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ORGANIZATIONAL STRUCTURE IN  
THE FOOD MANUFACTURING,  
CHEMICAL, AGRICULTURAL  
WHOLESALE AND  
BIOTECHNOLOGY INDUSTRIES**

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Working Paper #09-01

January 2009

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# **FACTORS INFLUENCING ORGANIZATIONAL STRUCTURE IN THE FOOD MANUFACTURING, CHEMICAL, AGRICULTURAL WHOLESALING AND BIOTECHNOLOGY INDUSTRIES**

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January 2009

## **Abstract**

The objective of this study is to identify factors determining a business investment strategy (i.e., the choice of investment commitment and form of organizational structure) in the food manufacturing, chemical, agricultural wholesaling and biotechnology industries. Propositions regarding strategic alliance theories are tested on over 400 inter-firm collaborative agreements using secondary data from major US and European companies for the 1994-97 period. Results suggest that transactions with lower technological and resource uncertainty levels are more likely to result in investments with a higher commitment level (i.e., acquisitions or majority equity-based controlling investments). The investment commitment level embedded in a single business transaction seems to be affected not only by a goal of cost minimization, but also by strategic motives and firm and industry factors.

Keywords: Transaction costs, strategic alliances, food manufacturing, chemical, agricultural wholesaling, ag-biotechnology, investment strategy, innovation

JEL Code: L10

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## **Introduction**

The evolution graphs of companies such as Pioneer and Syngenta presented by Fernandez-Cornego (2004) show how the agricultural sector has experimented with and implemented a wide variety of business transactions/agreements. Examples of organizational structures are joint ventures, share purchases, partnerships, alliances, mergers and acquisitions, franchising, licensing agreements, minority/majority equity interest, organic growth, and more. In this paper, we specifically focus on four of them: minority-equity agreements, majority-equity agreements, acquisitions, and horizontal agreements.

It is always hard in the management literature to establish a definition/understanding of organizational structure acknowledged by a majority of academics and practitioners (Stanek, 2004). In this paper we define a minority-equity agreement as an agreement between parties with less than 51% control, i.e., 50% equity investment, less than 50% equity investment, licensing or other type of collaborative agreement. In contrast, majority-equity agreements refer to agreements with controlling equity of 51% of the target-firm's capital (Hennart, 1998; Pisano, 1991). Acquisition is defined as the complete purchase of one company by another company. Horizontal agreements refer to the formation of agreements between companies in the same industry sector defined by SIC code.

These different business models can be used at several levels in the supply chain: research and development (R&D), supply, manufacturing, and commercialization. Business models at the R&D level are created to brainstorm new ideas, and/or develop new products, services, or technologies. Agreements at the supply level are used to secure supplies. Companies can also make choices of organizational structures to manufacture and commercialize the new products, services, or technologies.

The creation of these various organizational structures is motivated by diverse considerations such as risk mitigation and management; economies of scale and scope; access to resources and capabilities; and market positioning and strategy, e.g., competitive preempting (Stanek, 2004; Hagedoorn, 1993).

In short, firm executives must make critical organizational structure decisions. Assuming a particular technological project has the potential for high profits and competitive advantage, corporate managers need to decide on a business investment strategy, i.e., how much to invest and which governance structure to pursue. There are two main questions related to governance structure that this paper addresses.

Question 1: What are the factors determining the commitment level embedded in an individual business investment transaction?

We focus here on the study of three such alternatives: minority-equity agreements, majority-equity agreements, and acquisitions. We further limit our studies to four types of business agreements: R&D, supply agreement, manufacturing agreement, and commercialization agreement.

Question 2: Why do firms establish horizontal inter-firm agreements?

Our focus here is on agreements between firms in the same industry. As earlier, we further limit our study to four types of business agreements: R&D, supply agreement, manufacturing agreement, and commercialization agreement.

The paper contains the following sections. The first section presents a description of reasons behind organizational structure choices, the propositions being tested in this paper, and relevant findings in the literature. In the following section, a presentation of the data and variables is

proposed. The penultimate section presents the results. Finally, main conclusions and implications are highlighted.

### **Theoretical and Empirical Evidence**

Two important questions that management scholars have attempted to address are why companies cooperate in their efforts to innovate, and what determines the nature and boundaries of a new relationship and the level of commitment to that relationship (Hagedoorn, 1993; Harrigan, 1988; Kogut et al., 1992; Kreiner and Schultz, 1993). Before discussing the reasons behind those choices, it is fair to note the risk of opportunism associated with agreements between two parties who are often competitors. Opportunism (poaching of good employees, use of private information or trade secrets, and more) arises because actions that have efficiency consequences are not freely observable. Therefore, the firm taking those actions may choose to pursue its private interest at the expense of other firms (Milgrom and Roberts, 1992). Pisano (1989) and Pena (1999) suggest that for transactions with little or no risk of opportunism, involved parties can use simple market contracts as an agreement form. As the risk increases, monitoring becomes necessary and can be done through intermediate governance forms such as minority-equity or majority-equity agreements. For situations with high risk of information leakage, monitoring costs may be too high, making acquisition the only solution. This argument leads to the first proposition that will be tested in this paper.

Proposition 1: The higher the risk of opportunism entailed within a transaction (other factors being constant), the more likely the choice of an an acquisition transaction (Pena, 1999).

While there is risk of opportunism associated with a low committing organizational structure such as a minority-equity agreement, there are still a number of reasons for companies to make the decision to collaborate. Agricultural companies often face risk associated with R&D (Dwyer and Sivadas, 2000; Hagedoon, 1993), development and commercialization of products, and procurement of supplies and raw materials. One can classify uncertainty sources into three groups: technological uncertainty, extrinsic uncertainty, and resource uncertainty (McGrath and MacMillan, 1998). Technological uncertainty comes from the lack of knowledge about the viability of a technological project. The firm does not know whether or not the technology can be developed, and even less, whether or not it can reach the market. Technological uncertainty will be reduced once the project is undertaken. For highly uncertain technological projects, lower sunk costs would be preferred to higher sunk costs by risk adverse agents. McGrath and MacMillan (2000) propose the collaboration of firms through various organizational structures with different commitment levels. They suggest an inverse relationship between uncertainty and a hierarchical governance form. Namely, as uncertainty increases, less committing transactional arrangements will be preferred<sup>1</sup> (Pisano, 1989; McGrath and MacMillan, 2000), which brings us to the second proposition :

Proposition 2: The higher the technological uncertainty associated with an agreement (other factors being constant), the lower the degree of investment commitment embedded in the transaction (Pena, 1999).

Extrinsic uncertainty comes from forces external to a firm. Such exogenous factors may include unexpected government regulations, unpredictable climatic conditions, disease or product/food contamination, customers' financial problems, and the general business climate. In contrast to

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<sup>1</sup> In this study, a minority-equity agreement is the least committing organizational structure, equity agreement is a more committing agreement, and business acquisition is assumed to be the most committing business investment transaction.

technological uncertainty, undertaking investment in the project cannot reduce extrinsic uncertainty. For a risk adverse agent, higher extrinsic uncertainty will be associated with lower investment commitment (Long and Ravenscraft, 1993), which is proposition three.

Proposition 3: The higher the extrinsic uncertainty associated with an agreement (other factors being constant), the lower the degree of investment commitment embedded in the transaction (Pena, 1999).

Resource uncertainty arises from asymmetric information about the adequacy of the resources owned by the potential partner. One way to reduce resource uncertainty is by developing a long-term relationship with a partner where investment in the technological project is completed gradually (Kogut, 1994). As common knowledge about each partner's capabilities is gained over time, a firm is in a better position to commit further in the investment project. Once resource uncertainty is reduced, a firm may decide to culminate the prior relationship by completing an acquisition of the partner firm, which brings us to proposition four.

Proposition 4: The higher the resource uncertainty associated with an agreement (other factors being constant), the lower the degree of investment commitment embedded in the transaction (Pena, 1999).

Risk is not the only reason behind organizational structure choices. Access to markets, resources, and capabilities may also be motivators behind an agreement (Cavusgil et al., 1997; Oh, 1996). For example, firms may not possess in-house knowledge of the local or global markets, making some form of a relationship a learning opportunity (Stanek, 2004). Furthermore, with innovations being extremely costly, sharing costs of R&D may be desirable (Doz et al., 1989). Access to resources can also come in the form of cross-fertilization of scientific disciplines, complementary technology, intellectual property rights, people skills, use of the right

inputs, quality issues, and expansion of a product line (Insinga and Werle, 2000; Pena, 1999). In a competitive environment, access to complementary resources may shorten the period between product invention and market introduction (Pena, 1999).

A firm may also be interested in completing a particular transaction motivated by a strategic goal (e.g., preemption, market power and more). Competitive preemption consists of a firm forming alliances to block a competitor from forming similar ones, or to discourage a competitor from entering a market (Stanek, 2004). This can be particularly true in concentrated industries, where leading firms are clearly more motivated to preserve market power and are better endowed with resources to follow this type of strategy than competitors (Hitt et al., 1998). This type of preemption strategy requires a higher degree of investment commitment in order to gain majority-equity control of the partner company, and most importantly, of its valued assets. It would be more likely to be implemented by leading firms in concentrated industries.

Horizontal mergers and acquisitions could be an example of capturing a larger portion of the market in order to gain market power and leverage economies of scale and scope (Pena, 1999). A firm may wish to join efforts with another company in the same industry (i.e., horizontal inter-firm agreement) and create a new entity either to reduce costs through synergy effects, or to improve bargaining power through increasing industry concentration. The trend towards a higher industry concentration in the agricultural sectors may encourage firms inclined to enhance market share to further pursue inter-firm horizontal alliances (Hitt et al., 1998), which results in propositions 5a and 5b.

Proposition 5a: The more concentrated the industry of the dominant firm (other factors being constant), the higher the degree of investment commitment embedded in the transaction (Pena, 1999).



Proposition 5b: As concentration of the industry of the dominant firm increases (other factors being constant), so does the likelihood of a transaction between firms in the same industry (Pena, 1999).

Empirical evidence from studies of other industries provides support for these propositions. Osborn and Baughn (1990) studied 153 new alliances from 1984 to 1986 between US and Japanese companies in several industries. The purpose of the study was to test the effect of technological factors and size on choices of two collaborative relationships: joint venture (new entity with shared equity) and contractual agreements (do not involve shared equity). They found that a joint venture type of agreement was most likely when the purpose of the alliance was to pursue R&D activities, the technological intensity of the product was high, and the size of the parent firm was not large. Shan (1990) studied 278 start-up biotechnology firms and found that firm size is negatively correlated with the use of collaborative arrangements. He further found evidence that collaborative arrangements are predominantly used by high-tech, start-up firms in commercializing their new products in foreign markets. Eisenhardt and Schoonhoven (1996) used data on semiconductor firms to test both social and strategic explanations for alliance formation. They found that alliances form when firms are facing strategic risks or are led by large, experienced, and well-connected top management teams. Using data on 2647 strategic alliances formed over the period of 1993–2002 by 43 major biopharmaceutical firms in the U.S. and Europe, Zhang et al. (2007) found that the firm's knowledge breadth and the centrality of its R&D organization structure positively influence its propensity to form strategic alliances. In our study, we also focus on factors determining organizational structure choices, for three types of structure (minority-equity agreements, majority-equity agreements, and acquisitions) that differ not only from a legal standpoint but also at a commitment level. We test the effects of

industry (such as different SIC codes, concentration ratio), firm (such as age, size), past behavior, and project types (R&D, supply, manufacturing and commercialization) on this choice. Furthermore, we focus on a subject, to our knowledge, often forgotten: horizontal inter-firm agreement (agreement between firms in the same industry) choices. To our knowledge, this is one of the rare studies that looks at the food manufacturing, chemical, agricultural wholesaling and biotechnology industries.

### **Data and Methodology**

Secondary data are used to test the propositions presented earlier. All the companies studied are public and completed at least one business investment transaction (acquisition, equity agreement, or licensing agreement) during the 1994-97 period in order to acquire, develop, or commercialize food manufacturing, chemical, agricultural wholesaling and biotechnology technologies. For this paper, we focus our attention on major US and European companies developing new technologies in the food manufacturing, chemical, agricultural wholesaling and biotechnology industries which encompass the following three-digit SIC codes: 200, 286, 287, 519, and 873 (Pena, 1999).

The 1994-97 period was chosen for several reasons. First, this period follows major changes in food manufacturing, chemical, agricultural wholesaling and biotechnology that completely redefined the sector. Indeed, during the 1980s, government regulation played a decisive role in addressing environmental and food safety issues which led to dramatic increases for firms in research and development expenditures in these areas as well as increased technological, extrinsic, and resource uncertainty. Second, this period was marked by many business acquisitions, divestitures, and strategic partnerships particularly related to agricultural chemicals.

Third, the science of biology with its role in reshaping the food and fiber industry was in its early stages. Fourth, a new era seems to have emerged at the end of the twentieth century and the beginning of the twenty-first century, with an increased focus on the seed and genetics industry (Shimoda, 1996).

The diverse sources consulted for collecting the data are: Merger and Acquisitions, Bioscan, US Patent and Trademark Library database, Agricultural Statistics, Statistical Abstract and individual companies' annual reports. A list of business investment transactions (such as licensing agreement, purchase of equity or acquisition) and their characteristics (such as date, type of transaction, and name of the parties involved) was created using both Merger and Acquisitions and the Bioscan databases. The Patent and Trademark Library database was used to obtain information regarding patents. The sources Agricultural Statistics and Statistical Abstract were used to compile industry information. Annual reports were used to gather firm level information of the parties involved in the agreements.

The first question of this paper (What are the factors determining the commitment level embedded in an individual business investment transaction?) is addressed by conducting a statistical test to better understand which forces contribute most in differentiating among three levels of investment commitment for individual business transactions [i.e., 1) minority-equity investment, 2) majority-equity agreements, and 3) acquisition]. Using a discriminant analysis technique, a sample of 467 business investment transactions completed by agribusiness companies was examined.

The second question addressed in this study (Why do firms establish horizontal inter-firm agreements?) is focused on the formation of horizontal inter-organizational agreements, i.e., agreements between two or more firms in the same industry. This question is analyzed by using a

logistic regression model on a sample of 467 business investment transactions. This model is designed to test specifically whether industry concentration influences the use of horizontal agreements. The dependent variable is whether or not the parties involved in a business investment transaction network are from the same industry (as evidenced by belonging to the same SIC industry code at the three-digit level).

Variables used in the analyses for question 1 concerning the level of investment commitment in a transaction and question 2 concerning horizontal commitments are presented in Tables 1 and 2 respectively. Each variable is explicitly defined in these tables along with the proposition being tested, the rationale for inclusion as an explanatory or control variable, and the hypothesized sign where appropriate.

## **Discussion of Results**

Before initiating the discriminant analysis, a correlation test was conducted among the explanatory variables to check for multicollinearity. The Pearson correlation test showed that the variables were not significantly related, and consequently, all the explanatory variables were included in the analytical models.

### *Business Investment Commitment*

In response to question 1, the variables that contribute most in differentiating the three levels of investment commitment (i.e., minority-equity, majority-equity, and acquisition) are shown in Table 3 along with the respective values of the coefficients that optimize the discriminant function. The discriminant function accounts for 86 percent of the between group (i.e., level of investment commitment) variability. Mean values and standard deviations for all the variables

included in the model were computed for each group as shown in Table 3. In general, results show that the mean values for the significant variables vary considerably from group to group. The significant variables separating the three groups are SIC286, SIC519, DEBTRAT, TOTA, CPAP94, EXPAC, MD, and DD. The variables represent industry effects (organic chemical, agricultural wholesaling), acquirer's characteristics (financial situation, firm size, research and learning skills gained in the past, and experience in business acquisitions), and the type of agreement (manufacturing, commercialization).

As expected, acquisitions are the most popular form of agreement in the agricultural wholesaling industry (variable SIC519). A plausible explanation is that the agricultural wholesaling sector is more mature than industries such as ag-biotechnology. Companies in this industry do not face high extrinsic uncertainty like the biotechnology sector, where regulation about new products is not fully developed, markets are more volatile, and rivals' strategic moves are unpredictable. While acquisitions are also popular in the organic chemical industry sector (variable SIC286), probably because of the maturity of this industry as well, companies in this sector primarily adopt investment strategies based on majority-equity agreements. The larger coefficients compared to SIC519 suggest there is probably more risk associated with this sector than with the agricultural wholesaling sector, creating the need to share risks while evolving to stay competitive. One may suspect the higher coefficient for majority-equity-based agreements is justified by an exploratory investment conduct by which firms want to share risk while having some control over new technologies.

In the case of acquisitions, the financial condition of the acquirer (variable DEBTRAT) is not as strong compared to those companies that pursue less aggressive investment strategies; on average, the debt to asset ratio of acquirers is over 50%. Surprisingly, largest firms (variable

TOTA) are the ones involved in majority-equity agreements. This may be related to the results for the variable DEBTRAT suggesting that because companies involved in acquisitions are more highly leveraged, they are not involved in as many acquisitions that require larger capital commitments.

The results for the variable CPAC94 suggest that companies involved in majority-equity agreements are better endowed with research and learning skills. Prior to 1994, these companies held a larger number of patents relative to firms pursuing minority-equity or acquisition agreements. The explanation for this phenomenon may be twofold. First, most of their patents may come from past agreements suggesting that they have learned from the past and consequently are now better able to select the right partners and more accurately assess the uncertainty. Second, because they have more patents, they can attract partners and are in no need to make an acquisition to obtain the needed resources. As expected, results show that a firm's greater experience in completing business acquisitions (variable EXPAC) increases the likelihood of pursuing a new business acquisition.

Results suggest that acquisition agreements are more common in manufacturing (variable MD) and commercialization (variable DD) activities. Uncertainty involved in this type of transaction is lower than in R&D agreements; therefore, high commitment business investments are made. Indeed, rather than showing an exploratory behavior (i.e., assessment of new technologies), the parties seem to exploit their respective technological capabilities in a common front (e.g., a new operating system of established plants or new management of distribution channels).

*Business Investment Form*

The second question assesses the factors influencing the formation of horizontal inter-firm relationships. Table 4 shows the results for the logistic regression analysis of why firms establish horizontal agreements or network as reflected by being in the same industry measured by the SIC code. Comparing the predictions to the observed outcomes, one can observe that the model correctly classifies 74% of the agreements. Of the horizontal alliances included in the sample, 69% were classified correctly.

Nine variables representing transaction, firm and industry characteristics are of special importance in explaining the formation of horizontal agreements between firms operating in the food manufacturing, chemical, agricultural wholesaling and biotechnology industries markets. Eight of these variables are highly significant (i.e., a significance level of .05 or greater). The  $Exp(\beta)$  values represent the factor by which the odds (not the probability) change when the  $i^{th}$  explanatory variable increases by one unit. For instance, if  $\beta_i$  is positive, the factor will be greater than 1, which means that the odds for a horizontal agreement are increased. If  $\beta_i$  is negative, the factor will be less than 1, which means that the odds are decreased. When  $\beta_i$  is 0, the factor will equal 1, which leaves the odds unchanged.

Horizontal inter-firm relationships appear to be less likely in industries showing large variance in sales (variable DV); the sales variance is a measure of risk in the industry. One would have thought that more risk in an industry would be a motivator for companies in the same industry to ally to share the risk. However, sales variance may hide the fact that some companies (the leaders) may be extremely successful at maintaining a stable level of sales while others (the followers) are extremely unsuccessful. Leaders are unlikely to ally with each other because they have enough resources on their own and may fear leakage of private information while followers do not represent appealing partners.

Horizontal inter-firm relationships appear to be more likely in industries showing higher concentration ratios (variable SICR4), which supports proposition 5b. Follower firms may decide to collaborate with other industry companies to reach the competitive position achieved by industry leaders as suggested by the positive sign of the variable SICR4. Alternatively, leading firms may also decide to collaborate with other industry companies to enhance their competitive position, to achieve scale economies, to strengthen their bargaining power, or to support the market leadership of a particular technology. Regardless of the type (i.e., leaders or followers) and motive of companies (i.e., efficiency, market power, or technology) to pursue horizontal agreements, what seems obvious is that firms still continue to respond to the consolidation process initiated in many agricultural sectors at the end of the last decade.

Horizontal agreements seem to be less likely in agricultural wholesaling (variable SIC519) or agricultural biotechnology (variable SIC873) sectors. Different arguments may exist to explain this relationship. For agricultural wholesaling companies, it might be more interesting to pursue vertical agreements (e.g., product supply agreements), rather than horizontal agreements, in order to secure the delivery of products from manufacturing companies. As for biotechnology companies, such companies may not be willing to share proprietary knowledge with other biotechnology companies, since research knowledge is the main firm idiosyncratic asset and source of future revenues. Horizontal alliances are likely to endanger rent appropriation from technological projects. Agricultural biotechnology companies may also prefer vertical agreements to develop their innovations with manufacturing companies, because usually biotechnology firms lack complementary capabilities such as production facilities and operations management skills.



Companies that are more heavily leveraged (variable DEBTRAT) are more likely to engage in horizontal agreements, probably because they don't have the capital to buy all the needed resources. Horizontal agreements seem to be less likely when the dominant party has recognized experience in acquiring businesses (variable EXPAC). Antitrust laws may play a restrictive role among experienced acquirer firms in conducting further business acquisitions or other agreements.

Horizontal inter-firm relationships appear to be more common for R&D (variable RD) and manufacturing purposes (variable MD). The logic for conducting R&D agreements among firms in the same sector might be to complement research skills in terms of technological knowledge. As suggested by the significant variable MD, advantages derived from horizontal synergy effects might also serve to explain manufacturing agreements.

### **Conclusion and Implications**

Findings in our study indicate that in addition to cost and strategic specific factors, firm and industry factors are relevant in determining the choice of investment commitment level in a business exchange. Results in this paper were expected to provide insight into two important business investment strategy issues: 1) What are the factors determining the commitment level embedded in an individual business investment transaction? and 2) Why do firms establish horizontal inter-firm agreements?

Propositions 1, 2, 3, and 5b are at least partially supported. Propositions 4 and 5a are not supported by our analysis. According to the results, acquisitions are common in mature industries such as the agricultural wholesaling and organic chemical industries, and the most common form of agreement (among the three studied) for the agricultural wholesaling industry.

Acquirers tend to be more financially vulnerable than companies in other forms of agreement. While they have more assets than companies in minority-equity agreements, they have less than companies involved in majority-equity agreements. They also own fewer patents than companies involved in majority-equity agreements. As expected, results show that a firm's greater experience in completing business acquisitions increases the likelihood of pursuing a new business acquisition. Finally, acquisitions are more common in manufacturing and commercialization projects, i.e., more mature projects than R&D.

Companies pursuing majority-equity agreements portray different firm attributes. On the one hand, they seem to be larger as indicated by the average total asset amount. On the other hand, they are better endowed with research and learning skills. Prior to 1994, these companies owned a larger number of patents relative to firms pursuing minority-equity or acquisition agreements. Finally, minority-equity agreements seem to be associated with smaller firms conducting mostly R&D agreements, with an inferior competitive advantage regarding research and technological learning skills, and almost no experience in pursuing business acquisitions. Apparently, these are firms that lack the pool of tangible and intangible assets owned by firms classified in the rest of the groups. The risk to which they seem to be exposed appears to be higher relative to other firms (i.e., higher technological and resource uncertainty), and it is not surprising to notice a low investment commitment in their business transactions.

Horizontal agreements seem to be less common for the agricultural wholesaling and ag-biotechnology industries, but more common in highly concentrated industries with low variability in sales. They are usually for sharing R&D and manufacturing capabilities.

Companies with high levels of debt and less experience with acquisitions are more likely to be involved in this type of agreement.

This study provides several implications for how corporate managers may plan and implement their business investment projects. The first implication for corporate managers is that the choice of an optimum business investment strategy (i.e., investment commitment and form of investment) for a business transaction depends not only on minimizing transaction costs, but also on strategic objectives (e.g., exploration of new technologies and partners; exploitation of technological rents through market power; preemption; expansion towards new industry segments through business conglomerates; etc.).

Corporate managers competing in the food manufacturing, chemical, agricultural wholesaling and biotechnology markets should expect an acquisition-type of transaction to be more likely to occur when the exchange involves a manufacturing or commercialization agreement as opposed to a R&D or supply agreement. The acquisition investment outcome is also more likely when the acquirer has been operating for a long period in the industry and has experience and resources for acquiring companies. Managers should expect that industries where little extrinsic uncertainty prevails, like the mature food wholesaling sector, are very appropriate to complete business acquisitions. Advantages from synergy effects or strategic positioning in a consolidating industry may be reasons to explain such an investment behavior.

This study also offers some implications for policy makers. Our work suggests that most horizontal agreements in food manufacturing, chemical, agricultural wholesaling and biotechnology markets are equity-based agreements instead of business acquisitions. How these non-acquisition linkages will be treated by antitrust authorities is unclear. The propensity towards business acquisitions seems to be higher in concentrated industries. Regarding concentration and antitrust issues, the results suggest that government authorities should be less concerned with unstable industry sectors (i.e., industries with higher uncertainty such as

agricultural biotechnology) and more concerned with more stable industries (such as the agricultural wholesaling sector).

Results of this study should be interpreted with caution. Findings were derived from a reduced sample. Furthermore, the study sample represented a specific period of time, 1994-97. A larger sample with more companies and an extended time framework would improve the reliability of the results. Several avenues are suggested for further work for research scholars. In addition to the commitment and form of investment, it would be interesting to examine the timing of the investment. Some companies seem to prefer to invest earlier to benefit from first-mover advantages, whereas other firms prefer to wait-and-see how industry competition evolves before making any investment commitment. Analyzing the investment time dimension may shed further light on business investment strategy.

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Table 1. Description and Expected Sign of the Variables by Level of Investment Commitment Transaction

Variable Name	Definition of the Variable	Proposition being tested	Explanation
<u>Industry Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>			
DV	Variance in industry sales for the 1994-97 time period	3	This variable represents market volatility which is a proxy for extrinsic uncertainty.
SICR4	The four-firm industry concentration ratio	5a	The more concentrated the industry, the higher the degree of investment commitment to increase market power or for preemption reasons.
SIC200	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 200 -food manufacturing; and the value of 0 otherwise	2	Food manufacturing is a mature industry, which translates into less technological uncertainty (Hagedoorn, 1993).
SIC286	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 286 -organic chemicals; and the value of 0 otherwise	2	Organic chemicals is a mature industry, which translates into less technological uncertainty (Hagedoorn, 1993).
SIC287	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 287 -agricultural chemicals; and the value of 0 otherwise	2	Agricultural chemicals is a mature industry, which translates into less technological uncertainty (Hagedoorn, 1993).
SIC519	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 519 -agricultural wholesaling; and the value of 0 otherwise	2	Agricultural wholesaling is a mature industry, which translates into less technological uncertainty (Hagedoorn, 1993).

SIC873	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 873 -ag-biotechnology; and the value of 0 otherwise	2	Ag-biotechnology is a growing industry, which translates into more technological uncertainty (Hagedoorn, 1993).
<u>Financial Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>			
DEBTRAT	Ratio of financial liabilities over total assets	Control variable	Dominant firms with high debt levels are less likely to make full or partial acquisitions of a company.
INTLSALE	Ratio of sales to foreign markets over total sales for the year 1997	1	Firms involved in many markets will have more difficulty monitoring performance.
TOTA	Total assets in 1997 (in thousand US dollars)	Control variable	Captures the size of the firm; larger firms need fewer additional resources and are less interested in low committing organizational structures (Shan, 1990).
<u>Other Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>			
AGE	Age of the dominant firm in 1997	Control variable	Captures firm industry experience; no prior expectation with respect to this variable.
CPALLNC	Difference between the number of business investment transactions of the dominant firm and the average number of business investment transactions completed by the rest of the rivals in the same industry (same SIC code) and included in the sample for the 1994-1997 time period	1	Companies with experience in transactions have developed knowledge on how to evaluate the risk of opportunism.

CPAP94	Difference between the total number of patents before 1994 owned by the dominant firm and the average total number of patents before 1994 owned by the rest of the rivals in the industry included in the sample	2	Accumulation of patents is a proxy for how many R&D agreements in which a firm has been involved. Firms with high experience can better judge the uncertainty of a project and collaborate with the right partners, lowering the uncertainty associated with R&D projects (Cohen and Levinthal, 1990).
EXPAC	Number of previous acquisitions completed by the dominant party before each investment transaction during the 1994-1997 time period.	1	Firms that have experience with acquisitions may be biased towards acquisitions.
RELDIV	Dummy variable that takes the value of 1 if a firm possesses related products (i.e., products being sold in the same SIC code industry), 0 otherwise	1, 4	Firms with related products are more vulnerable to leakage of information and may have enough resources to not seek partners (Shan, 1990).
<u>Type of Business Transaction/Agreement</u>			
DD	Commercialization agreement	2	Low uncertainty expected with this agreement; easy to pinpoint the lacking resources and acquire them (Kogut, 1988).
MD	Manufacturing agreement	2	Low uncertainty expected with this agreement; easy to pinpoint the lacking resources and acquire them (Kogut, 1988).
SD	(Product or commodity) supply agreement	2	Low uncertainty expected with this agreement; easy to pinpoint the lacking resources and acquire them (Kogut, 1988).

RD	R&D agreement	2	R&D projects are highly uncertain; not easy to pinpoint the lacking resources and acquire them (Kogut, 1988).
<u>Other</u>			
SIM	Dummy variable that takes the value of 1 if the companies involved in the business transaction/agreement share the same SIC codes; 0 otherwise	4	As the similarity between partners increases, resource uncertainty is expected to decrease (Hitt et al., 1998; Sampson, 2007).

Table 2. Description and Expected Sign of the Variables for the Horizontal Agreements Analysis

Variable Name	Definition of the Variable	Proposition being tested	Explanation	Expected sign
<u>Industry Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>				
DV	Variance in industry sales for the 1994-97 time period	Control variable	Significant risks that may be shared.	+
SICR4	The four-firm industry concentration ratio	5b	A more concentrated industry may encourage firms to enhance market share (Hitt et al., 1998).	+
SIC200	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 200 -food manufacturing; and the value of 0 otherwise	Control variable	Food manufacturing has limited potential for proprietary knowledge; few risks that are outweighed by the benefits of agreements with other firms.	+
SIC286	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 286 -organic chemicals; and the value of 0 otherwise	Control variable	Organic chemicals is a mature industry with limited potential for proprietary knowledge; few risks that are outweighed by the benefits of agreements with other firms.	+
SIC519	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 519 -agricultural wholesaling; and the value of 0 otherwise	Control variable	Agricultural wholesaling has limited potential for proprietary knowledge; few risks that are outweighed by the benefits of agreements with other firms.	+
SIC873	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 873 -ag-biotechnology; and the value of 0 otherwise	Control variable	Ag-biotechnology is a growing industry with substantial risk associated with leakage of private information that would outweigh the benefits of agreements.	+
<u>Financial Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>				

DEBTRAT	Ratio of financial liabilities over total assets	Control variable	Dominant firms with high debt level cannot afford to acquire all the resources and need to ally.	+
INTLSALE	Ratio of sales to foreign markets over total sales for the year 1997	Control variable	Firms involved in many markets will have more difficulty finding a compatible partner.	-
TOTA	Total assets in 1997 (in thousand US dollars)	Control variable	Dominant firms with a large asset base may not have the need for allies except acquiring companies.	-
<u>Other Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>				
AGE	Age of the dominant firm in 1997	Control variable	Older firm may be more well-known and therefore represent fewer risks; makes them a more appealing partner.	+
CPALLNC	Difference between the number of business investment transactions of the dominant firm and the average number of business investment transactions completed by the rest of the rivals in the same industry (same SIC code) and included in the sample for the 1994-1997 time period	Control variable	Companies with experience in transactions have developed knowledge on how to evaluate the risk of opportunism.	+
CPAP94	Difference between the total number of patents before 1994 owned by the dominant firm and the average total number of patents before 1994 owned by the rest of the rivals in the industry included in the sample	Control variable	Accumulation of patents is a proxy for how many R&D agreements in which a firm has been involved. Because of risk of leakage of private information, we expect firms focusing in R&D to engage less in horizontal agreements.	-
EXPAC	Number of previous acquisitions completed by the dominant party before each investment transaction during the 1994-1997 time period.	Control variable	Firms that have experience with acquisitions may be biased towards acquisitions.	+

RELDIV	Dummy variable that takes the value of 1 if a firm possesses related products (i.e., products being sold in the same SIC code industry), 0 otherwise	Control variable	Firms with related products are more vulnerable to leakage of information; may only engage in a horizontal agreement if it's an acquisition.	-
<u>Type of Business Transaction/Agreement</u>				
DD	Commercialization agreement	Control variable	Low uncertainty and large benefits expected with this agreement.	+
MD	Manufacturing agreement	Control variable	Low uncertainty and large benefits expected with this agreement.	+
SD	(Product or commodity) supply agreement	Control variable	Low uncertainty and large benefits expected with this agreement.	+
RD	R&D agreement	Control variable	R&D projects are highly uncertain; risks outweigh the benefits.	-

Table 3. Discriminant Analysis Statistics for Variables by Level of Investment Commitment Transaction

Variable Name	Definition of the Variable	Minority-equity Agreements		Majority-equity Agreements	
		Mean	Std. Dev.	Mean	Std. Dev.
Industry Characteristics of the Dominant Firm in the Business Transaction/Agreement					
DV	Variance in industry sales for the 1994-97 time period	9.86	9.39	14.61	8.64
SICR4	The four-firm industry concentration ratio	50.25	21.55	47.57	19.99
SIC200	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 200 -food manufacturing; and the value of 0 otherwise	0.14	0.35	0.1	0.31
SIC286	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 286 -organic chemicals; and the value of 0 otherwise	0.46*	0.5*	0.63*	0.49*
SIC287	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 287 -agricultural chemicals; and the value of 0 otherwise	0.11	0.32	0.17	0.38
SIC519	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 519 -agricultural wholesaling; and the value of 0 otherwise	0.05*	0.22*	0.03*	0.18*
SIC873	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 873 -ag-biotechnology; and the value of 0 otherwise	0.23	0.42	0.07	0.25
Financial Characteristics of the Dominant Firm in the Business Transaction/Agreement					
DEBTRAT	Ratio of financial liabilities over total assets	38.41*	26.67*	42.88*	20.82*
INTLSALE	Ratio of sales to foreign markets over total sales for the year 1997	28.41	23.79	32.28	20.78
TOTA	Total assets in 1997 (in thousand US dollars)	5,031,327*	9,317,924*	8,990,229*	11,412,302*



Other Characteristics of the Dominant Firm in the Business Transaction/Agreement						
AGE	Age of the dominant firm in 1997	29.76	29.76	42.5	29.33	47
CPALLNC	Difference between the number of business investment transactions of the dominant firm and the average number of business investment transactions completed by the rest of the rivals in the same industry (same SIC code) and included in the sample for the 1994-1997 time period	2.17	3.82	1.68	3.75	1.
CPAP94	Difference between the total number of patents before 1994 owned by the dominant firm and the average total number of patents before 1994 owned by the rest of the rivals in the industry included in the sample	87.08*	1105.17*	1018.67*	1767.49*	109
EXPAC	Number of previous acquisitions completed by the dominant party before each investment transaction during the 1994-1997 time period.	0.44*	1.03*	0.86*	1.61*	2.
RELDIV	Dummy variable that takes the value of 1 if a firm possesses related products (i.e., products being sold in the same SIC code industry), 0 otherwise	0.6	0.49	0.47	0.51	0.
Type of Business Transaction/Agreement						
DD	Commercialization agreement	0.21*	0.41*	0.2*	0.41*	0.
MD	Manufacturing agreement	0.35*	0.47*	0.63*	0.49*	0.
SD	(Product or commodity) supply agreement	0.08	0.27	0.03	0.18	0.
RD	R&D agreement	0.46	0.5	0.3	0.47	0.
Other						
SIM	Dummy variable that takes the value of 1 if the companies involved in the business transaction/agreement share the same SIC codes; 0 otherwise	0.62	0.49	0.63	0.49	0.

\*Difference across type significant at the .05 level.

Table 4. Logistic Regression Results for Horizontal Agreements

**Dependent Variable:** SIM (takes value of 1 if transacting companies share same SIC code, 0 otherwise)

		Model Predictions:		
Observed:	0	1		Percent Correct:
0	205	56		78.61%
1	61	140		68.66%
	Overall:			74.27%

Variable Name	Definition of the Variable	$\beta$	$\text{Exp}(\beta)$
DV	Industry Characteristics of the Dominant Firm in the Business Transaction/Agreement		
	Variance in industry sales for the 1994-97 time period	-0.001***	0.98
SICR4	The four-firm industry concentration ratio	0.02***	1.01
SIC200	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 200 -food manufacturing; and the value of 0 otherwise	0.01	1.01
SIC286	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 286 -organic chemicals; and the value of 0 otherwise	-0.01	0.99

SIC519	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 519 - agricultural wholesaling; and the value of 0 otherwise	-1.21***	0.27
SIC873	Dummy variable that takes the value of 1 if the dominant firm bears the SIC code 873 - ag-biotechnology; and the value of 0 otherwise	-1.53***	0.18
<u>Financial Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>			
DEBTRAT	Ratio of financial liabilities over total assets	0.001***	1.01
INTLSALE	Ratio of sales to foreign markets over total sales for the year 1997	0	0.99
TOTA	Total assets in 1997 (in thousand US dollars)	0	1
<u>Other Characteristics of the Dominant Firm in the Business Transaction/Agreement</u>			
AGE	Age of the dominant firm in 1997	0.01*	1.01
CPALLNC	Difference between the number of business investment transactions of the dominant firm and the average number of business investment transactions completed by the rest of the rivals in the same industry (same SIC code) and included in the sample for the 1994-1997 time period	0.33	1.39

CPAP94	Difference between the total number of patents before 1994 owned by the dominant firm and the average total number of patents before 1994 owned by the rest of the rivals in the industry included in the sample	-0.07	0.93
EXPAC	Number of previous acquisitions completed by the dominant party before each investment transaction during the 1994-1997 time period.	-0.11**	0.79
RELDIV	Dummy variable that takes the value of 1 if a firm possesses related products (i.e., products being sold in the same SIC code industry), 0 otherwise	0.31	1.37
<u>Type of Business Transaction/Agreement</u>			
DD	Commercialization agreement	0.87	2.39
MD	Manufacturing agreement	0.54**	1.45
SD	(Product or commodity) supply agreement	0.26	1.29
RD	R&D agreement	0.72**	1.97
<u>Constant</u>			
		-2.98	0

\* Results are significant at the .1 level;

\*\* Results are significant at the .05 level;

\*\*\* Results are significant at the .01 level.