothesis 1a, the Incumbent Partner: Marketing result in column 1 of Table 2 shows that entrants with incumbent partners during their first year achieve greater first-year sales than businesses that enter independently. However, the negative Partner Sales coefficient shows that the benefit declines with partner sales. That is, the larger the sales of a partner, the less initial sales benefit an entrant receives. One interpretation of this result is that very large incumbents of an industry may seek entrants as allies in order to fill small niches in the market, so that collaboration with very large incumbents does not benefit entrants’ sales substantially. Beyond partner sales of about $131 million (2.63/0.02; within the range of the data), incumbent partners inhibit initial sales rather than contribute to sales. The central conclusion from column 1 of Table 2 is that entrants that ally with small and moderate-sized incumbents to co-market products gain greater first year sales, but entrants do not gain immediate
sales benefits when the undertake R&D partnerships, ally with very large incumbents, or ally with other entrants.

The results in columns 2 to 4 of Table 2 test Hypothesis 1b, which predicted greater initial sales growth for businesses with entry collaboration. The results support the hypothesis for entrant partners for all years and for R&D incumbent partners for 1-year growth. Partnership with other entrants leads to greater sales growth in all cases of columns 2 to 4. R&D partnerships with industry incumbents lead to greater 1-year sales growth (column 2). However, there are no significant 2-year or 3-year growth benefits of partnering with incumbents, as columns 3 and 4 show. Moreover, the significance of the Incumbent Partner results in columns 2 to 4 did not change when we dropped the partner sales variable in sensitivity analysis. The central conclusion from columns 2 to 4 of Table 2 is that entrants that collaborate with other entrants gain greater sales growth during the first three years, while they only gain shorter-term sales growth when they ally with incumbents.

The results in Table 2 support Hypotheses 1c and 1d, which predicted earlier impact from incumbent alliances than from entrant alliances, coupled with greater longer-term benefits from entrant alliances and longer-term constraints from incumbent alliances. As we noted above, column 1 shows that incumbent marketing allies influence entrants’ initial sales levels, while entrant allies do not. Columns 2 to 4 show that incumbent allies affect entrants’ 1-year sales growth only, while entrant allies also affect 2-year and 3-year sales growth. Jointly, the results suggest that incumbent allies contribute to sales levels in the first year and in the next year of growth. Entrant allies, by contrast, begin to affect sales growth only after the first year (consistent with Hypothesis 1c), but continue to have a positive influence on sales growth longer than do incumbents (consistent with Hypothesis 1d).

The likely explanation for the incumbent partner outcome is that entrants with incumbent allies often use the incumbents’ industry-specific distribution systems, technical skill, reputations, and other systems to obtain immediate positions in the market. The established systems support greater initial sales and first year sales growth. For longer-term sales growth, though, the entrant in an incumbent-entrant partnership must develop its own capabilities and products, rather than depend on its incumbent partner. Incumbents may help entrant allies become established, but are unlikely to work closely with these entrants to develop their
competing businesses. In contrast, two allied entrants receive no sales benefits from each other during the first year because they lack established industry-specific capabilities. However, entrants have incentives to work together to grow sales because they both need to create viable businesses. Thus, it appears that cooperation between entrants often provides longer-term sales benefits for both entrants, while entrant-incumbent cooperation provides shorter-term benefits for the entrant. Our results expand on Baum et al. (2000), who find that entrants who collaborate enjoy positive impact on initial revenue growth.

Several control variables in Table 2 influence initial sales. Initial sales levels are lower in large markets, likely because incumbents become more strongly established as an industry grows, making it more difficult for entrants to gain large sales. Initial sales growth is greater in growing markets. The entry collaboration selection variable has a significant impact on first year sales, showing the importance of controlling for collaboration selection influences, although it has no relationship with longer-term growth. Initial sales are greater when an entrant acquires a large business, which also has some influence on 3-year growth (we include sales inherited from the acquired business in first year sales, so that the sales growth analysis examines the combined sales of the acquiring and target business). Consistent with prior research, businesses that achieve greater sales in their first year achieve somewhat lower sales growth in subsequent years. In sensitivity analysis, we also investigated how industry-level business exits and business density affect initial sales, finding that the reported collaboration influences on sales and growth did not change materially. We omit the density and exit variables from the reported results because the variables correlate highly with the market size and market growth measures.

Post-Entry Collaboration

We now turn to the influences on the formation of post-entry collaborative relationships, which arise in Hypotheses 3a to 3c. Columns 1 and 2 of Table 3 report influences on formation of relationships with industry entrants and incumbents.

********** Table 3 about here **********

The results in Table 3 are consistent with Hypotheses 3a and 3b, which address the impact of sales levels and growth on post-entry collaboration. Consistent with Hypothesis 3a, Table 3 shows that the likelihood that the business will form a collaborative relationship in any period increases with Log Business Sales. In sensitivity analyses, we found that models that used
sales rather than log sales provided a poorer fit than the models reported (although sales remained strongly significant), based on the loglikelihood ratio statistic, which is consistent with the expected nonlinear impact of business sales on partnership formation. Consistent with Hypothesis 3b, businesses with greater 1-year sales growth are more likely to form collaborative relationships. In sensitivity analyses, we also found similar influences for prior 2-year and 3-year sales growth. The central conclusion from Table 3 is that large and growing businesses are more likely to collaborate than other businesses.

The results in Table 3 provide partial support for Hypothesis 3c, which predicted a positive relationship between past collaboration and current collaboration. The Cumulative Partnership variable has the expected impact of incumbent relationships (column 2), but the result does not hold for entrant relationships (column 1).

The difference between the results for entrant and incumbent relationships for Cumulative Partnerships estimates in columns 1 and 2 of Table 3 suggests an intriguing interpretation. Businesses that form many collaborative relationships are likely to become skilled managers of relationships. These businesses also become entrenched within the industry, with direct and indirect links to many people and organizations. The skills and entrenchment makes these businesses highly desirable partners. Many skillful and entrenched businesses will prefer to form relationships with incumbents rather than with entrants because the incumbents’ capabilities are easier to evaluate. Businesses with many past relationships have sufficiently strong positions in the industry that they often will be able to attract partners among entrants after they have gained experience in the market. In sensitivity analysis, we found that cumulative relationships are better predictors of new collaboration than the log of cumulative relationships, which suggests that a firm’s desirability as a partner continues to grow as it gains greater collaboration experience.

The results in Table 3 suggest that past collaborations play a different role from business sales and growth in the formation of new collaborative relationships. The Log Business Sales and Sales Growth results show that large incumbents and growing incumbents often form relationships with other businesses, whether incumbents or entrants. The relationships may support the incumbents’ sales positions or provide capabilities needed for growth. The need to support sales and growth makes a business willing to undertake relationships with entrants,
despite the uncertain value of their capabilities. The effects of Cumulative Partnerships with incumbent partners (column 2), by contrast, serve to extend a business’s ties with the established businesses in the industry. These ties may provide conduits for information and resources from other businesses and for influencing their actions. In this sense, the collaboration-driven ties serve longer-term purposes than sales and growth-driven relationships.

Several control variables in Table 3 influence post-entry partnership formation, especially partnerships with industry incumbents. Hardware manufacturers are more likely than others to collaborate with incumbent software businesses. Businesses that add products often form new collaborative relationships with incumbents. Older businesses are less likely to form relationships. The Partner Added Partner influence, showing that businesses often form relationships after their partners form new relationships, existed for both incumbents and entrants. The last result likely occurs because businesses will undertake the uncertainty of working with entrants when they fear that existing partners will de-emphasize relationships.

**Post-Entry Sales Growth**

Finally, we turn to influences on post-entry sales growth. The results in columns 1 to 3 of Table 4 test Hypotheses 2a and 2b. Hypothesis 2a predicted that forming post-entry collaborative relationships improves sales growth. Hypothesis 2b predicted that incumbent partners have earlier impact than entrant partners.

********** Table 4 about here **********

Table 4 reports how post-entry collaboration affects growth, controlling for partner sales and the factors causing the post-entry collaboration. Owing to the substantial correlation between partner sales and adding incumbent marketing partners ($r=0.81$), we first estimated the models without the partner sales variable (columns 1a, 2a, and 3a) and then added partner sales (columns 1b, 2b, and 3b), to ensure that the estimated partnership results were robust. Including the collaboration factors indirectly includes their underlying causes, including business sales and growth, in the analysis. Table 4 differentiates collaboration with entrants and incumbents, where entrant collaborations are those in which a firm forms a relationship with a business that entered the industry during the previous calendar year and incumbent collaborations are those in which a firm forms a relationship with a business that entered the industry more than a year earlier.

Table 4 reports three different growth periods. Column 1 reports 1-year growth, which is
the growth rate the firms realized during the calendar year following the formation of the collaboration (\(\ln \frac{\text{sales}_{t+1}}{\text{sales}_t}\), where \(t\) is the formation year). Columns 2 and 3 report influences on 2-year (\(\ln \frac{\text{sales}_{t+2}}{\text{sales}_t}\)) and 3-year (\(\ln \frac{\text{sales}_{t+3}}{\text{sales}_t}\)) growth. The 2-year growth analysis includes every second business-year, beginning with the second year that a business participated in the industry. The 3-year growth analysis includes every third business-year, beginning with the third year that a business participated in the industry. This procedure eliminates serial autocorrelation that would result if we included overlapping business-year spells in the 2-year and 3-year growth models. Where appropriate, the independent variables in models 2 and 3 account for lagged activities.

We note first that the “Post-entry collaboration selection” variable is negative and significant in all models of Table 4. This shows that firms that are more likely to add partners (growing firms, large firms, or firms with extensive partnership experience) tend to have slower growth in subsequent years, before considering the effects of adding partners. This is a sensible result because, other factors being equal, larger firms will tend to have lower growth rates, while firms with high past growth can sustain high growth for only so long. In addition, the difficulties of managing increasing numbers of partnerships may eventually inhibit growth opportunities. That is, successful firms cannot maintain growth indefinitely, without undertaking actions to maintain their growth, such as forming new collaborative ventures.

We next note that the results in Table 4 initially support Hypothesis 2a with respect to incumbent partners, although not with respect to entrant partners. Consider first the results that do not include the partner sales variable (columns 1a, 2a, and 3a). Incumbent partners contribute to greater one, two, and three-year growth rates, although the incumbent marketing partner result loses significance in year 3. By contrast, entrant partnerships are insignificant in all periods.

The impact of partner sales in Table 4 refines our understanding of Hypothesis 2a. The partner sales coefficient for one and two year growth (columns 1b and 2b) is positive and significant. Moreover, the incumbent marketing partner influence now loses significance for one-year growth and becomes negative for two-year growth. That is, only large marketing partners contribute to increased growth. By contrast, R&D partnerships continue to have a direct effect on growth, even controlling for partner size. The contrast between the marketing and R&D partnership results suggest that marketing partnerships provide immediate opportunities to
leverage a large ally’s sales and distribution systems, while R&D partnerships provide longer lasting opportunities to develop and introduce new products no matter what the size of the partner.

The conclusion that large incumbent partners contribute most to post-entry growth might seem to conflict with the earlier analyses concerning entry alliances, in which we found that large incumbent partners inhibited longer term growth (Table 2). The key difference in the analyses, though, is that the post-entry collaborations involve incumbents on both sides of the partnership. That is, once a firm becomes established within the industry, it faces less risk of being constrained by its partner. Instead, it is more likely to have the experience and systems to derive greater benefits from the new partner’s size.

The results in Table 4 support Hypothesis 2b, which concerns the differential timing impact of allying with incumbents and entrants. Incumbent relationships have immediate benefits, while entrant relationships become uniformly positive only in the third year – and even then do not reach statistical significance.

A question that arises here is why established firms would form relationships with entrants, if the partnerships do not contribute to an incumbent’s growth. Clearly, one possibility is that the relationships are systematic mistakes. More likely, though, if we assume intended rationality on the part of the firms’ managers, is the possibility that relationships with entrants provide longer-term benefits that do not show up in even three year growth rates. In addition, an incumbent may be able to share the profits from an entrant-partner’s initial sales – which Table 2 showed to be higher than the entrant would achieve without the collaboration – even if the incumbent does not gain additional sales itself.

Results summary

Overall, the results describe a pattern of bi-directional relationships between collaboration and sales. Figure 2 depicts the key relationships in the pattern. First, collaboration at entry helps a firm achieve greater initial sales levels and early sales growth, with collaboration with incumbents having earlier impact than collaboration with other entrants. Higher early growth then leads to higher subsequent sales levels. At the same time, though, there are constraints on the benefits of entry collaboration, because collaboration with large incumbent partners may constrain early growth opportunities. Second, higher annual sales levels and
ongoing growth increase the likelihood of post-entry collaboration. In addition, firms with greater collaborative experience often form new alliances with other incumbents. Third, now that a firm has established its own position in the industry, post-entry collaboration with industry incumbents contributes to ongoing growth (which in turn leads to higher annual sales).

Marketing and R&D partnerships have somewhat different post-entry effects, with large partners having the greatest benefit in marketing alliances and R&D partnerships of any size having the longest lasting effect. By contrast, post-entry collaboration with entrant firms does not contribute to incumbents’ near-term growth, though it might allow incumbents to share profits from the entrants’ greater initial sales levels.

********** Figure 2 about here **********

It is useful to consider the causality underlying this pattern. Two issues arise.

First, do the results stem from managerial choices about whether to collaborate and who to chose as partners or, instead, are unobserved factors driving the collaboration choices? Of course, we need to be cautious in interpreting the analysis. It is possible that unobserved heterogeneity among firms might predict sales, sales growth, and collaboration, and influence the results. For instance, product competencies that the existing control variables do not capture may influences sales and collaboration. Nonetheless, the broad set of control variables and the multi-stage structure of the analysis provides confidence that the analysis addresses many relevant dimensions of heterogeneity between firms. Moreover, the hospital operating software industry is focused and narrow, with relatively clear procedures and outcomes, and operates in a regulated hospital context. These industry characteristics have the effect of reducing variation among firms on many strategic and operational dimensions. The contrasts we draw in our analysis between incumbents and entrants also restrict the variance across categories of firms. Moreover, the overall pattern of results reduces the probability that unobserved characteristics systematically drive the results. For example, unmeasured competencies such as software skills or customer knowledge might explain why some entrants are attractive to incumbent partners. Yet the results show that entrants in incumbent-entrant relationships do not enjoy sales growth gains beyond a one or two year period. Therefore, while recognizing that the analyses omit relevant variables, we believe the results are substantively robust.

A second question concerning causality is whether firms understand collaboration
benefits and risks or, instead, whether variation in choices arises randomly in a series of lucky actions and mistakes. Do entrants, for example, choose to partner with other entrants with the knowledge that they are trading poorer short-term performance for longer-term growth? Do other firms choose not to collaborate knowing of possible lower growth or despite lacking such knowledge?

Discussions that we held with managers in this industry while we were developing the study suggest that variation reflects both lack of forethought and thoughtful attempts to manage in a boundedly-rational world. Clearly, some suboptimal choices were “mistakes”: sometimes made because of inadequate assessment of risks and benefits, sometimes stemming from agency-oriented managerial self-interest that under-emphasized business needs, sometimes stemming from confusion about whether to focus on the needs of an alliance or to consider the impact of an alliance on the overall performance of a parent business. Nonetheless, many of the people we spoke with were deeply aware of the potential benefits and risks of different collaboration choices, and were attempting to make choices that reflected their knowledge.

Nonetheless, even thoughtful people faced constraints that limited their choices. Commonly, constraints arose because of lack of desirable marketing or R&D partners because, in almost all cases, there are limited supplies of firms that are willing and able to form partnerships. Some constraints arose because of ambiguities in how benefits and risks would emerge in a potential relationship. Some constraints arose from company procedures that limited managers’ options in specific situations. Some constraints arose because of internal conflict in whether to seek short-term or long-term benefits. Most generally, collaboration has risks as well as benefits and thoughtful managers will sometimes weight the potential risks most heavily. Thus, we observe substantial variation in firms’ collaboration choices, both at and after entry, even when almost all managers in an industry are attempting to help their firms grow and prosper.

Clearly, these questions relate to issues of managerial and firm rationality. We believe that managers are generally aware of possible alternatives and have some understanding of the consequences of these outcomes. However, the complex causality between partner characteristics and alliance success, which even theoretical research continues to grapple with, compounds the existence of variation in managerial choices. Some may choose to collaborate when they would be better off operating independently, while others may reject valuable offers of
collaboration in favor of less productive alliances. Other managers may be driven by agency-related considerations. Specific knowledge of the findings of our study might help managers select and establish alliances more effectively, but will not eliminate the problems that produce the results we find. We believe that continued study of interfirm relationships is essential to develop a robust understanding and theory of business strategy and performance.

DISCUSSION

The results of this analysis suggest interactions between collaboration strategy and business growth, both at entry and during ongoing participation in an industry. The results outline implications of different entry paths into an industry, have implications for theories of business dynamics, and raise intriguing questions for future research.

Three collaboration routes that a business might take during entry have different implications for long-term sales growth. First, entry collaboration with an industry incumbent often provides immediate sales benefits and may help businesses overcome early problems that threaten their survival. Entrants that collaborate with large incumbents face later growth constraints, however, possibly because their partners constrain their expansion opportunities. Additional research could fruitfully investigate whether the small size of businesses that do not grow past their initial product-market segment causes the businesses to fail.

Second, entry collaboration with another entrant provides fewer immediate sales benefits than collaboration with an incumbent, but may provide a base for longer-term growth. The growth may then bring the business to sufficient size to have a high chance of surviving or being a desirable acquisition target. Nonetheless, businesses that desire collaborative entry must balance the immediate benefits offered by incumbent partners with the potential longer-term gains from entrant partners. An issue for further research is whether entrant businesses that collaborate with other entrants are particularly likely to fail soon after entry. In contrast to businesses that undertake independent entry and to entrant-incumbent partnerships, the businesses in an entrant-entrant pair must both establish their individual business routines and learn how to collaborate across organizational boundaries. Both activities are difficult and costly. Businesses that undertake business creation and collaboration simultaneously may be particularly likely to succumb to the problems that most new businesses encounter. Thus, increased risk of failure in an entrant-entrant pairing may offset the attraction of potentially stronger long-term
sales growth.

In the third entry route, businesses that undertake independent entry tend to attain lower initial sales and initial sales growth than entrants that collaborate at entry. Many independent businesses will fail because of lower sales. Nonetheless, independent businesses that manage to achieve substantial sales or sales growth become attractive partners for post-entry collaboration, which can reinforce their sales success and contribute to further growth.

A boundary condition arises, concerning why all firms do not undertake collaborative entry, either with incumbents or with other entrants. Some entrants may simply over-estimate their independent growth potential. Others may prefer to take the risk of lower growth in order to retain strategic independence. In addition, as we discussed above, the supply of desirable partners typically is limited, so that many firms must enter independently if they are to enter at all.

The results suggest three higher-level insights about aspects of collaborative relationships that relate to business dynamics. First, the patterns suggest that firms sometimes trade off long-term dependence for short-term benefits. In particular, consider entrant-incumbent partnerships. Any power exercised in such relationships usually will be the dependence of the entrant on the incumbent, which would suggest that incumbents would gain more than entrants in entrant-incumbent partnerships. Nevertheless, entrants often gain immediate sales benefits from relationships with incumbents. The short-term gains may come at the cost of longer-term constraints on growth, however, possibly because the incumbent partner limits the entrant’s ability to expand.

Second, the results reinforce the idea that imprinting arises from industry entrants’ choice of collaboration modes (Stinchcombe, 1965; Baum et. al., 2000), that is, initial conditions will have long term effects. Entrants’ choices of whether to collaborate and who to collaborate with have lasting impact on their strategy and performance.

Third, whichever entry route firms take, successful businesses and businesses with histories of collaboration often attract more partners. These businesses with collaborative relationships thereby become increasingly entrenched in an industry. The entrenched businesses tend to have greater sales than others and often enjoy preferred access to new partners with capabilities needed for continued growth and survival. Entrenched businesses may achieve efficient use of information from their partners and also may be able to influence their partners.
Further analysis that addresses the relative size, prior experience, and the broader corporate context of the partners would help develop our understanding of power and efficiency issues in collaborative relationships.

A second boundary question arises here, concerning limits on the benefits of ongoing collaboration. Why do we not see entrenched firms use their position to form desirable collaborations and grow indefinitely? Here, again, the availability of desirable partners applies, especially when we recognize that only incumbent partners appear to create mid-term growth opportunities. Moreover, firms can become enmeshed in a web of collaborations, such that past alliances limit a firm’s ability to adapt and grow (Weick, 1979: 185-187; Harrigan, 1985; Singh and Mitchell 1996). Thus, even entrenched incumbents face constraints on their ability to identify desirable partners and manage successful relationships.

Many research issues remain, in addition to those that we noted above. It would be valuable to extend the analysis to include informal collaboration, as well as other forms of formal collaboration in domestic and international contexts. It would be interesting to investigate how refinements of the collaboration categories influence the process of business growth and survival. The accumulation of partnerships with incumbents and partnerships with entrants may have varied short-term and long-term influences on post-entry sales growth and on collaboration formation. Various combinations of entrants and incumbents in the mix of initial and later partners may have different influences.

Research also could examine other factors that influence the bi-directional relationship between business growth and collaboration. Eisenhardt and Schoonhoven (1990) found that first year sales were higher if a new semiconductor business was innovative. Several analysts suggest that innovative businesses and businesses with greater stocks of complementary assets will be particularly desirable partners (e.g., Arora and Gambardella, 1990). The degree of integration of a business within an industry network might influence relationship formation (Kogut, et al., 1992). It would also be useful to compare collaboration-growth relationships to acquisition-growth relationships. In addition, it would be valuable to study the impact of relative business size and other factors on the likelihood that any given pair of incumbents would collaborate.

A related question arises concerning whether the bi-directional influences are mirrored in cases of declining sales and ineffective collaboration. That is, would ineffective collaboration
lead to declining sales, which in turn would reduce the opportunities for collaboration, thus entrenching firms into cycles of decline and failure? We expect to see the mirror image of our present results, with the costs and difficulties of unsuccessful collaboration hindering performance. This will reduce the attractiveness of the firm to potential partners, and reduce the resources available for partnerships that are established. This issue would be a useful focus of future research.

Theories of dynamic business strategy and performance would benefit from greater conceptual understanding of the evolutionary role of collaboration. In the past decade, many strategy researchers have drawn from Penrose’s (1959) seminal work to argue that many business advantages stem from creation of critical business-specific resources (e.g., Wernerfelt, 1984; Barney, 1986). In a complementary counter-point to transaction cost theory (Williamson, 1975), the resource-based approach argues that business boundaries result more from the idiosyncratic resources that firms create over time and less from discrete choices about which resources to internalize at a given time. However, strategists and organizational theorists dating to back to Coase (1937) have long recognized that no one business can create all critical resources needed to prosper and grow. Instead, collaboration among businesses that possess complementary resources is often necessary for survival and growth.

Despite its importance, collaboration is an uncertain and imperfect learning process, both in the sense that collaborating businesses often face difficulties and because any given collaboration is available to only a few businesses. In turn, collaboration contributes to differential business performance and survival. Developing our understanding of the evolutionary roles of interfirm collaboration is important to improve understanding of business strategy.
ENDNOTES

1 We modeled the effects of specific firm characteristics directly because we have substantial information available about each firm, rather than using random effects or fixed effects models to address unspecified sources of firm-specific heterogeneity.

2 There were too few marketing partnerships with other entrants to obtain reliable estimates for the 3-year growth model in column 4. It is reasonable that R&D partnerships outnumber marketing partnerships among entrants, because the entrants are introducing their first products.
REFERENCES


Figure 1. Summary of Predicted Influences

Entry collaboration with entrants or incumbents

H1a, lc, 1d

H1b, lc, 1d

Initial sales level | Annual sales level
H3a

Initial sales growth | Annual sales growth
H3b

Post-entry collaboration
H3c

H2a, 2b
Figure 2: Collaboration-Sales Relationships (positive impact unless indicated)

Entry marketing collaboration with incumbents
Entry marketing or R&D collaboration with entrants

Initial sales level | Annual sales level

Early sales growth | Ongoing sales growth

Post-entry collaboration
With incumbents
With entrants

Large partners: Immediate growth
R&D partners: Lasting growth

Large partners: Growth constraints
Table 1. Variables
(Financial variables deflated by the U.S. Producer Price Index, with 1982 as base year)

A. Dependent variables
1. Initial Sales Level (equation 1). Sales revenue in first full calendar year ($ million).
2. Initial Sales Growth (equations 2a-2c). 1-year, 2-year, and 3-year percentage change in sales after the first full year (\(\ln S_2/S_1\), \(\ln S_3/S_1\), and \(\ln S_4/S_1\); where \(S_1, S_2, S_3,\) and \(S_4\) are sales in years 1 to 4).
3. Post-Entry Sales Growth (equations 3a-3c). 1-year \((\ln S_{t+1}/S_t; t>1)\), 2-year \((\ln S_{t+2}/S_t;\ t=2,4,6...)\), and 3-year \((\ln S_{t+3}/S_t;\ t=3,6,9...)\) percentage change in sales.
4. Created Relationship (equations S1, S2, and 4a-4b). Dummy variables that record if a business formed at least one relationship in a given year.
   4a. Created Entrant Relationship (0-1). Relationships with industry entrants.
   4b. Created Incumbent Relationship (0-1). Relationships with industry incumbents.

B. Independent variables
2. Entrant Partner (0-1). Relationships with industry entrants formed in a given year.
   2a. Entrant partner: Marketing. Relationship was used to market products.
   2b. Entrant partner: R&D. Relationship was used to develop products.
3. Incumbent Partner (0-1). Relationships with industry incumbents formed in a given year.
   3a. Incumbent partner: Marketing. Relationship was used to market products.
   3b. Incumbent partner: R&D. Relationship was used to develop products.
4. Log Business Sales. Natural log of annual sales revenue ($ million), lagged one year.
5. Sales Growth. 1-year percentage changes in sales, lagged one year \((\ln S_{t-1}/S_{t-2})\).
6. Cumulative Partnerships. Cumulative number of partnerships, lagged one year (assigned 0 if no partnerships).

C. Industry-level control variables
2a. Market Growth, 2b. Log Market Growth. Growth in market size \((M_t/M_{t-1}\) and \(\ln M_t/M_{t-1};\ M=Market\ Size)\).
3. Industry Age. Years since first product introduced to market (calendar year-1960).
D. Business-level control variables

1a. Partner Sales, 1b. Log Partner Sales. Sales of partners in year before relationship formed ($ million; log variable assigned value of 0 for entrant partners; sum of partner sales if multiple partnerships formed in same year).

2a. Diversifying Entrant: Previous Hardware Experience (0-1). Entrant was an established firm with experience manufacturing computer hardware that are likely to realize sales advantages from compatibility for their software products.

2b. Diversifying Entrant: No Previous Hardware Experience (0-1). Entrant was an established firm with no experience manufacturing computer hardware.

2c. Diversifying Entrant: Previous software experience (0-1). Entrant had computer software experience in other industries, but no previous computer hardware experience.

2d. Diversifying Entrant: Firm Age at Entry. Years since firm was established.

3a. Acquired Business (0-1). Denotes that firm acquired another hospital software business during previous year (current year sales of acquirer include sales inherited from target).

3b. Sales of Acquired Business, 3c. Log Sales of Acquired Business. Previous year sales of businesses acquired when the business entered the industry ($ million; log variable assigned value of 0 for observation years with no acquisitions; sum of acquired business sales if acquired more than one business in same year).

4a. Product Line Breadth. Number of product classes that the business sold.

4b. Added Products. Number of product classes added during past year.

5. Log Business Age. Log of number of years that firm has participated in the industry.

6a. Partner Dissolution (0-1). At least one partner shut down during the past five years.

6b. Partner Added Partner (0-1). At least one partner formed a collaborative relationship with a new partner during the past five years.

7. Private firm (0-1). Business was privately held, rather than a public corporation.
Table 2. Least squares estimates of influences on initial sales levels and growth
(positive coefficient = higher sales)

<table>
<thead>
<tr>
<th></th>
<th>(1) Initial sales level:</th>
<th>(2) Initial sales growth:</th>
<th>(3) Initial sales growth:</th>
<th>(4) Initial sales growth:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1 sales</td>
<td>1-year growth</td>
<td>2-year growth</td>
<td>3-year growth</td>
</tr>
<tr>
<td></td>
<td>(ln S2/S1)</td>
<td>(ln S3/S1)</td>
<td>(ln S4/S1)</td>
<td></td>
</tr>
<tr>
<td>Coef.</td>
<td>s.e.</td>
<td>Coef.</td>
<td>s.e.</td>
<td>Coef.</td>
</tr>
<tr>
<td>Entrant partner: Marketing</td>
<td>H1 -0.68</td>
<td>2.07</td>
<td>0.40</td>
<td>0.32 *</td>
</tr>
<tr>
<td>Entrant partner: R&amp;D</td>
<td>H1 -0.68</td>
<td>1.27</td>
<td>0.35</td>
<td>0.16 **</td>
</tr>
<tr>
<td>Incumbent partner: Marketing</td>
<td>H1 2.63</td>
<td>0.89 ***</td>
<td>0.08</td>
<td>0.11</td>
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<tr>
<td>Incumbent partner: R&amp;D</td>
<td>H1 0.69</td>
<td>1.14</td>
<td>0.18</td>
<td>0.14 *</td>
</tr>
<tr>
<td>Partner Sales (year 0)</td>
<td>-0.02</td>
<td>0.01</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Sales of Acquired Business (year 0)</td>
<td>0.47</td>
<td>0.12 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Size (year 0)</td>
<td>-0.002</td>
<td>0.0003 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Growth (year 0)</td>
<td>0.25</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Partner Sales (year 0)</td>
<td></td>
<td></td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Log Business Sales (year 1)</td>
<td></td>
<td></td>
<td>-0.07</td>
<td>0.01 ***</td>
</tr>
<tr>
<td>Log Sales of Acquired Business (year 0)</td>
<td>0.04</td>
<td>0.16</td>
<td>0.13</td>
<td>0.52</td>
</tr>
<tr>
<td>Log Market Size (year 0)</td>
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<td></td>
<td>-0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>Log Market Growth (year 0)</td>
<td></td>
<td></td>
<td>0.44</td>
<td>0.13 ***</td>
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<tr>
<td>Entry collaboration selection</td>
<td>2.38</td>
<td>0.28 ***</td>
<td>-0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>Intercept</td>
<td>8.30</td>
<td>0.90 ***</td>
<td>0.27</td>
<td>0.34</td>
</tr>
<tr>
<td>Cases</td>
<td>935</td>
<td></td>
<td>861</td>
<td></td>
</tr>
<tr>
<td>R-square</td>
<td>0.13</td>
<td></td>
<td>0.06</td>
<td></td>
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</table>

*** p<.01, ** p<.05, * p<.10 (heteroscedastic-consistent standard errors)
Table 3. Probit estimates of influences on post-entry collaboration by industry incumbents
(positive coefficient = greater likelihood of forming a new partnership)

<table>
<thead>
<tr>
<th></th>
<th>Created Entrant</th>
<th>Created Incumbent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef. s.e.</td>
<td>Coef. s.e.</td>
</tr>
<tr>
<td>Log Business Sales (year t-1)</td>
<td>0.13 0.04 ***</td>
<td>0.15 0.03 ***</td>
</tr>
<tr>
<td>Sales Growth (ln(St-1/St-2))</td>
<td>0.30 0.11 ***</td>
<td>0.27 0.09 ***</td>
</tr>
<tr>
<td>Cumulative Partnerships (year t-1)</td>
<td>-0.01 0.02</td>
<td>0.03 0.01 ***</td>
</tr>
<tr>
<td>Previous hardware experience</td>
<td>0.02 0.22</td>
<td>0.34 0.13 ***</td>
</tr>
<tr>
<td>No previous hardware experience</td>
<td>0.05 0.11</td>
<td>0.04 0.08</td>
</tr>
<tr>
<td>Previous software experience</td>
<td>0.04 0.23</td>
<td>0.10 0.17</td>
</tr>
<tr>
<td>Acquired Business (year t-1)</td>
<td>-0.14 0.29</td>
<td>-0.04 0.19</td>
</tr>
<tr>
<td>Product Line Breadth (year t-1)</td>
<td>0.02 0.02</td>
<td>0.01 0.02</td>
</tr>
<tr>
<td>Added Products (year t)</td>
<td>0.02 0.09</td>
<td>0.13 0.05 ***</td>
</tr>
<tr>
<td>Log Business Age (year t-1)</td>
<td>-0.11 0.07 *</td>
<td>-0.19 0.05 ***</td>
</tr>
<tr>
<td>Partner Dissolution</td>
<td>0.07 0.22</td>
<td>-0.10 0.15</td>
</tr>
<tr>
<td>Partner Added Partner</td>
<td>0.47 0.11 ***</td>
<td>1.74 0.08 ***</td>
</tr>
<tr>
<td>Log Market Size (year t-1)</td>
<td>-0.32 0.19 *</td>
<td>0.24 0.22</td>
</tr>
<tr>
<td>Log Market Growth (year t-1)</td>
<td>0.09 0.46</td>
<td>0.55 0.36 *</td>
</tr>
<tr>
<td>Industry Age</td>
<td>0.05 0.02 ***</td>
<td>0.01 0.02</td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.39 1.10 *</td>
<td>-4.46 1.34 ***</td>
</tr>
<tr>
<td>Loglikelihood ratio statistic (15 df)</td>
<td>81.3 ***</td>
<td>1082.2 ***</td>
</tr>
<tr>
<td>Partnerships (5,720 business-years)</td>
<td>79 376</td>
<td></td>
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</table>

*** p<.01, ** p<.05, * p<.10
Table 4. Least squares estimates of influences on post-entry sales growth  
(positive coefficient = greater sales growth)

<table>
<thead>
<tr>
<th></th>
<th>1-year growth (ln St+1 / St; t&gt;1)</th>
<th>2-year growth (ln St+2 / St; t=2,4...)</th>
<th>3-year growth (ln St+3/St; t=3,6 ...)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1a) Coef. s.e.</td>
<td>(1b) Coef. s.e.</td>
<td>(2a) Coef. s.e.</td>
</tr>
<tr>
<td>Added entrant partner: Marketing</td>
<td>0.01 0.06</td>
<td>0.01 0.06</td>
<td>0.08 0.11</td>
</tr>
<tr>
<td>Added entrant partner: R&amp;D</td>
<td>-0.01 0.07</td>
<td>-0.01 0.07</td>
<td>-0.19 0.14</td>
</tr>
<tr>
<td>Added incumbent partner: Marketing</td>
<td>0.06 0.03 **</td>
<td>0.00 0.04</td>
<td>0.004 0.06 *</td>
</tr>
<tr>
<td>Added incumbent partner: R&amp;D</td>
<td>0.13 0.04 ***</td>
<td>0.11 0.04 ***</td>
<td>0.17 0.09 *</td>
</tr>
<tr>
<td>Log Partner Sales (year t-1)</td>
<td>0.02 0.01 **</td>
<td>0.04 0.02 **</td>
<td>0.04 0.02 **</td>
</tr>
<tr>
<td>Post-entry collaboration selection</td>
<td>-0.05 0.01 ***</td>
<td>-0.05 0.01 ***</td>
<td>-0.03 0.02 **</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.01 0.02</td>
<td>-0.01 0.02</td>
<td>0.10 0.04 **</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.15</td>
<td>0.16</td>
<td>0.18</td>
</tr>
<tr>
<td>Business-years</td>
<td>3,924</td>
<td>3,924</td>
<td>1,768</td>
</tr>
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</table>

*** p<.01, ** p<.05, * p<.10 (heteroscedastic-consistent standard errors)
Appendix 1. Hospital software system product classes

1. Accounting, business, and finance: Financial and business office operations.
4. Clinical laboratory: Laboratory department management and test result reporting.
5. Pharmacy: Inpatient and outpatient pharmacy management.
6. Radiology: Radiology department management; Picture archiving systems.
7. Nursing: Nursing department management.
8. Other administrative: Miscellaneous administration.
12. Operating room: Operating room management.
Appendix 2a. Product-moment correlations and summary statistics: Initial sales level variables (n=935; Table 2)

<table>
<thead>
<tr>
<th>variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrant partner: Marketing</td>
<td>1.00</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.06</td>
<td>-0.01</td>
</tr>
<tr>
<td>Entrant partner: R&amp;D</td>
<td>-0.01</td>
<td>1.00</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.03</td>
<td>-0.01</td>
<td>-0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Incumbent partner: Marketing</td>
<td>-0.01</td>
<td>-0.01</td>
<td>1.00</td>
<td>0.05</td>
<td>0.47</td>
<td>0.04</td>
<td>0.16</td>
<td>-0.04</td>
</tr>
<tr>
<td>Incumbent partner: R&amp;D</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.05</td>
<td>1.00</td>
<td>0.28</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Partner Sales</td>
<td>0.00</td>
<td>0.03</td>
<td>0.47</td>
<td>0.28</td>
<td>1.00</td>
<td>0.03</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>Sales of Acquired Business</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.04</td>
<td>-0.01</td>
<td>0.03</td>
<td>1.00</td>
<td>-0.05</td>
<td>-0.02</td>
</tr>
<tr>
<td>Market Size</td>
<td>0.06</td>
<td>-0.06</td>
<td>0.16</td>
<td>0.04</td>
<td>0.09</td>
<td>-0.05</td>
<td>1.00</td>
<td>-0.33</td>
</tr>
<tr>
<td>Market Growth</td>
<td>-0.01</td>
<td>0.05</td>
<td>-0.04</td>
<td>0.00</td>
<td>0.01</td>
<td>-0.02</td>
<td>-0.33</td>
<td>1.00</td>
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**Summary statistics**

<table>
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<tr>
<th>Mean</th>
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<th>0.01</th>
<th>0.03</th>
<th>0.02</th>
<th>1.52</th>
<th>0.12</th>
<th>1356</th>
<th>1.11</th>
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<tr>
<td>s.d.</td>
<td>0.06</td>
<td>0.09</td>
<td>0.15</td>
<td>0.11</td>
<td>9.84</td>
<td>0.99</td>
<td>481</td>
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<tr>
<td>Min.</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.01</td>
<td>0.89</td>
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<tr>
<td>Max.</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>148.5</td>
<td>16.23</td>
<td>2048</td>
<td>7.21</td>
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### Appendix 2b. Product-moment correlations and summary statistics: Post-entry partnership formation variables (n=5720; Table 3)

<table>
<thead>
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<th>2</th>
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<th>4</th>
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<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Log Business Sales (year t-1)</td>
<td>1.00</td>
<td>-0.31</td>
<td>0.15</td>
<td>0.20</td>
<td>0.18</td>
<td>0.04</td>
<td>0.15</td>
<td>0.45</td>
<td>0.12</td>
<td>0.46</td>
<td>0.07</td>
<td>0.24</td>
<td>-0.21</td>
<td>0.03</td>
<td>-0.27</td>
</tr>
<tr>
<td>2 Sales Growth (ln(St-1/St-2))</td>
<td>-0.31</td>
<td>1.00</td>
<td>-0.02</td>
<td>-0.04</td>
<td>-0.07</td>
<td>-0.02</td>
<td>0.01</td>
<td>-0.09</td>
<td>0.02</td>
<td>-0.37</td>
<td>-0.02</td>
<td>-0.04</td>
<td>-0.05</td>
<td>0.16</td>
<td>-0.06</td>
</tr>
<tr>
<td>3 Cumulative Partnerships (year t-1)</td>
<td>0.15</td>
<td>-0.02</td>
<td>1.00</td>
<td>0.10</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.18</td>
<td>0.00</td>
<td>0.10</td>
<td>0.28</td>
<td>0.28</td>
<td>0.06</td>
<td>-0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>4 Previous hardware experience</td>
<td>0.20</td>
<td>-0.04</td>
<td>0.10</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.05</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.01</td>
<td>0.07</td>
<td>0.05</td>
<td>0.07</td>
<td>-0.10</td>
<td>0.05</td>
<td>-0.14</td>
</tr>
<tr>
<td>5 No previous hardware experience</td>
<td>0.18</td>
<td>-0.07</td>
<td>-0.01</td>
<td>-0.13</td>
<td>1.00</td>
<td>0.37</td>
<td>0.04</td>
<td>0.08</td>
<td>0.03</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.09</td>
<td>0.03</td>
<td>-0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>6 Previous software experience</td>
<td>0.04</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.05</td>
<td>0.37</td>
<td>1.00</td>
<td>-0.02</td>
<td>-0.06</td>
<td>0.00</td>
<td>0.03</td>
<td>0.00</td>
<td>0.06</td>
<td>-0.02</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>7 Acquired Business (year t-1)</td>
<td>0.15</td>
<td>0.01</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.04</td>
<td>-0.02</td>
<td>1.00</td>
<td>0.13</td>
<td>0.03</td>
<td>0.02</td>
<td>-0.01</td>
<td>0.05</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>8 Product Line Breadth (year t-1)</td>
<td>0.45</td>
<td>-0.09</td>
<td>0.18</td>
<td>0.03</td>
<td>0.08</td>
<td>-0.06</td>
<td>0.13</td>
<td>1.00</td>
<td>0.05</td>
<td>0.29</td>
<td>0.07</td>
<td>0.33</td>
<td>0.07</td>
<td>-0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>9 Added Products (year t)</td>
<td>0.12</td>
<td>0.02</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.00</td>
<td>0.03</td>
<td>0.05</td>
<td>1.00</td>
<td>0.09</td>
<td>0.03</td>
<td>0.06</td>
<td>-0.01</td>
<td>0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td>10 Log Business Age (year t-1)</td>
<td>0.46</td>
<td>-0.37</td>
<td>0.10</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.02</td>
<td>0.29</td>
<td>0.09</td>
<td>1.00</td>
<td>0.07</td>
<td>0.22</td>
<td>0.22</td>
<td>-0.18</td>
<td>0.25</td>
</tr>
<tr>
<td>11 Partner Dissolution (past five years)</td>
<td>0.07</td>
<td>-0.02</td>
<td>0.28</td>
<td>0.05</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.07</td>
<td>0.03</td>
<td>0.07</td>
<td>1.00</td>
<td>0.14</td>
<td>0.04</td>
<td>-0.01</td>
<td>0.04</td>
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<tr>
<td>12 Partner Added Partner (past five years)</td>
<td>0.24</td>
<td>-0.04</td>
<td>0.28</td>
<td>0.07</td>
<td>0.09</td>
<td>0.00</td>
<td>0.05</td>
<td>0.33</td>
<td>0.06</td>
<td>0.22</td>
<td>0.14</td>
<td>1.00</td>
<td>0.18</td>
<td>-0.09</td>
<td>0.22</td>
</tr>
<tr>
<td>13 Log Market Size (year t-1)</td>
<td>-0.21</td>
<td>-0.05</td>
<td>0.06</td>
<td>-0.10</td>
<td>0.03</td>
<td>-0.06</td>
<td>0.00</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.22</td>
<td>0.04</td>
<td>0.18</td>
<td>1.00</td>
<td>-0.43</td>
<td>0.86</td>
</tr>
<tr>
<td>14 Log Market Growth (year t-1)</td>
<td>0.03</td>
<td>0.16</td>
<td>-0.02</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.03</td>
<td>-0.01</td>
<td>-0.03</td>
<td>0.03</td>
<td>-0.18</td>
<td>-0.01</td>
<td>-0.09</td>
<td>-0.43</td>
<td>1.00</td>
<td>-0.45</td>
</tr>
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<td>15 Industry Age</td>
<td>-0.27</td>
<td>-0.06</td>
<td>0.07</td>
<td>-0.14</td>
<td>0.06</td>
<td>-0.02</td>
<td>0.00</td>
<td>0.07</td>
<td>-0.02</td>
<td>0.25</td>
<td>0.04</td>
<td>0.22</td>
<td>0.86</td>
<td>-0.45</td>
<td>1.00</td>
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**Summary statistics**

- **Mean**: 0.09 0.17 0.27 0.05 0.25 0.04 0.02 2.53 0.08 1.33 0.00 0.11 7.25 0.06 23.41
- **s.d.**: 1.58 0.43 2.11 0.21 0.43 0.21 0.13 1.89 0.47 0.83 0.07 0.31 0.41 0.12 5.87
- **Min.**: -4.78 -2.78 0.00 0.00 0.00 0.00 1.00 -11.00 0.00 0.00 0.00 0.01 -0.12 2.00
- **Max.**: 5.79 4.39 60.00 1.00 1.00 1.00 13.00 6.00 3.40 1.00 1.00 7.62 1.98 31.00
Appendix 3. Entry collaboration selection equation: Probit estimates of collaboration likelihood (positive coefficient = greater likelihood of entry collaboration)

<table>
<thead>
<tr>
<th></th>
<th>Coef</th>
<th>s.e.</th>
</tr>
</thead>
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<tr>
<td>Industry age</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Private firm</td>
<td>-0.51</td>
<td>0.16</td>
</tr>
<tr>
<td>Diversifying entrant: Previous hardware experience</td>
<td>-0.15</td>
<td>0.21</td>
</tr>
<tr>
<td>Diversifying entrant: No previous hardware experience</td>
<td>1.38</td>
<td>0.29</td>
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<tr>
<td>Diversifying entrant: Previous software experience</td>
<td>-0.09</td>
<td>0.48</td>
</tr>
<tr>
<td>Diversifying entrant: Firm age at entry</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.28</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Cases (collaboration) 935 (56)
Model log-likelihood ratio (df) 68.8 (6) ***

*** p<.01, ** p<.05, * p<.10