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Gautam Ray
University of Texas at Austin

Ling Xue
University of Texas at Austin

Bin Gu
University of Texas at Austin

Prabhudev Konana
University of Texas at Austin

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Gautam Ray
Department of Information, Risk and Operations Management
University of Texas at Austin
Gautam.Ray@mccombs.utexas.edu

Ling Xue
Department of Information, Risk and Operations Management
University of Texas at Austin
lingxue@mail.utexas.edu

Bin Gu
Department of Information, Risk and Operations Management
University of Texas at Austin
Bin.Gu@mccombs.utexas.edu

Prabhudev C. Konana
Department of Information, Risk and Operations Management
University of Texas at Austin
pkonana@mail.utexas.edu

Abstract

The literature in IS suggests that IT affects firms' vertical and horizontal boundaries. This research examines how the nature of firms' assets and information technology interact to influence the level of vertical integration and horizontal diversification. Using panel data from 2001 to 2004, the analysis suggests that the negative relationship between IT and vertical integration identified in the literature is attributable to IT's role in coordinating firms' tangible assets. On the other hand, the positive relationship between IT and firms' horizontal diversification is attributable to IT's role in leveraging a firm's intangible assets across different businesses. The analysis also indicates that for less vertically integrated firms, IT increases the contribution of tangible assets to performance. And for more diversified firms, IT may increase the contribution of intangible assets to performance. The general implication of this research is that firms with more tangible assets may use information technology to become more vertically specialized, whereas firms with more intangible assets may deploy information technology to become more horizontally diversified.

Keywords: Firm structure, information technology, vertical integration, diversification, tangible asset, intangible asset.

Introduction

Empirical studies in IS suggest that investments in IT are associated with a decrease in vertical integration (Hitt, 1999; Dewan et al., 1998). Similarly, Brynjolffson et al. (1994) show that IT is associated with a decrease in firm size. These studies suggest that firms are becoming more vertically specialized, where firms focus on a few activities and use IT to coordinate with vendors for other activities. Empirical studies in IS also suggest that IT investments are associated with an increase in horizontal scope as firms use IT to coordinate across different businesses/product markets. Hitt (1999), for example, finds that investments in IT are associated with an increase in diversification. Similarly Dewan et al. (1998) find that firms use IT to coordinate across related businesses, i.e., firms that are diversified across related businesses use more IT than firms diversifying across unrelated businesses. However, there is little research that explicates how IT influences firms to become more *or less* vertically integrated, or to become more *or less* horizontally diversified. In this research we investigate

how the nature of assets (i.e., tangible and intangible assets) interacts with IT to impact firms' vertical and horizontal scope.

A firm's assets can be classified into (i) tangible and (ii) intangible assets. The collection of raw materials, physical resources, and plant and equipment, comprise the tangible assets (Farjoun, 1998). Intangible assets, on the other hand, include human capital (the skill, expertise, and insights of its workforce), organizational capital (e.g. organizational culture, norms, and routines), technological capital (patents, trademarks, innovation capability), and relational capital (reputation, brand name, relationships with customers and suppliers) (Fernandez et al., 2000). This research examines how firms' tangible and intangible assets interact with IT to shape the vertical and horizontal scope of the firm. Further, this research explores the implications of the relationship between asset characteristics, firm scope, and information technology for firm performance.

The empirical analysis in this paper suggests that IT has a moderating effect on tangible assets in decreasing the level of vertical integration, and IT has a moderating effect on intangible assets in increasing the level of horizontal diversification. The rationale is that tangible assets are transaction-specific and have limited use. Therefore, firms use their tangible assets to specialize in a limited number of activities (for which they have the specialized asset), and use IT to coordinate with the external suppliers for other activities in the value chain. In contrast to tangible assets, intangible assets such as R&D capability, customer base, reputation, brand name, etc., though firm-specific, have multiple uses. Ghemawat and Sol (1998) refer to such assets as being firm-specific but usage-flexible. Firms use IT to leverage their intangible assets across different product markets, increasing their horizontal scope. Finally, the analysis suggests that for less vertically integrated firms, IT increases the contribution of tangible assets to performance. Similarly, for more diversified firms, IT increases the contribution of intangible assets to performance. The general implication of this research is that firms with more tangible assets may use IT to specialize vertically, whereas firms with more intangible assets may use IT to diversify into different businesses.

The rest of the paper is organized as follows. Section two develops the hypotheses, and section three describes the data and presents the operationalization of the variables. Section four presents the empirical analysis, and section five concludes with a discussion of the findings.

Hypotheses Development

Tangible Assets, Information Technology, and Vertical Integration

Firms possess a combination of tangible and intangible assets. If a firm's key assets are specialized physical plant and machinery, the firm may use these assets to produce one or more products. The firm-specific nature of these assets implies that firms have distinctive advantage when they focus on few activities and specialize to produce a narrow range of outputs. This is an issue about resource flexibility, i.e., how many different uses a firm-specific resource can be put to (Ghemawat and Sol 1998). The argument here is that physical assets are less flexible and, therefore, are useful in a narrower range of industries. Chatterjee (1986), for example, found no evidence of manufacturing/production related synergies in a collection of diversified firms. Farjoun (1998) also makes the point that physical resources are usually more product-specific than other resources, and such resources are limited in the range of industries to which they can be applied to. Additionally, there are physical limits, such as capacity constraints, to reusing tangible resources (Chatterjee and Wernerfelt, 1991).

Firms with specialized physical assets have the choice of coordinating more activities in vertically integrated organizations, or specializing in a narrow range of activities and coordinating more activities with external suppliers. As information technology facilitates coordinating with external suppliers, firms with specialized tangible assets may focus on the activities supported by their assets, and use information technology to coordinate with external specialists for other activities (Malone et al., 1987; Gurbaxani and Wang, 1991; Afuah, 2003; Brews and Tucci, 2004). Thus, information technology may interact with tangible assets to decrease vertical integration. Zenger and Hesterly (1997) refer to this as the infusion of hierarchical elements, such as monitoring and rich communication, into markets. Firms can use information technology to get the benefit of rich collaboration and tight coordination found within firms and at the same time have access to the scale and specialization of market suppliers.

Afuah (2003) examines external coordination from the perspective of suppliers and suggests that information technology can reduce asset specificity and make market exchanges more profitable. The point here is that firms can invest in specialized assets as information technology can reduce external coordination costs and enable them to find more users/customers for their output. Brews and Tucci (2004) also find that information technology is associated with a narrowing of vertical specialization. Thus, firms with specialized tangible assets focus on the key activities enabled by their asset and use information technology to find and coordinate with

customers. In this context, use of information technology is associated with increased specialization and a decrease in vertical integration.

As an illustration, in the electronics manufacturing industry firms like Cisco specialize on design and coordinate manufacturing with contract manufacturers like Solectron (Lee and Hoyt, 2001). Solectron uses capital intensive surface mount technology (SMT) to build printed circuit boards (PCB). In this case a Web-enabled extranet allows coordination between Solectron and its customers like Cisco. This organization of the value chain is beneficial for Cisco as well as for Solectron. On one hand, it allows Cisco to specialize on design and outsource manufacturing to a specialist like Solectron. On the other hand, this organization of the value chain enables Solectron to use the extranet to find and coordinate with the more number of customers that justifies the investment in the surface mount technology. The above discussion leads to the following hypothesis.

H1: In firms with more tangible assets, IT is likely to be associated with a greater decrease in vertical integration.

Intangible Assets, Information Technology, and Diversification

In contrast to tangible assets, intangible assets are more flexible. In the language of Ghemawat and del Sol (1998) intangible assets such as technology and brand name are firm-specific but usage flexible. Such intangible resources can be more easily leveraged across different businesses. Thus, intangible assets such as technology and brand, for example, form the basis for diversification (e.g. Lu and Beamish, 2004; Delios and Beamish, 2001). Similarly, Farjoun (1994) examines human skill and expertise and suggests that human resource similarity can serve as a basis for diversification. Also, another distinctive (w.r.t. tangible assets) characteristic of intangible assets is that they do not depreciate when employed in different markets (Lu and Beamish, 2004). Chatterjee and Wernerfelt (1991), for example, suggest that intangible assets have softer capacity constraints and are more flexible. Thus, intangible resources can be used repeatedly with little cost or depreciation of the original resource (Chatterjee and Wernerfelt, 1991). Finally, an individual's skills and insights are also distinguished from physical resources by the individual's ability to learn and to transfer knowledge from one domain to many others and to combine them in increasingly productive ways (Farjoun, 1998). Thus, intangible assets such as knowledge and expertise can in fact grow with use, recombination and sharing (e.g. Kogut and Zander, 1992; Nahapiet and Ghoshal, 1998). ,

In contexts where key assets are intangible assets such as information and knowledge about products, technologies, and customers, firms can use information technology to leverage these assets across different industries/businesses. For example, in banking, finance, and insurance industries, a firm's key assets are the knowledge of and relationships with its customers. A firm can use information technology to leverage these relationships to sell a variety of financial services to these customers. The role of technology here is to provide a platform for the firm to leverage its assets across different businesses. These arguments lead to the following hypotheses:

H2: In firms with more intangible assets, IT is likely to be associated with a greater increase in horizontal scope.

Performance Implications

A firm with specialized tangible assets may use information technology to specialize in a few activities when it is more advantageous to do so. In that case, though the firm performs fewer activities, it is likely to achieve higher performance than firms that do not organize their vertical chain in such a manner. This is likely as firms are able to concentrate on activities in which they have a scale or specialization advantage, and coordinate with specialists for other activities (Prahalad and Hamel, 1990; Hamel and Prahalad, 1992). Thus, firms with specialized tangible assets may use information technology to organize their activities in less vertically integrated firms, and such an organization of the value chain is likely to be associated with an increase in firm performance. However, since tangible assets have limited variety of uses, tangible assets cannot be leveraged across different businesses. Chatterjee (1986), for example, found that tangible assets did not improve performance in diversified organizations. Similarly, St. John and Harrison (1999) found that manufacturing relatedness does not lead to superior performance in diversified firms. Thus, the use of information technology to specialize with tangible assets in a limited number of activities in the value chain is likely to be associated with an increase in performance.

In contrast to tangible assets, returns from intangible assets are greater when the scope of use of the intangible asset is greater. Thus, one way to exploit intangible assets is to use them in a broader range of markets/industries (Teece, 1980). Empirical studies show that intangible assets are associated with improved performance in multi-business firms (Carmeli and Tishler, 2004; Delgado-Gomez et al., 2004; Tanriverdi and Venkatraman, 2005). Roberts and Dowling (2002), for example, examine the impact of corporate reputation and find that good

corporate reputation is associated with persistent above-average profits. If a firm is able to use information technology to leverage its intangible assets across different businesses, it may be able to generate more value from its intangible assets than firms that do not leverage their intangible assets in that manner. Using information technology to exploit intangible assets across different businesses may also give rise to increasing returns (Teece, 1998). These arguments lead to the following hypotheses:

H3: Use of IT to coordinate tangible assets in less vertically integrated firms is associated with an increase in performance.

H4: Use of IT to leverage intangible assets across different businesses / product markets is associated with an increase in performance.

Data and Sample

In this study, we combine data from three primary sources. First, we derive a proxy for IT-intensity from the *CI Technology Database* from Harte-Hanks. This database contains information about the technology infrastructure in over 500,000 sites in the United States and Canada. Harte-Hanks maintains this database through over 7,000 phone-based interviews every month. The information in the database covers 10 key technology areas, including personal computing, systems and servers, networking, software, storage, managed service, etc. Based on this database, we adopt the number of PCs per employee as a proxy for IT-intensity of the firm (Mahmood and Mann, 1993).[1] Second, we obtain (tangible and intangible) assets and performance information from the COMPUSTAT database. Third, we measure firms' vertical integration and horizontal diversification using data from the COMPUSTAT segment database and the Input-Output tables from the Bureau of Economic Analysis (BEA). We also use COMPUSTAT segment database to calculate industry-level variables such as concentration and demand uncertainty. Our panel dataset contains 2183 observations, which cover 745 unique firms over a four-year period from 2001 to 2004. All of these firms are Fortune 1000 companies.

Tangible and Intangible Assets

We adopt PPE (plant, property, and equipment) as the measure of physical assets that are used in production processes (Konar and Cohen, 2001). These tangible assets are the key assets used in production/service operations.[2] Regarding intangible assets, we consider three different measures for intangible assets. First, we consider R&D expenditure (*RND*) as a proxy for technology and R&D capability of the firm (Stimpert and Duhaime, 1997; Hitt et. al., 1997). Second, we use advertising expenditure (*ADV*) as a proxy for brand name and goodwill (Lu and Beamish 2004).[3] We adopt a third measure to capture other intangible assets that are not captured by *RND* and *ADV*. In doing so, we first use the following measure to capture the difference between the firm's book value and its market value,

$$MVI = \frac{MV + PS + DEBT - TA}{TA}$$

where *MV*=(Closing price of share at the end of financial year) × (Number of common shares outstanding), *PS*= Preferred stock, *DEBT*=Short term debt + Long term debt, *TA*=Book value of total asset. Note that *MVI* is essentially equivalent to the firm's Torbin's q (e.g. Wernerfelt & Montgomery 1988; Lang and Stulz 1994; Bharadwaj et. al., 1999).[4] It captures the extra intangible value of the firm that has not been included in the book value but is identified by the market. Therefore, we call it *market-valued intangible assets* (*MVI*). Since *MVI* may already incorporate the impact of advertising and R&D, we use *residual MVI* as the variable in the empirical analysis. That is, we remove the variance in the *MVI* contributed to by advertising and R&D, and use

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[1] In order to ensure the robustness of the empirical analysis, we also use several alternative measures such as the number of servers per employee, number of LAN nodes per employee, etc. These alternative operationalizations of IT produce very consistent results.

[2] We do not consider inventory, short-term investment, and receivables, which may be also considered as part of tangible assets in some situation (Konar and Cohen, 2001).

[3] As recognized in the prior literature (e.g. Bharadwaj 1999), a number of firms in COMPUSTAT have missing values for their advertising and R&D expenditures. Following this literature, we replace the missing values with their industry means.

[4] Tobin's q has been used in many studies as a measure reflecting intangible assets (Hall, 1993; Hirschey, 1982; Megna & Klock, 1993).

the residual as a measure of intangible asset.[5] In this way, residual *MVI* is a measure of intangible assets not captured by advertising and R&D investment.

Vertical Integration

To assess firms' vertical integration (*VI*), we employ the measure used in Fan and Lang (2000). This measure uses the aggregate Input-Output (IO) Use table from Bureau of Economic Analysis to capture the input-output interdependencies between the firm's primary segment and its secondary segments. This VI measure is similar in nature to other VI measures used in prior studies (e.g. D'Aveni and Ravenscraft, 1994; Maddigan, 1981).[6] The following three steps are used to calculate the VI measure. First, we identify the primary segment (the 4-digit-NAICS segment with the highest sales) from the COMPUSTAT Segment database and all the other secondary segments for each firm. Second, we calculate the vertical relatedness between each secondary segment and the primary segment based on the Input-Output (IO) table from the Bureau of Economic Analysis. Specifically, the vertical relatedness between a secondary segment in industry *j* and a primary segment in industry *i*, denoted as V_{ij} , is calculated as

$$V_{ij} = 1/2 \left(a_{ij}/T_j + a_{ji}/T_i \right)$$

where a_{ij} denotes the dollar value of industry *i*'s output required to produce industry *j*'s total output, and T_j denotes the industry *j*'s total output. If the two segments have strong make-buy relationship according to the material flow data in the IO table, they will have a high value of vertical relatedness. Third, based on the calculation from the first two steps, we assess each firm's VI using the following formula:

$$VI = \sum_j W_j V_j$$

where W_j is the ratio of the *j*th secondary segment's sales to the total sales of all the secondary segments. If a firm's secondary segment(s) has (have) very strong vertical relatedness with its primary segment, e.g. a car manufacturer with a secondary segment that produces tires, then the firm will a high VI index and will be regarded as being highly vertical integrated.

Horizontal Diversification

We consider three different measures of diversification: (i) horizontal complementarity; (ii) related diversification; (iii) unrelated diversification. Following Fan and Lang (2000), horizontal complementarity (*HC*) is calculated using the following three-step processes. First, from the I-O Use table, for each industry *i*, we compute the percentage of its output supplied to each intermediate industry *k*, denoted as b_{ik}. Then, for each pair of industries *i* and *j*, we calculate the correlation coefficient between b_{ik} and b_{jk} across all *k* except for *i* and *j*. Second, for each industry we calculate the percentage of its input from each intermediate industry *k*, denoted as d_{ik}. For each pair of industries *i* and *j*, we then calculate the correlation coefficient between d_{ik} and d_{jk} across all *k* except for *i* and *j*. The complementarity coefficient between industry *i* and *j*, denoted by C_{ij}, is calculated as the average of the two correlation coefficients, i.e.,

$$C_{ij} = 1/2 \left(corr \left(b_{ik}, b_{jk} \right) + corr \left(d_{ik}, d_{jk} \right) \right)$$

Finally, we assess each firm's HC using the following formula:

$$HC = \sum_j W_j C_j$$

---

[5] We run a regression of *MVI* on advertising and R&D, and use the residuals as a measure of market-valued intangible asset.

[6] One drawback of the VI measure in Maddigan (1981) is that it does not capture the level at which a firm participates in a specific industry. For example, a car manufacturer will report the same VI value no matter whether its tire factory supplies 1% or 100% of the tires for its car factory. In contrast, the VI measure in Fan and Lang (2000) captures the information regarding the industry shares in the intermediate goods markets to calculate vertical integration. Therefore, we adopt the latter VI measure.

where C_j is the complementarity coefficient between the jth secondary segment and the primary segment, and W_j is the ratio of the jth secondary segment's sales to the total sales of all the secondary segments. Intuitively, horizontal complementarity measures the commonality between segments on the input and the output side. If two segments have common inputs, then they can share common buying processes. Similarly, if two segments have common outputs, they can sell to the same sets of consumers and use the same distribution channels. Thus, if a firm has high horizontal complementarity, it implies that its various segments can share common buying and selling processes.

We employ the entropy measures as in Palepu (1985) to calculate related diversification (*DR*) and unrelated diversification (*DU*). Related diversification captures the extent to which a firm's output is distributed within industry groups in the same 2-digit NAICS code. Unrelated diversification captures the extent to which a firm's output is distributed across unrelated industry groups. If a firm participates in N 4-digit industries which can be grouped as M 2-digit industry groups, then the firm's diversification can be measured as

$$DR = \sum_{j=1}^{M} p^j \sum_{i=1}^{N_j} p_i^j \ln\left(1/p_i^j\right); \; DU = \sum_{j=1}^{M} p^j \ln\left(1/p^j\right)$$

where N_j is the number of 4-digit industries within the 2-digit industry group j that the firm participates in, p_i^j is the share of the segment i of group j in the total sales of the firm, and $p^j = \sum_{i \in j} p_i^j$ is the share of the jth group's sales in the total sales of the firm. One weakness of the entropy measures is that they do not directly capture the input-output interdependency between industries. Thus, our use of the *HC* measure bridges this gap. Note that although both the *HC* measure and the *DR* measure capture related diversification, they capture different aspects of relatedness. *HC* captures process relatedness, i.e., how the primary segment and secondary segments can share related buying and selling processes. In contrast, *DR* captures the relatedness of product markets for different segments. Therefore, we incorporate both of these two diversification measures.

Firm Performance

We adopt return on asset (ROA), as the measure of firm performance (e.g. Lu and Beamish, 2004; Hitt et. al., 1997; Stimpert and Duhaime, 1997; Hitt and Brynjolfsson, 1996).[7] Table 1a and Table 1b present descriptive statistics and the correlations between the key variables in the study.

Table 1a: Descriptive Statistics of Key Variables		
	Mean	Std.
VI (Vertical Integration)	0.07	0.10
HC (Horizontal Complementarity)	0.55	0.41
DR (Related Diversification)	0.17	0.31
DU (Unrelated Diversification)	0.15	0.26
IT (PC per employee)	0.29	0.42
PPE (Plant, Property, Equipment by Sales)	0.37	0.49
ADV (Advertising by Sales)	0.03	0.08
RND (R&D by Sales)	0.03	0.09
MVI (Market-valued Intangible Asset)	0.39	1.03
ROA (Return on Asset)	0.05	0.22

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[7] We also use the ratio of net income to asset for robustness check and obtain largely consistent results.

Table 1b: Correlations Between the Key Variables									
	VI	*HC*	*DR*	*DU*	*IT*	*PPE*	*AD*	*RD*	*MVI*	*ROA*
VI	1									
HC	0.55***	1								
DR	0.08***	0.22***	1							
DU	-0.09***	-0.07***	0.01	1						
IT	0.07***	0.01	0.01	-0.04**	1					
PPE	-0.06***	0.01	-0.02	0.04**	0.09***	1				
ADV	0.03	0.02	0.01	-0.04*	0.29***	0.08***	1			
RND	0.04*	-0.01	-0.04**	-0.01	0.11***	0.05**	0.17***	1		
MVI	-0.11***	-0.09***	-0.08***	-0.08***	-0.10***	-0.12***	0.01	0.20***	1	
ROA	-0.04**	-0.05**	-0.04**	-0.01	0.05**	-0.07***	-0.03	-0.09***	0.19***	1

Note: (1) Pearson Correlation Coefficients are reported; (2) * $p<0.1$, ** $p<0.05$, *** $p<0.01$

Control Variables

In the scope models, we use several variables to control for industry- and firm-level effects. First, we include industry-level control variables such as concentration (*Con*), dynamism (*Dyn*), munificence (*Mun*), and capital intensity (*Cap*). For example, firms in concentrated industries are likely to be more vertically integrated (Balakrishnan and Wernerfelt 1986). Similarly, industry-level characteristics such as dynamism, munificence, and capital intensity are expected to influence firms' choice of diversification level (Keats and Hitt, 1988; Chatterjee and Singh, 1999). All of these industry-level control variables are calculated using COMPUSTAT segment database. Dynamism and munificence are calculated following the procedure in Keats and Hitt (1998). Concentration is measured as the ratio of the total sales of the top four firms in the industry to industry sales. Capital intensity is calculated as the total industry assets divided by total industry sales. For each multisegment firm, the values of these variables are weighted by sales across all industries the firm participates in. Second, we include firm-level control variables such as capital investment (*Cin*) measured as total invested capital divided by total assets, and the firm's capital age (*Age*) measured as ((Gross PPE – Net PPE)/(Depreciation)). Firms with large capital investments may have more capabilities to diversify into different businesses (Stimpert and Duhaime, 1997). Similarly, older and more established firms may have more experience and accumulated capabilities to diversify into different businesses (Dierickx and Cool, 1989).

In the performance model, we also use several variables to control for industry- and firm-level effects. First, we include industry-level control variables such as concentration, dynamism, munificence, capital intensity (Keats and Hitt, 1988; Bharadwaj et al. 1999), and exposure to foreign competition (*ExIm*) measured as the total value of industry-level exports and imports. We also include industry average return on assets (*IROA*) to control for other industry effects. Second, we include firm-level control variables such as capital investment, debt-to-equity ratio (*DEQ*) measured as sum of long-term and short-term debt divided by the book value of total equity; and market share (*MKS*) measured as firm sales as a percentage of industry sales at the primary four-digit NAICS industry level. As identified in prior studies (e.g. Lu and Beamish 2004; Hitt, et. al., 1997; Stimpert and Duhaime, 1997; Hitt and Brynjolfsson 1996), these variables may affect firm performance.

Finally, in all the models, we use the number of employee (*EMP*) as a control variable for firm size and use three year dummy variable (*Y01*, *Y02*, and *Y03*) to control for year-specific effects.

Instrument Variables

As discussed below, we adopt a simultaneous equations model and conduct a 2-stage least square (2SLS) analysis. Therefore, we use a set of instrument variables in our estimation of IT intensity and firm scope. First, to estimate IT intensity, we use an instrument variable that captures the average industry-level IT-intensity for the 3-digit NAICS industries that the firm participates in. The industry-level IT-intensity is calculated as the IT capital ratio of each industry the firm participates in, weighted by its sales in that industry. We obtain industry-level IT capital ratio information from the *Current-Cost Investment in Private Nonresidential Fixed Assets Table* from Bureau of Economic Analysis. Industry-level IT capital ratio is the ratio of computers and peripheral equipment and software, to the value of total assets. Second, we use a set of instrument variables that reflect the exogenous environment of IT investment, including industry-level operating surplus, tax on production, the ratio

of the material input to energy input, and the ratio of the service input to energy input (Bartelsman et. al., 1994; Hitt, 1999). This is due to the assumption that the firms' IT investment is expected to be higher in industries with higher operating surplus, lower tax rates, and higher material and service inputs. All of these industry-level data is obtained from Bureau of Economic Analysis. Third, to estimate firm scope variables, we use a set of dummy variables for each 2-digit industry that the firm participates in (Wernerfelt & Montgomery 1988; Hitt 1999).

Model

Vertical and horizontal scope and IT investments are firms' endogenous choices, as firms may choose their IT level depending on their scope and their scope depending on their IT (Hitt, 1999). Therefore, we estimate a simultaneous equations model (SEM) rather than an OLS model. Hausman tests on our dataset also show that IT intensity and firm scope are endogenous, thus rejecting the OLS estimation in favor of two-stage least squares (2SLS). The simultaneous equation model is defined as follows.

$$
\begin{aligned}
FS_i = \beta_0 &+ \beta_1 PPE_i + \beta_2 ADV_i + \beta_3 RND_i + \beta_4 MVI_i + \beta_5 IT_i + \beta_6 IT_i \times PPE_i + \beta_7 IT_i \times ADV_i \\
&+ \beta_8 IT_i \times RND_i + \beta_9 IT_i \times MVI_i + \beta_{10} Emp_i + \beta_{11} Cin_i + \beta_{12} Age_i + \beta_{13} Con_i + \beta_{14} Dyn_i \\
&+ \beta_{15} Mun_i + \beta_{16} Cap_i + \beta_{17} Y01_i + \beta_{18} Y02_i + \beta_{19} Y03_i + \varepsilon_i
\end{aligned}
\tag{1}
$$

$$
\begin{aligned}
IT_i = \beta_0 &+ \beta_1 PPE_i + \beta_2 ADV_i + \beta_3 RND_i + \beta_4 MVI_i + \beta_5 VI_i + \beta_6 HC_i + \beta_7 DR_i + \beta_8 DU_i \\
&+ \beta_9 Emp_i + \beta_{10} Cin_i + \beta_{11} Age_i + \beta_{12} Con_i + \beta_{13} Dyn_i + \beta_{14} Mun_i \\
&+ \beta_{15} Cap_i + \beta_{16} Y01_i + \beta_{17} Y02_i + \beta_{18} Y03_i + \varepsilon_i
\end{aligned}
\tag{2}
$$

$$
\begin{aligned}
ROA_i = \beta_0 &+ \beta_1 PPE_i + \beta_2 ADV_i + \beta_3 RND_i + \beta_4 MVI_i + \beta_5 IT_i + \beta_6 VI_i + \beta_7 HC_i + \beta_8 DR_i + \beta_9 DU_i \\
&+ \beta_{10} IT_i \times PPE_i + \beta_{11} IT_i \times ADV_i + \beta_{12} IT_i \times RND_i + \beta_{13} IT_i \times MVI_i + \beta_{14} Emp_i \\
&+ \beta_{15} Cin_i + \beta_{16} Deq_i + \beta_{17} Mks_i + \beta_{18} Con_i + \beta_{19} Dyn_i + \beta_{20} Mun_i + \beta_{21} Cap_i + \beta_{22} Ex\,Im_i + \beta_{23} IROA_i \\
&+ \beta_{24} Y01_i + \beta_{25} Y02_i + \beta_{26} Y03_i + \varepsilon_i
\end{aligned}
\tag{3}
$$

where $FS_i = \{VI_i,\ HC_i,\ DR_i,\ DU_i\}$ represents the vertical integration and diversification levels. Equation 1 captures how IT influences firm scope (i.e., vertical integration, horizontal complementarity, and total diversification). The coefficients of the interaction terms between IT and different assets capture how IT moderates the impact of different assets on firm scope. Equation 2 captures how firms' vertical integration and diversification level influence the choice of IT intensity.

Equation 3 captures how firm scope and information technology influence firm performance. We split the sample into two groups by using the predicted value of scope variables. For example, we split the sample into *High-VI* and *Low-VI* groups. Observations in the *High-VI* (*Low-VI*) groups have predicted VI values above (below) the mean value. For each group, we examine the difference between the coefficient of the *IT×PPE* interaction terms across the two groups to study how the impact of the IT and tangible asset interaction affects performance differently. Similarly, we also split the sample into High- and Low- diversification groups, and examine the difference in the impact of IT and intangible asset interaction on performance across the groups.

Results

Firm Scope

Table 2 presents the results of the simultaneous equations model (equation 1). The four columns of Table 2 correspond to one measure of vertical scope and three measures of horizontal scopes. We start with consider the moderating effect of IT with asset characteristics on vertical scope. In column 1, the coefficient of the *IT×PPE* interaction term is negative and significant ($p<0.01$). This suggests that IT enables firms with more tangible assets to further decrease their vertical integration. This is consistent with hypothesis 1.

We now consider the moderating role of IT on horizontal scopes. In the results for *HC*, the coefficient of the *IT×MVI* interaction term is positive and significant ($p<0.01$). However, the coefficients of *IT×ADV* and

IT×RND interaction terms are not significant. This suggests that IT enables firms with larger market-valued intangible assets to further increase their horizontal complementary. This is consistent with hypothesis 2.

In the *DR* model, the coefficients of the *IT×ADV* and *IT×MVI* interaction terms are positive and significant ($p<0.05$ and $p<0.01$, respectively). However, the coefficient of the *IT×RND* interaction term is not significant. This analysis provides some evidence that IT enables firms with larger brand and market-valued intangible assets to further increase their related diversification. This is consistent with hypothesis 2.

Finally, in the *DU* model, the coefficient of the *IT×MVI* interaction term is positive and significant ($p<0.01$). However, the coefficients of the *IT×ADV* and *IT×RND* interaction terms are not significant. This analysis provides some evidence that IT enables firms with larger market-valued intangible assets to further diversify across unrelated businesses. This is consistent with hypothesis 2.

Table 2: Simultaneous Equations Model on IT and Firm Scope								
	VI		HC		DR		DU	
PPE	-0.14***	(-7.68)	-0.10***	(-4.71)	-0.11***	(-4.91)	0.04	(1.38)
ADV	0.07**	(2.00)	-0.23***	(-4.92)	-0.27***	(-5.75)	-0.18***	(-3.05)
RND	0.03*	(1.84)	-0.04	(-1.64)	0.05**	(2.26)	0.03	(0.99)
MVI	-0.11***	(-6.57)	-0.11***	(-5.48)	-0.07***	(-3.33)	-0.07***	(-2.62)
IT	-0.02	(-0.40)	0.81***	(12.28)	0.83***	(12.50)	0.23***	(2.74)
IT×PPE (β_6)	-0.12***	(-7.28)	-0.04**	(-2.10)	0.02	(1.08)	0.03	(0.92)
IT×ADV (β_7)	0.02	(0.47)	0.01	(0.28)	0.09**	(2.16)	0.06	(1.16)
IT×RND (β_8)	0.06	(1.46)	0.01	(0.30)	-0.07	(-1.45)	0.03	(0.53)
IT×MVI (β_9)	0.09***	(3.05)	0.11***	(3.12)	0.15***	(4.18)	0.10**	(2.16)
Emp	0.09**	(2.55)	0.75***	(16.89)	0.96***	(21.24)	0.25***	(4.28)
Cin	-0.09***	(-5.44)	0.001	(0.05)	0.05**	(2.55)	0.04	(1.38)
Age	0.05***	(3.73)	0.07***	(3.93)	0.26***	(14.45)	0.05**	(2.16)
Con	-0.55***	(-27.37)	-0.28***	(-11.2)	0.20***	(8.02)	0.10***	(2.95)
Dyn	0.51***	(28.34)	-0.15***	(-6.78)	-0.31***	(-13.4)	0.04	(1.43)
Mun	-0.0002	(-0.02)	-0.07***	(-3.45)	-0.05**	(-2.43)	0.01	(0.30)
Cap	0.06***	(3.98)	0.11***	(5.86)	0.13***	(6.88)	-0.06**	(-2.36)
Y01	0.18***	(9.02)	-0.07***	(-2.75)	-0.04	(-1.57)	0.08**	(2.39)
Y02	0.12***	(5.96)	-0.12***	(-4.92)	-0.08***	(-3.29)	0.04	(1.15)
Y03	-0.04**	(-2.15)	-0.02	(-1.17)	-0.02	(-0.73)	0.03	(1.20)
R^2	0.636		0.429		0.418		0.04	
F	199.04***		85.65***		81.68***		4.85***	
N	2813		2810		2813		2813	

Note: (1) Standardized coefficients are reported; (2) t-statistics are in parenthesis; (3) * $p<0.1$, ** $p<0.05$, *** $p<0.01$

Performance Implication

The analysis examining the performance implications of the IT and assets interactions is presented in Table 3. First, we study the subgroup analysis based on sample split using *VI*. The coefficient of *IT×PPE* interaction term in the *Low-VI* group is positive and significant ($p<0.01$) and that in the *High-VI* group is positive but not significant. A t-test indicates that the difference between these two coefficients is significant ($p<0.05$). This suggests that for less vertically integrated firms, IT enhances the performance contribution of tangible assets. This is consistent with hypothesis 3.

In the subgroup analysis based on sample split using *HC*, the coefficient of the *IT×MVI* interaction term is negative and significant ($p<0.1$) in the *Low-HC* group but is positive and not significant in the *High-HC* group. A t-test indicates that the difference between these two coefficients is significant ($p<0.01$). Therefore, the moderating role of IT on the contribution of market-valued intangible assets on performance is higher for more diversified firms. This is consistent with hypothesis 4. However, the difference between the coefficients of *IT×ADV* and *IT×RND* interaction terms across *High-HC* and *Low-HC* groups are not significant.

In the *DR* model, the coefficient of the *IT×ADV* interaction term in the *Low-DR* group is negative and that in the *High-DR* group is positive. A t-test indicates that these two coefficients are significantly different ($p<0.01$). This suggests that in firms with higher related diversification, IT may increase the contribution of brand to performance. This is consistent with hypothesis 4. However, the coefficient of the *IT×RND* interaction term in the *Low-DR* group is positive and significant ($p<0.05$), and that in the *High-DR* group is negative and not significant. A t-test indicates that these two coefficients are significantly different ($p<0.01$). This suggests that in

firms with lower related diversification, IT may increase the contribution of technological capability to performance. Also, the coefficients of the *IT×MVI* interaction terms across the *High-DR* and *Low-DR* groups are not significantly different. Thus, the analysis with *RND* and *MVI* also does not support hypothesis 4.

In the subgroup analysis based on sample split using *DU*, the coefficients of the *IT×MVI* interaction terms in the *Low-DU* group and the *High-DU* group are both negative and not significant. However, a t-test indicates that the coefficient of the *IT×MVI* interaction term in the *High-DU* group is significantly higher ($p<0.05$) than that in the *Low-DU* group. Similarly, the coefficient of the *IT×RND* interaction term in the *High-DU* group is positive and significant ($p<0.05$), but that in the *Low-DU* group is not significant. A t-test indicates that these two coefficient are significantly different ($p<0.05$). This may suggest that in firms with higher unrelated diversification, IT increases the contribution of technological capability and market-valued intangible assets on performance. This is consistent with hypothesis 4. In contrast, the coefficient of the *IT×ADV* interaction term in the *High-DU* group is negative and significant ($p<0.05$), but that in the *Low-DU* group is not significant. A t-test indicates that these two coefficients are significantly different ($p<0.01$). This suggests that in firms with higher unrelated diversification, IT may decrease the contribution of brand to performance.

Table 3: Group Analysis on Performance								
	Sample Split by VI		Sample Split by HC		Sample Split by DR		Sample Split by DU	
	Low VI	High VI	Low HC	High HC	Low DR	High DR	Low DU	High DU
PPE	-0.14***	-0.13***	-0.04	-0.12***	-0.08	-0.16***	-0.11***	-0.16***
ADV	0.01	-0.10	-0.04	-0.16*	-0.04	-0.37**	-0.17*	0.02
RND	-0.25***	-0.15***	-0.20**	-0.16***	-0.22***	-0.13***	-0.10***	-0.20***
MVI	0.52***	0.08**	0.17***	0.26***	0.20***	0.29***	0.19***	0.37***
IT	0.06	0.04	-0.13	0.29**	-0.06	0.42**	0.14	0.16
VI	-0.03	0.01	0.05	0.11*	0.09	0.08*	0.15*	0.12**
HC	-0.06	0.02	-0.03	0.04	-0.08	0.01	0.03	-0.08*
DR	0.05	-0.02	0.13**	-0.03	0.06	0.04	0.02	-0.06
DU	-0.01	0.02	-0.02	0.01	0.02	0.01	-0.05	0.04
IT×PPE (β_9)	0.14***	0.07	0.01	0.12***	0.03	0.17***	0.05	0.14***
IT×ADV (β_{10})	-0.17***	0.18*	-0.04	-0.02	-0.04	0.12	0.04	-0.11**
IT×RND (β_{11})	0.43***	-0.31***	0.11	0.06	0.18**	-0.07	0.01	0.11**
IT×MVI (β_{12})	0.12**	-0.28***	-0.12*	0.002	-0.06	-0.08	-0.09	-0.002
Emp	0.13	-0.02	-0.19	0.19**	-0.11	0.34***	-0.003	0.23
Cin	0.14***	0.31***	-0.07	0.50***	0.01	0.64***	0.29***	0.25***
Deq	0.005	0.01	0.01	-0.02	0.01	-0.04	-0.01	0.01
Mks	0.001	0.07	-0.001	0.04	0.02	-0.06	0.03	0.05
Con	-0.04	-0.01	-0.12	0.06	-0.10	0.17***	0.08	-0.03
Dyn	-0.04	-0.01	-0.02	0.02	-0.04	-0.02	-0.06	0.01
Mun	0.04	0.04	0.03	0.03	0.02	-0.02	0.03	0.05
Cap	-0.05	0.02	-0.06	0.05*	-0.04	0.06**	0.01	0.04
ExIm	0.03	-0.02	-0.06	-0.02	-0.02	-0.04	-0.10	0.01
IROA	0.02	0.03	0.01	0.04*	0.02	0.02	0.03	0.01
Y01	-0.18***	-0.09	-0.09	-0.07	-0.09*	-0.10**	-0.10**	-0.14**
Y02	-0.12***	-0.06	-0.06	-0.05	-0.08*	-0.04	-0.06	-0.15**
Y03	-0.06*	0.05	0.03	0.01	0.03	-0.02	0.04	-0.05
R^2	0.339	0.127	0.068	0.310	0.067	0.477	0.119	0.289
F	21.10***	5.96***	2.28***	22.70***	3.08***	35.62***	7.32***	11.32***
N	1095	1088	849	1334	1117	1066	1433	750

Discussions and Conclusion

Prior work (e.g. Hitt, 1999; Dewan et al., 1998) has suggested that IT leads to changes in firm's vertical and horizontal scope. The purpose of this research is to examine how the nature of firms' assets interacts with IT to impact vertical and horizontal scope. The analysis in this paper suggests that the negative relationship between IT and vertical integration discussed in the literature is largely attributable to the role of IT in coordinating firms' tangible assets. On the other hand, the positive relationship between IT and firms' horizontal complementary and diversification is mainly attributable to the role of IT in leveraging firms' intangible assets

across diversified businesses. Thus, the primary contribution of this study is that it complements the existing literature by offering a structural explanation of the relationship between IT and firm boundaries.

The second contribution of this research is to examine the impact of the relationship between IT and firm scope on performance. We investigate whether IT moderates the contribution of tangible and intangible assets on performance differently in firms with different levels of vertical integration and diversification. The analysis suggests that IT is likely to increase the contribution of tangible assets on performance in less vertically integrated firms. The implication is that the economics of specialization (i.e., the benefit of being less vertically integrated) can be attributed to the focus on the activities enabled by the tangible asset and better external coordination using IT. Also, the analysis indicates that IT is likely to increase the contribution of intangible assets on performance in more diversified firms. The implication here is that the economics of scope (i.e., the benefit of being more horizontally diversified) can be attributed to being able to use IT to leverage intangible assets across different product markets. The general implication of this research is that firms with more tangible assets will use IT to specialize, whereas firms with more intangible assets will use IT to diversify into different businesses.

This study also provides several directions for future research. For example, this analysis suggests that the interaction between IT and different types of intangible assets may have different performance impacts on in diversified firms. For example, Table 3 indicates that the $IT \times ADV$ interaction has a higher impact on performance for related diversified firms, and a lower impact on performance for unrelated diversified firms. In contrast, the $IT \times RND$ interaction has a higher impact on performance for unrelated diversified firms, and a lower impact on performance for related diversified firms. This suggests that IT may enable firms to benefit from leveraging their brand across related businesses, whereas IT may enable firms to benefit from leveraging their technological capabilities across unrelated markets. Such difference in the impact of IT deserves future research. Also, Table 3 indicates that the main effects of tangible assets on performance are lower in diversified firms. However, the interaction between IT and tangible assets has significant positive impact on performance in more diversified firms (i.e., the coefficients of $IT \times PPE$ interaction terms are positive and significant in *High*-diversification groups). This suggests that the IT may moderate the negative impact of the specificity of tangible assets on performance in diversified firms. Future research can also develop theoretical explanation and conduct more specific empirical examination on this issue.

References

Afuah, A. "Redefining Firm Boundaries in the Face of the Internet: Are Firms Really Shrinking?," *Academy of Management Review*, 2003 (28:1), pp. 34-53

Balakrishnan, S., Wernerfelt, B. "Technical Change, Competition, and Vertical Integration Strategies," *Strategic Management Journal* (7), 1986, pp. 347-359

Bartelsman, E. J., Caballero, R. J., Richard K. Lyons. "Customer- and Supplier-Driven Externalities," *American Economic Review* (84:4), 1994, pp. 1075-1084

Bharadwaj, A. S., Bharadwaj, S. G., and Konsynski, B. R. "Information Technology Effects on Firm Performance as Measured by Tobin's *q*", *Management Science* (45:6), 1999, pp. 1008-1024

Brews, P. J., Tucci, C. L. "Exploring The Structural Effects of Internetworking," *Strategic Management Journal* (25), 2004, pp. 429-451

Brynjolfsson, E., Malone, T. W., Gurbaxani, V., Kambil, A. "Does Information Technology Lead to Smaller Firms?," *Management Science* (40:12), 1994, pp. 1628-1644

Carmeli, A., Tishler, A. "The Relationship Between Intangible Organizational Elements and Organizational Performance," *Strategic Management Journal* (25), 2004, pp. 1257-1278

Chatterjee, S. "Types of synergy and economic value: The impact of acquisitions on merging and rival firms," *Strategic Management Journal* (7:2), 1986, pp. 119-139

Chatterjee, S., Singh, J. "Are Tradeoffs Inherent in Diversification Moves? A Simultaneous Model for Type of Diversification and Mode of Expansion Decisions," *Management Science* (45:1), 1999, pp. 25-42

Chatterjee, S., Wernerfelt, B. "The Link Between Resources and Type of Diversification: Theory and Evidence," *Strategic Management Journal* (12), 1991, pp. 33-48

D'Aveni, R., Ravenscraft, D. J. "Economies of Integration versus Bureaucracy Costs: Does Vertical Integration Improve Performance?" *Academy of Management Journal* (37:5), 1994, pp. 1167-1206

Delgado-Gomez, J. M., Ramirez-Aleson, M., Espitia-Escuer, M. A. "Intangible Resources as a Key Factor in the Internationalization of Spanish Firms," *Journal of Economic Behavior & Organization* (53), 2004, pp. 477-494

Delios, A., Beamish, P. W., "Geographic Scope, Product Diversification, and the Corporate Performance of Japanese Firms," *Strategy Management Journal* (20), 1999, pp. 711-727

Delios, A., Beamish, P. W. "Survival and profitability: The Roles of Experience and Intangible Assets in Foreign Subsidiary Performance," *Academy of Management Journal* (44:5), 2001, pp. 1028-1038

Dewan, S., Michael, S., Min, C. "Firm Characteristics and Investments in Information Technology: Scale and Scope Effects," *Information Systems Research* (9:3), 1998, pp. 219-232

Dierickx, I., Cool, K. "Asset stock accumulation and sustainability of competitive advantage," *Management Science* (35:12), 1989, pp. 1504-1513

Fan, J. P. H., Lang, L. H. P., "The Measurement of Relatedness: An Application to Corporate Diversification," *Journal of Business* (73:4), 2000, pp. 629-660

Farjoun, M. "Beyond industry boundaries: human expertise, diversification and resource-related industry groups," *Organization Science* (59:2), 1994, pp. 185-199

Farjoun, M. "The Independent and Joint Effects of the Skill and Physical bases of Relatedness in Diversification," *Strategic Management Journal*, (19), 1998, pp. 611-630

Fernandez, E., Montes, J., Vazquez, C. J. "Typology and Strategic analysis of intangible resources: A resource-based approach," *Technonation* (20), 2000, pp. 81-92

Ghemawat, P., del Sol, P. "Commitment versus flexibility?," *California Management Review* (40:4), 1998, pp. 3-42

Gurbaxani, V., Wang, S. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34:1), 1991, pp. 59-75

Hamel, G., Prahalad, C. K. "Capabilities-Based Competition," *Harvard Business Review* (70:3), 1992, pp. 164-170

Hitt, L. "Information Technology and Firm Boundaries: Evidence from Panel Data," *Information Systems Research* (10:2), 1999, pp. 134-149

Hitt, L. M., Brynjolfsson, E., "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS Quarterly* (20:2), 1996, pp.121-143

Hitt, M. A., Hoskinsson, R. E., Kim, H. "International Diversification: Effects on Innovation and Firm Performances in Product-Diversified Firms," *Academy of Management Journal* (40:4), 1997, pp. 767-198

Keats, B. W., and Hitt, M. A, "A Causal Model of Linkages among Environmental Dimensions, Macro Organizational Characteristics, and Performance," *Academy of Management Journal* (31:3), 1988, pp. 570-598

Kogut, B., Zander, U. "Knowledge of the Firm, Combinative Capabilities and the Replication of Technology," *Organization Science* (3), 1992, pp. 383-397

Konar, S., Cohen, M. A. "Does The Market Value Environmental Performance?" Review of Economics and Statistics (83:2), 2001, pp. 281-289

Lang, H. P., Stulz, R. "Tobin's q, Corporate Diversification, and Firm Performance," *Journal of Political Economy* (102), 1994, pp. 1248-1280

Lee, H. L., Hoyt, D. "Solectron: From Contract Manufacturer to Global Supply Chain Integrator," *Stanford University Case: GS24*, 2001

Lu, J. W., Beamish, P. W. "International Diversification and Firm Performance: The S-Curve Hypothesis," *Academy of Management Journal* (47:4), 2004, pp. 598-609

Maddgan, R. 1981. "The Measurement of Vertical Integration," *Review of Economic Statistics* (63:3), pp. 328-335

Mahmood, M. A., Mann, G. J., "Measuring the Organizational Impact of Information Technology Investment: An Exploratory Study," *Journal of Management Information Systems* (10:1), 1993, pp. 97-122

Malone, T. W., Yates, J., Benjamin, R. I. "Electronic Markets and Electronic Hierarchies," Communications of the ACM (30:6), 1987, pp. 484-497

Nahapiet, J., Ghoshal, S. "Social Capital Intellectual Capital and the Organizational Advantage," *Academy of Management Review* (32:2), 1998, pp. 242-266

Palepu, K. "Diversification Strategy, Profit Performance and the Entropy Measure," *Strategic Management Journal* (6), 1985, pp. 239- 255

Prahalad, C. K., Hamel, G., "The Core Competence of the Organization," *Harvard Business Review* (8:3), 1990, pp. 79-91

Roberts, P. W., Dowling, G. R. "Corporate Reputation and Sustained Superior Financial Performance," *Strategic Management Journal* (23), 2002, pp. 1077- 1093

St. John, C. H., Harrison, J. "Manufacturing-Based Relatedness, Synergy, and Coordination," *Strategic Management Journal* (20), 1999, pp. 129-145

Stimpert, J. L., Duhaime, I. M., "Seeing the Big Picture: The Influence of Industry, Diversification, and Business Strategy on Performance", *Academy of Management Journal* (40:3), 1997, pp. 560-583

Tanriverdi, H., Venkatraman, N. "Knowledge Relatedness and the Performance of Multi-business Firms," *Strategic Management Journal* (26), 2005, pp. 97-119

Teece, D. "Capturing Value from Knowledge Assets: The New Economy, Markets for Know-How, And Intangible Assets," *California Management Review* (40:3), 1998, pp. 55-79

Teece, D. "Economies of scope and the scope of the enterprise," *Journal of Economic Behavior and Organization* (1:3), 1980, pp. 223-247

Wernerfelt, B., Montgomery, C. A. "Tobin's q and the Importance of Focus in Firm Performance," *American Economic Review* (78), 1988, pp. 246-250

Zenger, T., Hesterly, W. S. "The Disaggregation of Corporations: Selective Intervention, High-powered Incentives, and Molecular Units," *Organization Science* (8:3), 1997, pp. 209-222