Joseph P. H. Fan
Hong Kong University of Science and Technology

Larry H. P. Lang
Chinese University of Hong Kong

The Measurement of Relatedness: An Application to Corporate Diversification*

Employing commodity flow data from input-output (IO) tables, we construct two IO-based measures to capture interindustry and intersegment vertical relatedness and complementarity. At the industry level, we demonstrate that the new IO-based measures outperform traditional measures based on Standard Industry Classification (SIC) codes. At the firm level, we report that firms increase their degree of vertical relatedness and complementarity over time. The increasing pattern is robust; it is not sensitive to accounting changes in segment definition, different weighting methods, and different IO data employed. As an application, we examine the valuation effects of relatedness in the context of corporate diversification.

I. Introduction

Measuring how industries, firms, or segments within firms are related is often critical in industrial organization, finance, and management research. However, objectively measuring relatedness on a large sample is difficult.[1] Existing measures typically rely on the Standard Industry Classification (SIC) system. To capture relatedness, researchers classify two businesses as unrelated if they do not share the same two-,

* We acknowledge helpful comments from referee Judy Chevalier, editor Doug Diamond, and from Amar Bhattacharya, Kalok Chan, Peter Chen, Stijn Claessens, Diane Denis, Simeon Djankov, Jin-Chuan Duan, Yih Jeng, Steve Kaplan, Ken Lehn, Harold Mulherin, Nahid Rahman, David Scharfstein, Andrei Shleifer, René Stulz, as well as seminar participants at the World Bank, Hong Kong University of Science and Technology, National Taiwan University, National Central University, the Seventh Security and Financial Markets Conference at National Sun Yat-Sen University, and an Association of Financial Economists session of the Ninety-Ninth Allied Social Science Association annual meeting. Paul Chan and Virginia Unkefer provided excellent research and editorial assistance, respectively. Larry Lang gratefully acknowledges the Hong Kong UGC earmarked grant for research support.
Corresponding author Fan may be reached at the Department of Finance, HKUST, Clear Water Bay, Kowloon, Hong Kong. Telephone: 852-2358-8016; Fax: 852-2358-1749; E-mail: pjfan@ust.hk.

1. In his classic study of firm diversification, Rumelt (1974, 1982) uses a combination of objective and subjective criteria to classify relatedness.

(*Journal of Business,* 2000, vol. 73, no. 4)

0021-9398/2000/7304-0005$02.50

three-, or four-digit SIC code, and vice versa.[2] The SIC-based measures of relatedness are unsatisfactory in several aspects. First, they do not reveal relatedness types. Second, they are discrete and hence do not measure the degree of relatedness. Third, they are subject to classification errors. The SIC-based measures are particularly unsatisfactory when used to classify vertically related businesses. For example, the oil-refining (SIC 29) and chemical (SIC 28) businesses are classified as unrelated according to the two-digit SIC code classifications, when in fact they are vertically related.[3]

In this article, we employ commodity flow data in U.S. input-output (IO) tables and construct two IO-based measures, so as to capture (1) interindustry and (2) intersegment (within a diversified firm) vertical relatedness and complementarity. To be more specific, two businesses are vertically related if one can employ the other's products or services as input for its own production or supply output as the other's input. Two businesses are complementary if they can procure input jointly or share marketing and distribution.[4]

We take two steps to develop the new relatedness measures. The first step is to build on the work of Lemelin (1982) to develop a pair of interindustry relatedness coefficients. With the IO data, vertical relatedness is conveniently captured by the dollar amount of input transfer between industries.[5] Complementarity is captured by the degree of overlap in the industry's input and output markets. By these coefficients, the oil-refining and the chemical industries would be vertically related as well as complementary. At the industry level, we systematically compare the relationship and descriptive power between the IO-based coefficients and a SIC-based variable. Not surprisingly, the two IO-based coefficients are both positively correlated with the SIC-based variable. The correlation with the SIC-based variable is stronger for

2. The method has been directly applied to mergers and diversification studies, such as Morck, Shleifer, and Vishny (1990) and Berger and Ofek (1995), among others. It has also been used to construct more sophisticated diversification measures, such as the entropy measure (Berry 1974; Jacquemin and Berry 1979; Palepu 1985) and the concentric index (Caves, Porter, and Spence 1980; Wernerfelt and Montgomery 1988).

3. Most oil companies in the United States as well as in other parts of the world own chemical segments.

4. By construction, the definition of complementarity is broader than ''horizontal integration'' in that complementarity could cover different industries, while horizontal integration is restricted to expansion within the same industry. See discussion in Dutz (1989).

5. Maddigan (1981), Caves and Bradburd (1988), and Davis and Morris (1995) have used IO data to measure vertical integration. Maddigan's measure is constructed at the firm level, which cannot be applied to the industry level. The reverse is true for Caves and Bradburd's measure. Davis and Morris's method is more general, as it can be used at both levels. However, it requires additional information on firm market shares, which limits its application to large samples. In the context of mergers, McGuckin et al. (1991) utilize IO data to classify the relationship between merging firms into vertical, horizontal, or conglomerate. However, their approach is rather event and data dependent, and hence, it is difficult to generalize.

complementarity and much weaker for vertical relatedness. More important, the IO-based coefficients provide a richer description of relatedness. They also completely replace the explanatory power of the SIC-based variable.

The second step is to estimate the intersegment relatedness of firms using the industry-level relatedness coefficients. The firm-level measures are then applied to a large panel of U.S. multisegment firms. We find that both the vertical relatedness and the complementarity of the firms have increased over time. Between 1979 and 1997, the firms' average level of vertical relatedness increased by about 40%, and their average complementarity level increased by about 10%. These increasing patterns are generally insensitive to the size weighting methods of constructing the measures and accounting changes in firms' segment reporting. The results still hold after adjusting for the effects of using different versions of IO tables.

As an application of our firm-level vertical relatedness and complementarity measures, we examine the issue of corporate diversification. Previous studies document that specialized firms outperform diversified firms (Lang and Stulz 1994; Berger and Ofek 1995; Comment and Jarrell 1995; Servaes 1996; Rajan, Servaes, and Zingales 1997; Stein 1997; Scharfstein 1998). Intuitively, it is quite difficult to understand why the corporate strategy of diversifying into a related business, say, sharing input or marketing or integrating vertically, would hurt performance. The literature has vividly illustrated that firms may use vertical integration to mitigate the costs of market transactions.[6] In a related literature, it is argued that diversification allows firms to realize complementary benefits associated with the utilization of noncontractible resources through the joint procurement of human or physical inputs or the sharing of marketing and distribution activities (Penrose 1959; Teece 1980, 1982). Using the vertical relatedness and complementarity measures at the firm level, we investigate the impact of related diversification on value.

We document that firms with vertically related segments are, on average, associated with low value in the past 2 decades. Given the negative valuation effect, a natural question arises regarding why firms still increase their vertical relatedness over time. Further investigation reveals that the increase in vertical relatedness is attributable only to narrowly diversified firms, that is, firms with two or three segments. The value of these firms is not sensitive to vertical relatedness. In contrast, we find strong evidence that value is negatively related to vertical relatedness for widely diversified firms operating in more than three segments. Moreover, such widely diversified firms, on average, maintain

6. This view was pioneered by Coase (1937) and extended by Williamson (1971, 1979) and Klein, Crawford, and Alchian (1978).

a higher and more stable level of vertical relatedness than narrowly diversified firms do. It must be noted, however, that the number of widely diversified firms in our sample decreases substantially over time. Rumelt (1974) observes that vertically integrated firms are typically in mature and low-profit industries. He argues that the rigidity in technologies, production processes, and management skills inhibits such firms from restructuring or downsizing to improve their performance. Consistent with his argument, our evidence indicates that the negative valuation effect of vertical integration mainly comes from those remaining widely diversified firms that have not restructured over time.

Complementarity added value in the late 1970s and early 1980s, but its valuation effect became neutral thereafter. We also examine the valuation effects of complementarity separately for narrowly and widely diversified firms. We find that complementarity enhances value when firms are widely diversified, that is, when firms have more segments. In contrast, the values of narrowly diversified firms are generally neutral to complementarity. The evidence suggests that if firms widely diversify into many industry segments, complementarity among the segments helps preserve value. Recent studies, including Rajan et al. (1997), Scharfstein (1998), and Shin and Stulz (1998), have documented that heterogeneity in investment opportunities across diversified firms' segments induces capital misallocation and, hence, diversification discounts. We argue that higher segmental complementarity implies lower heterogeneity in procurement and marketing, and it therefore enhances the economy of scale effect of diversification.

This article proceeds as follows. In Section II, we discuss the procedure to construct the interindustry relatedness coefficients. We provide summary statistics of the coefficients and compare them with the traditional SIC-based measure. In Section III, we construct intersegment relatedness measures and document relatedness patterns for U.S. multisegment firms. In Section IV, we examine the relations between relatedness and firm value. We conclude the article in Section V.

II. Measuring Interindustry Relatedness

As the first step, we follow the approach of Lemelin (1982) to construct the interindustry relatedness coefficients. The building block of these coefficients is the "Use Table" provided by the Bureau of Economic Analysis. The "Use Table" is a matrix containing the value of commodity flows between each pair of roughly 500 private-sector, intermediate IO industries.[7] The Bureau of Economic Analysis updates the table every 5 years. The table reports for each pair of industries, *i* and

7. See Lawson (1997) for details.

j, the dollar value of i's output required to produce industry j's total output, denoted as a_{ij}.

A. Vertical Relatedness

We divide a_{ij} by the dollar value of industry j's total output to get v_{ij}, representing the dollar value of industry i's output required to produce 1 dollar's worth of industry j's output. Conversely, we divide a_{ji} by the dollar value of industry i's total output to get v_{ji}, representing the dollar value of industry j's output required to produce 1 dollar's worth of industry i's output. We then take the average of the two input requirement coefficients to obtain the vertical relatedness coefficient of industries i and j, $V_{ij} = 1/2(v_{ij} + v_{ji})$. V_{ij} can be intuitively interpreted as a proxy for the opportunity for vertical integration between industries i and j.

Appendix table A1 provides several examples illustrating how the vertical relatedness coefficients are constructed. Take the plastics (i) and nontextile bags (j) industries as an example. In 1992, the total plastics output was $31,502 million. The total output of bags was $8,389 million. The bags industry consumed $1,259 million in plastics (a_{ij}), whereas the plastics industry utilized $10 million of bags ($a_{ji}$) as input. On the per dollar basis, the bag industry consumed $0.15 (= 1,259/8,389) of plastics for each dollar of bags produced (v_{ij}), whereas the plastics industry consumed $0.0003 (= 10/31,502) of bags for each dollar of plastics produced (v_{ji}). The vertical relatedness between the two industries is 0.0751 [$V_{ij} = 1/2(v_{ij} + v_{ji}) = 1/2(0.15 + 0.0003)$], which indicates the average input transfers between the two industries on a per dollar basis.

B. Complementarity

To construct the complementarity coefficient, we measure the degrees to which industries i and j share their output and input. From the "Use Table," we compute for each industry the percentage of its output supplied to each intermediate industry k, denoted as b_{ik}. For each pair of industries i and j, we compute the simple correlation coefficient between b_{ik} and b_{jk} across all k except for i and j. A large correlation coefficient in the percentage output flows suggests a significant overlap in the markets to which industries i and j sell their products.[8] For each pair of industries i and j, we also compute a simple correlation coefficient across industry input structures (all k except for i and j) between

8. One issue of using the IO data is the treatment of the wholesale and retail sectors. It is an open question whether two industries/firms that sell products to the wholesale/retail sector can be counted as having joint marketing potential. We have experimented with our analysis by including and excluding the wholesale and retail sectors. We do not find observable difference in results. In this article, we still include the two sectors since we cannot find a convincing reason to exclude any one of the industries from our sample.

TABLE 1 Summary Statistics of the Relatedness Coefficients

	Vertical Relatedness			Complementarity		
	1982	1987	1992	1982	1987	1992
Number of observations	138,601	105,750	114,003	102,814	90,935	90,938
Mean	.0115	.0118	.0119	.1162	.1304	.1347
Standard error	.0082	.0081	.0079	.1288	.1508	.1420
Percentile:						
0	.0000	.0000	.0000	−.0199	−.0144	−.0155
10	.0000	.0000	.0000	.0139	.0149	.0185
20	.0000	.0000	.0000	.0281	.0285	.0343
30	.0000	.0000	.0000	.0423	.0431	.0506
40	.0000	.0000	.0000	.0578	.0594	.0684
50	.0000	.0000	.0000	.0760	.0792	.0895
60	.0000	.0000	.0000	.0982	.1043	.1155
70	.0000	.0000	.0000	.1283	.1393	.1509
80	.0002	.0002	.0003	.1751	.1948	.2059
85	.0005	.0005	.0007	.2124	.2406	.2487
90	.0014	.0014	.0016	.2708	.3165	.3119
95	.0039	.0040	.0040	.3676	.4517	.4142
100	.4354	.4341	.3956	1.0000	1.0000	1.0000

NOTE.—This table reports the means, standard errors, and percentile distribution of the vertical relatedness and complementarity coefficients as defined in the text. These statistics are computed from all pairs of the input-output industries with data available from the "Use Table" provided by the Bureau of Economic Analysis.

the input requirement coefficients v_{ki} and v_{kj} of the two industries. A large correlation coefficient between the two suggests a significant overlap in inputs required by industries i and j. Hence, we define the complementarity coefficient as the average of the two correlation coefficients, that is, $C_{ij} = \frac{1}{2}[\text{corr}(b_{ik}, b_{jk}) + \text{corr}(v_{ki}, v_{kj})]$. C_{ij} serves as a proxy for the degree of complementarity between industries i and j.

Appendix table A1 illustrates several examples of the construction of C_{ij}. For example, consider the plastics and the paperboard containers industries. The correlation of output flows between the two industries is 0.2940 [$\text{corr}(b_{ik}, b_{jk})$], whereas the correlation of their input flows is 0.0384 [$\text{corr}(v_{ki}, v_{kj})$]. The complementarity coefficient between the two industries is calculated as the average of the input- and output-flow correlations, 0.16 [(0.294 + 0.0384)/2].[9]

C. *Summary Statistics*

In Table 1, we report the means, standard errors, and the percentile distributions of the relatedness coefficients across all pairs of the IO

9. The interindustry relatedness measures are available from the web page at http://home.ust.hk/~pjfan/relatedness.htm.

industries using data in the 1982, 1987, and 1992 IO tables.[10] First, we focus on vertical relatedness. The level and the distribution of the coefficient are similar in the 3 years. The mean vertical relatedness coefficients are 0.0115, 0.0118, and 0.01 in 1982, 1987, and 1992, respectively. The distribution of the coefficient is highly skewed. The percentile distribution indicates that economically significant vertical relatedness is only found among less than 5% of the industry pairs. The maximum value of input transfer from an upstream to a downstream industry for the production of 1 dollar's worth of output ranges between 39 cents and 43 cents in the 3 selected years.

The level and the distribution of the complementarity coefficients are also quite similar in these 3 years. The mean complementarity coefficients are 0.11, 0.13, and 0.13, respectively. Compared with the vertical relatedness coefficients, the complementarity coefficients are more smoothly distributed. The maximum value of the coefficient is one, when the two industries in question are identical. If we exclude the pairs of identical industries, the maximum value of the coefficient is around 0.36, 0.45, and 0.41 in the respective 3 years.

D. *Relations between IO-Based Relatedness Coefficients and SIC-Based Measure*

Prior studies have used a SIC-based variable to classify relatedness. Specifically, the variable equals one if two industries are classified into the same two-digit SIC code and zero otherwise. Does the SIC-based variable capture vertical relatedness and complementarity? To answer this question, we compare the mean relatedness coefficients between IO industry pairs classified into different two-digit SIC industries, and IO industry pairs classified into common two-digit SIC industries. As in table 2, the mean vertical relatedness and the mean complementarity coefficients are both significantly smaller when industry pairs are classified into different two-digit SIC codes. The relation is stronger for complementarity and weaker for vertical relatedness. Not surprisingly, the above comparison suggests that the SIC-based variable captures more complementarity and less vertical relatedness.

E. *Comparison of Explanatory Power*

To compare the explanatory power of the IO-based relatedness coefficients and the SIC-based variable, we conduct a subsequent industry-level ordinary least squares (OLS) regression analysis. The analysis is performed separately for 1982, 1987, and 1992, when the "Use Table" is available. The following model is used:

10. The number of observations used to compute the statistics varies with the coefficients and time. This is due to changes in the classification system and missing observations in the "Use Table" over time.

TABLE 2 Relations between the IO-Based and the SIC-Based Relatedness Measures

	1982		1987		1992	
	Mean	Observation	Mean	Observation	Mean	Observation
A. Vertical relatedness:						
Different two-digit SIC codes	.0009	131,826	.0008	100,475	.0008	108,809
Same two-digit SIC codes	.0061	6,775	.0070	5,095	.0073	5,194
t-Statistic for difference	−16.52		−16.78		−17.82	
B. Complementarity:						
Different two-digit SIC codes	.1035	97,717	.1162	86,136	.1205	86,344
Same two-digit SIC codes	.3585	5,097	.3858	4,799	.401	4,594
t-Statistic for difference	−67.72		−67.00		−69.81	

NOTE.—This table presents the means relatedness coefficients of input-output industry pairs classified into different two-digit Standard Industry Classification (SIC) codes and IO industry pairs classified into the same two-digit SIC codes. The relatedness coefficients are calculated from data in the 1982, 1987, and 1992 use tables provided by the Bureau of Economic Analysis.

$$\begin{aligned}\mathrm{DIV}_{ij} = b_0 &+ b_1 \times \mathrm{SIC2}D_{ij} + b_2 \times V_{ij} \\ &+ b_3 \times C_{ij} + b_4 \times V_{ij} \times \mathrm{SIC2}D_{ij} \\ &+ b_5 \times C_{ij} \times \mathrm{SIC2}D_{ij} + u_{ij},\end{aligned}$$

for all i and j. The dependent variable, DIV_{ij}, is the fraction of firms primarily in IO industry i also having a segment in IO industry j. On the right-hand side, $\mathrm{SIC2}D_{ij}$ is a dummy variable equal to one if industries i and j are classified into the same two-digit SIC code and zero otherwise. V_{ij} and C_{ij} are the vertical relatedness and complementarity coefficients as defined earlier. The model also allows each of the relatedness coefficients to interact with the SIC-based variable.

Because the independent variables vary at the industry level, we define the dependent variable, DIV_{ij}, at that level as well. To construct DIV_{ij}, we use the segment data in the Compustat Industry Segment (CIS) database. Starting with the fiscal year ending December 15, 1977, Financial Accounting Standards Board (FASB) no. 14 required that public traded multi-industry firms disclose industry segment information on sales, assets, operating profits, depreciation, and capital expenditures if the segment comprised more than 10% of consolidated sales, assets, or profits. In addition to segment financial data, Compustat assigns a four-digit SIC code for each segment according to the segment's business activity.

From the CIS database, we select the 1982, 1987, and 1992 firms that report at least two segments. We define the primary segment of a firm as the segment with the greatest amount of sales. We exclude firms with missing segment sales figures to ensure that we properly identify primary segments. We also exclude firms with missing segment SIC codes so that we can link the segment data with the IO data by segments' industry identities. Finally, we exclude firms primarily in the finance sector (SIC 6,000–6,999) because only a small number of publicly traded finance firms are covered by the CIS database.

The CIS database classifies segments by SIC codes. The IO data in the "Use Table," which are used to construct the relatedness coefficients, are classified by IO codes. To link the segment data with the IO data, we converted each segment's SIC code into an appropriate IO code. This was not a trivial task because both the IO and the SIC codes have undergone changes in definition over time. There are differences in industry definitions among the 1982, 1987, and 1992 use tables. The SIC system was also revised in 1987. We prepared a conversion table taking into account the changes in industry definitions.[11] The table was

11. The conversion table is available from the web page at http://home.ust.hk/~pjfan/relatedness.htm.

constructed from the 1982, 1987, and 1992 conversion tables prepared by the Bureau of Economic Analysis.

Table 3 presents the regression results. Equation (1) of table 3 has only one independent variable, SIC2D_{ij}. The estimated coefficients are positive and significant in all 3 years, suggesting that the firms are more likely to own segments within the same two-digit SIC industry. In equation (2) of table 3, we further include the vertical relatedness and complementarity coefficients. Their estimated coefficients are both positive and highly significant in the 3 years. This suggests that the firms are more likely to own secondary segments that are vertically related to and complementary with their primary segments. The coefficient of SIC2D_{ij} in each of the 3 years remains positive, but its level of significance is reduced. Equation (3) of table 3 presents the estimated full model. Most of the estimated coefficients of the interaction terms are positive and significant. The estimated coefficient of the interaction term $C_{ij} \times$ SIC2D_{ij} is significantly positive in all of the 3 years. The estimated coefficient of $V_{ij} \times$ SIC2D_{ij} is significantly positive only in 1987. The evidence suggests that even within the same two-digit SIC code, variation in the relatedness coefficients affects the firms' diversification decisions: the firms are more likely to own secondary segments that are related to their primary segments. On the other hand, the estimated coefficient of SIC2D_{ij} becomes insignificant once the other variables are added, suggesting that the relatedness coefficients outperform the SIC-based variable in describing relatedness.

III. Measuring Intersegment Relatedness at the Firm Level

In this section, we measure relatedness at the firm level. The first measure captures the opportunity for a firm to integrate forward and/or backward into its secondary segment(s), given its primary segment. The second measure captures the opportunity for the primary and the secondary segments to complement each other in procurement and marketing. Ideally, we would use intersegment transfer data of firms to construct these variables. Since that data is not available, we impute intersegment relatedness from the industry-level relatedness coefficients. The details are described below.

A. *Definitions and Examples*

In constructing the firm-level measures of relatedness, we denote a firm's largest segment in sales as the primary segment and the remaining segment(s) as secondary segment(s). The two firm-level relatedness measures are defined as follows:

TABLE 3 **Comparison between Two-Digit SIC Codes and the IO-Based Relatedness Coefficients in Characterizing Diversification Decisions**

	1982 Equations			1987 Equations			1992 Equations		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	.0036**	−.0003	.0004**	.0034**	.0006**	.0011**	.0033**	.0001	.0008**
	(26.73)	(−1.63)	(2.34)	(24.66)	(3.66)	(6.23)	(22.14)	(.67)	(3.87)
$SIC2D_{ij}$	.0206**	.0108**	.0001	.0153**	.0086**	.0007	.0197*	.0118**	.0009
	(33.00)	(15.89)	(.09)	(25.31)	(13.28)	(.70)	(28.63)	(15.85)	(.70)
V_{ij}		.4286**	.4290**		.4828**	.4153**		.4738**	.4377**
		(27.34)	(20.63)		(28.99)	(18.52)		(25.54)	(17.24)
C_{ij}		.0321**	.0250**		.0181**	.0145**		.0208**	.0155**
		(27.31)	(19.61)		(18.42)	(13.52)		(17.91)	(12.27)
$V_{ij} \times SIC2D_{ij}$			−.0432			.1183**			.0263
			(−1.36)			(3.51)			(.70)
$C_{ij} \times SIC2D_{ij}$			.0370**			.0230**			.0323**
			(12.37)			(8.54)			(10.27)
R^2	.0078	.0198	.0209	.0052	.0160	.0168	.0069	.0163	.0173
Observations	139,051	139,051	139,051	121,816	121,816	121,816	118,413	118,413	118,413

NOTE.—This table presents the industry-level OLS regressions on the relations between relatedness and interindustry diversification. The dependent variable is the fraction of firms in industry i also having a segment in industry j. The sample used to construct the dependent variable includes multisegment firms in the COMPUSTAT Industry Segment database in 1982, 1987, 1992. Firms primarily operating in the finance sector (SIC 6,000–6,999) are deleted. The input-ouput (IO) classification system is used to classify each of the firms' primary and secondary segments into one appropriate industry. In equation (1), $SIC2D_{ij}$ is a dummy variable that equals one if industries i and j can be classified into the same two-digit SIC code or else zero. In equation (2), V_{ij} and C_{ij} are the vertical relatedness and complementarity coefficients of the pair of IO industries. In equation (3), the relatedness coefficients are each allowed interacting with $SIC2D_{ij}$. The t-statistics are in parentheses. SIC = Standard Industry Classification.

* Significant at the 5% level.

** Significant at the 10% level.

$$V = \sum_j (w_j \times V_{ij}),$$

and

$$C = \sum_j (w_j \times C_{ij}),$$

where w_j is the sales weight equal to the ratio of the jth secondary segment sales to the total sales of all secondary segments; V_{ij} and C_{ij} are the vertical relatedness and complementarity coefficients associated with the pair of IO industries to which the primary i and the jth secondary segments belong. The relatedness coefficients are each weighted by w_j and summed across all j to obtain the firm-level relatedness measures, V and C.

To illustrate, we compute in appendix table A2 the relatedness measures for several companies selected from the CIS database in 1997. These companies are Air Products and Chemicals, Allegheny Teledyne, Gillette, W. R. Grace, Raytheon, Time Warner, and Union Camp. From the computation, we can tell how and to what degree the primary and the secondary segments of a firm are related. We use Union Camp to illustrate. Its primary business segment is paper and paperboard (SIC 2,621). It has four secondary segments: packaging products (SIC 2,631), chemicals (SIC 2,869), real estate (SIC 6,552), and wood products (SIC 2,421). The chemicals and wood products segments can supply their outputs to the primary segment. For each dollar's worth of paper and paperboard produced, the primary segment could potentially employ 6 cents' worth of chemicals and 4 cents' worth of woods from the two secondary segments. Conversely, the two secondary segments for the most part do not consume paper and paperboard. We take the average of the input transfers between the primary and the chemicals (wood products) segments to obtain the vertical relatedness coefficients (V_{ij}), 0.03 (0.02). In terms of complementarity, the packaging products segment has the highest complementarity (equals one) with the primary segment. Indeed, paper, paperboard, and packaging products are made from similar materials and sold to similar customers. The wood products and the chemicals segments also exhibit complementarity with the primary segment, with complementarity coefficients (C_{ij}) around 0.26 and 0.24, respectively. As expected, the real estate segment has the weakest relatedness with the primary segment with the vertical relatedness close to zero and the complementarity coefficient around 0.12. Finally, to compute the firm-level $V = 0.0135$ and $C = 0.5374$, we sum up V_{ij} and C_{ij} weighted by w_j, $j = 1, \ldots, 4$.

We can compare the relatedness variables V and C across firms. For example, ranked by vertical relatedness, the companies in order are Air Products and Chemicals (0.1744), W. R. Grace (0.0821), Raytheon

(0.0146), Union Camp (0.0135), Allegheny Teledyne (0.0068), Time Warner (0.0005), and Gillette (0). We can also describe how the firms diversify. Air Products and Chemicals and W. R. Grace diversify into businesses that are both vertically related to and complementary with their core businesses. Gillette and Union Camp mainly pursue complementarity by diversifying into businesses with which their primary businesses overlap in procurement and marketing. Finally, the secondary businesses of Allegheny Teledyne, Raytheon, and Time Warner exhibit low relatedness with their primary businesses.

In a related article, McGuckin, Nguyen, and Andrews (1991) employ the plant-level product and input information from the *Census Longitudinal Research Database* to classify the relationship between the acquiring and acquired firms in 94 mergers during 1977 through 1982. The relationship between a pair of merging firms is classified into vertical, horizontal, or conglomerate types. Using the data set, the researchers construct their input-output matrix containing pairs of input requirement coefficients analogous to v_{ij} in our article. The main difference is that we utilize the IO information to construct a within-firm segment-weighted vertical relatedness measure, whereas they use the IO information simply to categorize vertical relationships across merging firms. They classify a pair of merging firms as horizontally related if the firms share the same four-digit SIC code. Rather than relying on SIC codes, our complementarity measure is constructed from IO tables. It therefore offers a more intuitive proxy for joint procurement or marketing. Moreover, contrary to the measures in McGuckin et al.'s (1991) study, our measures are not event or data dependent. They can thus be conveniently applied to other large sample studies.[12]

B. Relatedness Patterns of U.S. Firms

In this section, we first describe the sample and discuss the segment reporting practices of firms. We then document the patterns of relatedness of the firms.

The sample firms and their segment reporting practices. As documented in table 4, there are between 5,000 and 8,500 nonfinance firms covered by the CIS database each year from 1979 through 1997.[13] Overall, about 70% of them are single-segment firms. Of the remaining firms, 13% are two-segment firms, 8% are three-segment firms, 4% are four-segment firms, and 3% are five-or-more-segment firms. Over time, the number and fraction of multisegment firms display a decreasing trend. In 1979, there were over 2,300 (46%) multisegment firms. In 1996, there were only over 1,600 (20%) multisegment firms.

12. The firm level intersegment relatedness measures are available from the web page at http://home.ust.hk/~pjfan/relatedness.htm.

13. The number of firms in 1997 is substantially smaller because the data of some firms were not yet available when the 1998 COMPUSTAT was published.

TABLE 4 Number and Fraction of COMPUSTAT Firms by Their Segment Numbers

	Number of Firms		Fraction of Firms				
Period	Total	Multisegment	SEGN = 1	SEGN = 2	SEGN = 3	SEGN = 4	SEGN ≥ 5
1979	5,083	2,332	.5412	.1792	.1359	.0767	.0668
1980	5,191	2,295	.5578	.1739	.1331	.0716	.0633
1981	5,220	2,214	.5758	.1729	.1199	.0703	.0609
1982	5,594	2,152	.6153	.1598	.1063	.0627	.0557
1983	5,864	2,104	.6412	.1505	.0985	.0615	.0480
1984	5,917	2,009	.6604	.1446	.0971	.0566	.0410
1985	6,289	1,931	.6929	.1356	.0911	.0473	.0329
1986	6,577	1,865	.7164	.1283	.0816	.0437	.0298
1987	6,632	1,818	.7258	.1239	.0805	.0414	.0281
1988	6,483	1,756	.7291	.1255	.0786	.0385	.0280
1989	6,375	1,680	.7364	.1222	.0784	.0393	.0271
1990	6,399	1,625	.7460	.1142	.0732	.0395	.0268
1991	6,504	1,610	.7524	.1173	.0688	.0365	.0247
1992	6,860	1,641	.7607	.1145	.0666	.0338	.0241
1993	7,207	1,660	.7696	.1092	.0659	.0312	.0240
1994	7,556	1,650	.7816	.1016	.0647	.0281	.0238
1995	8,337	1,676	.7989	.0958	.0594	.0277	.0179
1996	8,183	1,613	.8028	.0933	.0582	.0276	.0178
1997	5,398	1,081	.7997	.0970	.0589	.0283	.0159
1979–82	21,088	8,993	.5735	.1712	.1234	.0701	.0616
1983–87	31,279	9,727	.6890	.1361	.0894	.0497	.0356
1988–92	32,621	8,312	.7451	.1187	.0723	.0375	.0261
1993–97	36,681	7,680	.7906	.0992	.0614	.0285	.0200
1979–97	121,669	34,712	.7147	.1264	.0823	.0436	.0329

NOTE.—The sample includes all firms covered by the COMPUSTAT Industry Segment database, excluding firms in the finance sector (SIC 6,000–6,999). SEGN = segment number.

The FASB segment reporting requirements have not changed during the period under study. However, firms have discretion over how to define their segments. Prior studies have found that firms make strategic segment reporting decisions. Hayes and Lundholm (1996) find that the segment disclosure policies of firms are related to the degrees of competition in their industries. Under severe competition, firms with similar financial results tend to report them as separate segments; firms with dissimilar results tend to report a single segment. Harris (1998) finds that firms operating in more profitable businesses are more likely to conceal information by not reporting these businesses as segments to prevent competition. It is therefore important for us to examine how significant the segment accounting changes are in our sample.

In table 5, we report the segment reporting changes of the firms. In a typical year, about 7% of the firms report different segment numbers from the previous year. To distinguish whether the changes are real or accounting changes, we examine the associated changes in total asset value. We define an accounting change as an increase (decrease) in segment number that is not associated with a minimum 5% increase

TABLE 5 Changes in Segment Reported by COMPUSTAT Firms

Period	Total Number of Firms	Number of Firms with Segment Number Changes	Fraction of Firms with Segment Number Changes	Number of Accounting Changes	Fraction of Segment Number Changes due to Accounting Changes
1980	5,191	478	.0920	172	.3598
1981	5,220	506	.0969	207	.4090
1982	5,594	486	.0868	195	.4012
1983	5,864	502	.0856	215	.4282
1984	5,917	529	.0894	230	.4347
1985	6,289	538	.0855	213	.3959
1986	6,577	554	.0842	235	.4241
1987	6,632	517	.0779	196	.3791
1988	6,483	578	.0891	207	.3581
1989	6,375	480	.0752	189	.3937
1990	6,399	406	.0634	161	.3965
1991	6,504	396	.0608	153	.3863
1992	6,860	377	.0549	149	.3952
1993	7,207	455	.0631	187	.4109
1994	7,556	451	.0596	180	.3991
1995	8,337	463	.0555	186	.4017
1996	8,183	457	.0558	180	.3938
1997	5,398	296	.0548	112	.3783
1980–82	16,005	1,470	.0918	574	.3904
1983–87	31,279	2,640	.0844	1,089	.4125
1988–92	32,621	2,237	.0685	859	.3840
1993–97	36,681	2,122	.0578	845	.3980
1980–97	116,586	8,649	.0726	3,367	.3975

NOTE.—The sample includes all firms covered by COMPUSTAT Industry Segment database. Firms primarily in the finance sector (SIC 6,000–6,999) are deleted. Accounting change is defined as an increase (decrease) in reported segment number that is not associated with a minimum 5% increase (decrease) in total asset value.

(decrease) in total assets. Based on this definition, about 40% of the segment reporting changes are classified as accounting changes.

From the above statistics, only a few firms change their segment definitions in a given year. Most of these changes are real changes involving significant assets restructuring. In the following analysis of relatedness patterns, we will examine whether the patterns are sensitive to the accounting changes in segment definitions.

Patterns of relatedness. Based on the multisegment firm sample, we compute the mean vertical relatedness and complementarity year by year as well as period by period. The IO data in the 1982, 1987, and 1992 use tables are employed for the computation of the firm relatedness measures during 1979–86, 1987–91, and 1992–97, respectively.

Table 6 reports the mean vertical relatedness statistics. We compute vertical relatedness using both sales and, alternatively, assets weights. Columns 2 and 3 report the mean sales- and assets-weighted measures,

TABLE 6 Patterns of the Mean Vertical Relatedness for Multisegment Firms

Period (1)	Sales-Weighted Measure (2)	Assets-Weighted Measure (3)	Measure Constructed Solely from the 1987 IO Data (4)	Years of Segment Accounting Changes Deleted (5)	All Firms Experiencing Accounting Changes Deleted (6)
1979	.0169	.0169	.0159	.0169	.0164
1980	.0171	.0172	.0162	.0173	.0165
1981	.0180	.0181	.0168	.0175	.0168
1982	.0185	.0188	.0166	.0185	.0172
1983	.0183	.0185	.0165	.0182	.0166
1984	.0188	.0188	.0169	.0187	.0175
1985	.0200	.0200	.0186	.0194	.0189
1986	.0195	.0192	.0176	.0197	.0174
1987	.0182	.0188	.0182	.0180	.0170
1988	.0195	.0200	.0195	.0193	.0190
1989	.0204	.0204	.0204	.0207	.0216
1990	.0207	.0211	.0207	.0206	.0219
1991	.0205	.0217	.0205	.0203	.0221
1992	.0200	.0214	.0210	.0200	.0226
1993	.0210	.0220	.0221	.0211	.0236
1994	.0210	.0216	.0219	.0211	.0240
1995	.0211	.0220	.0224	.0215	.0233
1996	.0218	.0230	.0229	.0218	.0246
1997	.0239	.0260	.0242	.0240	.0271
1979–82	.0176	.0178	.0164	.0175	.0167
1983–87	.0190	.0190	.0175	.0188	.0175
1988–92	.0202	.0209	.0204	.0202	.0214
1993–97	.0216	.0227	.0226	.0217	.0244
1979–97	.0195	.0199	.0190	.0194	.0197

NOTE.—The sample includes all multisegment firms in the COMPUSTAT Industry Segment database with sufficient segment data to compute the relatedness measures, excluding those primarily in the finance sector (SIC 6,000–6,999). Accounting change is defined as an increase (decrease) in reported segment number that is not associated with a minimum 5% increase (decrease) in total asset value. IO = input-output.

respectively. Both the mean sales- and assets-weighted measures increase throughout the period. Between 1979 and 1997, the mean sales- and assets-weighted vertical relatedness increased by 41% and 54%, respectively.

To examine if the pattern is affected by the different IO data used, we recompute the variable using just 1 year of IO data. Column 4 reports the mean vertical relatedness constructed solely from the 1987 IO data. It displays a similar increasing pattern. The similar pattern remains if we alternatively use the 1982 or the 1992 IO data.

We next consider if the pattern is related to accounting changes in segment definition. In column 5 of table 6, we report the mean statistics after deleting the observations (firm-years) of accounting changes. In column 6, we report the mean statistics after deleting all firms that experienced accounting changes. The increasing pattern remains.

We would like to compare the pattern with prior evidence. Unfortunately, there is little research evidence on this subject.[14] McGuckin et al. (1991) provides evidence that many mergers in the late 1970s and early 1980s involved the combination of vertically related business lines. Recent vertical mergers in the communications, drug, health-care services, leisure, and petrochemical industries provide anecdotal evidence that some firms have increased their vertical relatedness through mergers.[15] We examine the mean vertical relatedness of firms primarily in these industries in our sample. We are able to find consistent increasing patterns in the 1990s for the drug (SIC 2,813) and petrochemical (SIC 2,820 and 2,860) industries. However, the other industries do not exhibit identifiable patterns.

Table 7 presents the pattern of mean complementarity. As reported in columns 2 and 3, the mean sales- and assets-weighted complementarity increased by 18% and 19% between 1979 and 1997, respectively. The pattern is not sensitive to the accounting changes in segment definition, as reported in columns 5 and 6. However, we observe that when the 1982 IO data are used to construct the complementarity measure, the levels of complementarity would be on average lower by 0.03 than the levels when the 1987 or 1992 IO data are alternatively used. Because we have constructed the measure using the 1982 IO data from 1979 through 1986 and using the 1987 IO data in the following period, this explains why the above table columns all report an increase in mean complementarity by 0.03 between 1986 and 1987. When the complementarity measure is constructed from only one of the three IO tables, the change between 1986 and 1987 is modest. In column 4, we report the mean complementarity measure constructed solely from the 1987 IO data. By this measure, the complementarity level was stable at the 0.35 level throughout the 1980s, began to increase in the early 1990s, and eventually reached 0.39 in 1997. In fact, after adjusting for the 0.03 difference, the mean statistics in columns 2, 3, 5, and 6 also show the same pattern. Based on the overall evidence, we suggest that the intersegment complementarity of the firms increased by about 10% and that all of the increase occurred in the 1990s.

Following the same procedure as constructing *V* and *C*, we construct a firm-level SIC-based relatedness measure. For a given firm, we first

14. Ó hUallacháin (1996) studies the vertical integration in American manufacturing industries using the 1977 and 1987 census establishment data. He defines vertical integration of an industry as the proportion of its establishments' shipments that were forwarded to other establishments belonging to the same corporation. He finds that the level of vertical integration in aggregate U.S. manufacturing was modest in 1977. Comparing the level in 1977 with that in 1987, he reports a mixed pattern: the level of vertical integration was higher in some industries but lower in other industries.

15. For example, see Barber (1995), Jensen (1995), *Healthcare Financial Management* (1997), Karrer-Rueedi (1997), and Morris (1998). See Morse (1998) for a discussion of recent vertical mergers and related antitrust cases in a number of industries.

TABLE 7 Patterns of the Mean Complementarity for Multisegment Firms

Period (1)	Sales-Weighted Measure (2)	Assets-Weighted Measure (3)	Measure Constructed Solely from the 1987 IO Data (4)	Years of Segment Accounting Changes Deleted (5)	All Firms Experiencing Segment Accounting Changes Deleted (6)
1979	.3315	.3298	.3719	.3311	.3230
1980	.3240	.3227	.3641	.3251	.3141
1981	.3181	.3161	.3563	.3177	.3019
1982	.3209	.3181	.3546	.3189	.3056
1983	.3228	.3184	.3548	.3208	.3129
1984	.3225	.3217	.3527	.3270	.3041
1985	.3290	.3273	.3580	.3294	.3171
1986	.3267	.3237	.3577	.3267	.3121
1987	.3550	.3510	.3550	.3535	.3424
1988	.3578	.3588	.3578	.3567	.3457
1989	.3615	.3610	.3615	.3615	.3515
1990	.3517	.3518	.3517	.3527	.3420
1991	.3541	.3558	.3541	.3520	.3472
1992	.3701	.3685	.3640	.3687	.3773
1993	.3753	.3731	.3713	.3754	.3745
1994	.3799	.3779	.3743	.3809	.3896
1995	.3886	.3869	.3816	.3884	.3995
1996	.3891	.3877	.3870	.3889	.4056
1997	.3905	.3937	.3890	.3944	.4160
1979–82	.3237	.3219	.3620	.3238	.3118
1983–87	.3304	.3276	.3556	.3295	.3167
1988–92	.3592	.3592	.3578	.3585	.3523
1993–97	.3843	.3831	.3800	.3850	.3966
1979–97	.3473	.3455	.3632	.3470	.3416

NOTE.—The sample includes all multisegment firms in the COMPUSTAT Industry Segment database with sufficient segment data to compute the relatedness measures, excluding those primarily in the finance sector (SIC 6,000–6,999). Accounting change is defined as an increase (decrease) in reported segment number that is not associated with a minimum 5% increase (decrease) in total asset value. IO = input-output.

classify each primary-secondary segment pair according to its two-digit SIC codes. We use a dummy variable to capture whether the two segments are related. If the pair of segments is classified into the same two-digit SIC code, we assign a value of one and zero otherwise. We multiply each of the segment dummy variables by the sales (assets) weight of the corresponding secondary segment. We sum across the multiples of the secondary segments to get the firm-level SIC-based measure.

We are interested in comparing the pattern of the SIC-based measure with those of the IO-based measures. As reported in column 2 of table 8, the mean SIC-based relatedness was constant at the levels between 0.26 and 0.27 throughout the 1980s, began to increase in 1992, and eventually reached the level of 0.31 in 1997. Again, the pattern is not

TABLE 8 Patterns of Mean SIC-Based Relatedness for Multisegment Firms

Period (1)	Sales-Weighted Measure (2)	Assets-Weighted Measure (3)	Years of Segment Accounting Changes Deleted (4)	All Firms Experiencing Segment Accounting Changes Deleted (5)
1979	.2655	.2672	.2655	.2558
1980	.2604	.2594	.2636	.2543
1981	.2674	.2661	.2693	.2626
1982	.2579	.2577	.2580	.2626
1983	.2621	.2535	.2631	.2692
1984	.2637	.2588	.2652	.2656
1985	.2650	.2577	.2708	.2746
1986	.2626	.2526	.2643	.2596
1987	.2647	.2562	.2663	.2719
1988	.2715	.2672	.2758	.2731
1989	.2716	.2668	.2709	.2830
1990	.2685	.2641	.2690	.2858
1991	.2673	.2649	.2698	.2781
1992	.2818	.2774	.2826	.2968
1993	.2903	.2822	.2901	.3103
1994	.2873	.2860	.2876	.3141
1995	.3002	.2933	.2988	.3188
1996	.3064	.3012	.3076	.3300
1997	.3153	.3175	.3176	.3308
1979–82	.2629	.2627	.2642	.2585
1983–87	.2636	.2558	.2659	.2682
1988–92	.2722	.2681	.2736	.2833
1993–97	.2987	.2944	.2990	.3206
1979–97	.2731	.2688	.2745	.2807

NOTE.—The sample includes all multisegment firms in the COMPUSTAT Industry Segment database with sufficient segment data to compute the relatedness measures, excluding those primarily in the finance sector (SIC 6,000–6,999). Accounting change is defined as an increase (decrease) in reported segment number that is not associated with a minimum 5% increase (decrease) in total asset value. SIC = Standard Industry Classification system.

sensitive to the different weighting methods and accounting changes in the sample (cols. 3–5). Notice the similarity in the patterns between the SIC-based relatedness and the complementarity measures (in table 7). The similarity reinforces the reported pattern of complementarity and is also consistent with the view that the SIC-based measure captures complementarity better than it captures vertical relatedness.

IV. Relatedness and Firm Value

In this section, we conduct regression analyses to examine whether the value of diversified firms is sensitive to intersegment relatedness.

A. *Regressions and Results*

To measure value, we adopt the excess value measure of Berger and Ofek (1995). This measure captures the value of a diversified firm relative to its industry-matched portfolio of pure-play firms. We also use the industry-adjusted Tobin's q (Lang and Stulz 1994) as our value measure. Our empirical results are not sensitive to the choice of the measure, however. We report results based on the excess value measures to keep up with the more recent literature. Excess value (EXV) is defined as the ratio of the firm's actual value to its imputed value. The actual value is measured as market capitalization, the market value of common equity plus the book value of debt. The imputed value of the firm is constructed from the stand-alone values of the firm's segments, which also need to be estimated. To estimate the stand-alone value, we compute the median capital to sales ratio for a portfolio of single-segment firms from the same industry as the segment in question, then multiply the median ratio by the sales value of the segment.[16] We then sum the estimated stand-alone value across all segments to get the imputed value of the firm.

We regress the natural logarithm of excess value on the relatedness variables. As control variables, we also include segment number (SEGN) and the natural logarithm of firm assets in the 1982–84 constant dollar (SIZE).[17] Given the diversification discount documented in the prior literature, we expect a negative relation between SEGN and excess value; SIZE, according to the literature, is expected to correlate positively with excess value.

Our sample selection procedure also follows the literature. From the sample of multisegment firms in the CIS database, we exclude firms in the finance sector (SIC 6,000–6,999), firms with less than $20 million annual sales, and firms lacking financial data for computing excess value and the control variables. We further exclude observations associated with extreme excess values. That is, we exclude those firms whose actual value is four times larger or one-fourth smaller than the imputed value. The above procedure results in a total of 20,486 firm-years during 1979 through 1997.

16. Our procedure to construct the portfolio is similar to that of Berger and Ofek (1995). We include in the portfolio all single-segment firms with the same four-digit SIC industry as the segment in question. If there are fewer than five firms in the portfolio, we reconstruct the portfolio using all single-segment firms within the same three-digit SIC industry. If there are still fewer than five firms in the portfolio, we use all single-segment firms in the same two-digit SIC industry. If even this portfolio contains fewer than five firms, we use all single-segment firms in the same industry group as defined by Campbell (1996). This industry matching procedure preserves observations for our subsequent analysis. We could have also computed excess value using assets and profit weights. We focus our empirical analysis on the sales-weighted excess value because firms always fully allocate their sales but not necessarily their assets and profits to their segments. The analysis based on the sales-weighted measure is therefore more reliable.

17. See Berger and Ofek (1995), Denis, Denis, and Sarin (1997), Fauver, Houston, and Naranjo (1998), and Lins and Servaes (1999). Unlike these studies, we do not include profits or capital expenditures in the regression model, because we expect relatedness to affect valuation by affecting investment policies and profitability.

Our sample contains panel data covering more than one thousand firms for 19 years. The OLS method is not appropriate because it does not take into account effects of cross correlation of error terms. To control for the potential bias caused by within-firm intertemporal correlation of error terms, we estimate one-way random effect models using the method of Fuller and Battese (1974). The variances of error components are estimated by the fitting-of-constants method in the first stage, and then the regression parameters are estimated using the generalized least squares method in the second stage. In addition to the full sample regression, we also perform subsample analysis covering the periods of 1979–82, 1983–87, 1988–92, and 1993–97.

Table 9 presents the regression results. The full-sample results in equation (1) of table 9 indicate a negative relation between vertical relatedness and firm value, as the estimated coefficient of V is negative and statistically significant at the 1% level. The results also indicate a weak positive relation between complementarity and firm value, as the estimated coefficient of C is positive and significant at the 10% level. The results of the subsample regressions are reported in equations (3), (5), (7), and (9). From the estimated coefficients of V, we find that firm value is generally negatively related to vertical relatedness across the periods. However, the negative relation is statistically significant (at the 1% level) only during the earlier period 1979–82 and the more recent period 1993–97. The effect of complementarity is significantly positive during 1979 through 1982 and becomes insignificantly different from zero in the latter periods. The even-number equations in table 9 report the regression results using the SIC-based relatedness measure. The full-sample results in equation (2) of table 9 indicate no relation between this measure and firm value. The subsample results in the remaining equations, (4), (6), (8), and (10), are generally quite weak. At only the 10% level of significance, there is a positive relatedness effect during 1983 through 1987 and a negative effect during 1993 through 1997. Finally, the estimated coefficients of the control variables are generally consistent with the predictions. The segment effect is negative, and the size effect is positive. Both are strong and persistent throughout the sample period.

As a sensitivity test, we replace the sales-weighted excess value and the relatedness variables by corresponding asset-weighted measures and rerunning the regressions. The results generally hold. To test if the results are sensitive to accounting changes in segment reporting, we run the regressions after deleting the firm-years of accounting changes. The results still hold.

Based on the evidence, we reject the notion that relatedness always improves firm value. The finding that vertical relatedness diminishes value is striking. Rumelt (1974) found that vertically integrated firms generally performed poorly in the 1950s and 1960s. Our evidence sug-

TABLE 9 **Regressions of Excess Value on Relatedness, Controlling for Segment Number and Firm Size**

	1979–97 Equations		1979–82 Equations		1983–87 Equations		1988–92 Equations		1993–97 Equations	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept	−.31**	−.30**	−.25**	−.21**	−.33**	−.34**	−.38**	−.38**	−.29**	−.30**
	(−18.67)	(−19.19)	(−7.08)	(−6.18)	(−10.22)	(−10.82)	(−13.03)	(−14.13)	(−8.67)	(−9.61)
SIC2		.00		.00		.03*		.00		−.03*
		(.18)		(.21)		(1.74)		(.22)		(−1.76)
V	−.40**		−.70**		−.20		−.17		−.51**	
	(−4.91)		(−4.37)		(−1.32)		(−1.05)		(−3.03)	
C	.02*		.12**		−.00		.00		−.02	
	(1.76)		(4.44)		(−.08)		(.11)		(−.89)	
SEGN	−.06**	−.06**	−.07**	−.07**	−.07**	−.07**	−.05**	−.05**	−.05**	−.05**
	(−21.85)	(−21.69)	(−13.81)	(−13.66)	(−12.52)	(−12.35)	(−8.21)	(−8.18)	(−7.87)	(−7.79)
SIZE	.05**	.05**	.04**	.04**	.05**	.05**	.06**	.06**	.05**	.05**
	(25.51)	(24.81)	(10.71)	(10.01)	(13.46)	(13.07)	(14.93)	(14.76)	(11.49)	(11.37)
−Residual log likelihood	30,783	30,805	8,737	8,769	8,361	8,358	6,758	6,758	6,942	6,950
Observations	20,486	20,486	5,712	5,712	5,676	5,676	4,888	4,488	4,610	4,610

NOTE.—This table presents results of regressions on relatedness and firm value. The dependent variable is the natural logarithm of excess value (Berger and Ofek 1995). The independent variables are defined as follows: SIC2 is the SIC-based relatedness measure; *V* and *C* are the vertical relatedness and complementarity measures; SEGN is the number of segments; SIZE is the natural logarithm of the constant dollar asset value. The regressions adjust for within-firm intertemporal correlations of error terms using one-way random effect models (Fuller and Battese 1974). The sample includes all multisegment firms in COMPUSTAT with sufficient data to construct the empirical measures. SIC = Standard Industry Classification. Firms in the finance sector (SIC 6,000–6,999) are deleted. Observations with extreme excess value (excess value >4 or <0.25) are also deleted. The *t*-statistics are in parentheses.

* Significant at the 10% level.

** Significant at the 1% level.

TABLE 10 Patterns of Mean Relatedness Measures by Multisegment Firms' Segment Numbers

	Vertical Relatedness		Complementarity		SIC-Based Relatedness	
Period	SEGN = 2, 3	SEGN ≥ 4	SEGN = 2, 3	SEGN ≥ 4	SEGN = 2, 3	SEGN ≥ 4
1979	.0170	.0167	.3380	.3151	.2732	.2484
1980	.0171	.0170	.3341	.3003	.2708	.2364
1981	.0170	.0202	.3228	.3074	.2794	.2400
1982	.0171	.0217	.3273	.3143	.2665	.2383
1983	.0166	.0225	.3243	.3194	.2669	.2507
1984	.0170	.0236	.3266	.3116	.2688	.2506
1985	.0179	.0264	.3368	.3058	.2689	.2533
1986	.0181	.0235	.3329	.3077	.2629	.2618
1987	.0168	.0222	.3615	.3340	.2688	.2524
1988	.0184	.0232	.3673	.3251	.2781	.2507
1989	.0192	.0242	.3694	.3351	.2751	.2607
1990	.0194	.0248	.3573	.3336	.2713	.2601
1991	.0196	.0232	.3653	.3152	.2730	.2493
1992	.0194	.0222	.3822	.3290	.2863	.2670
1993	.0206	.0223	.3902	.3232	.2965	.2691
1994	.0206	.0221	.3948	.3281	.2951	.2605
1995	.0205	.0233	.4031	.3363	.3068	.2763
1996	.0211	.0242	.4048	.3342	.3106	.2915
1997	.0224	.0295	.3948	.3748	.3109	.3315
1979–82	.0170	.0188	.3299	.3093	.2725	.2409
1983–87	.0173	.0236	.3358	.3152	.2673	.2534
1988–92	.0192	.0236	.3686	.3277	.2786	.2575
1993–97	.0209	.0238	.3977	.3366	.3035	.2820
1979–97	.0185	.0222	.3567	.3200	.2793	.2557

NOTE.—The sample includes all multisegment firms in the COMPUSTAT Industry Segment database with sufficient data to construct the relatedness measures. Firms primarily in the finance sector (SIC 6,000–6,999) are deleted. SEGN denotes the segment number.

gests that some firms with vertically related segments lost value even in more recent years.

B. Relatedness and the Breadth of Diversification

In the previous section, we document that firms have increased their degrees of vertical relatedness and complementarity over time. This raises the question of why vertical relatedness is associated with negative valuation effects. Table 10 provides some evidence on this issue. The table compares the relatedness patterns between firms with two to three segments and firms with more than three segments. We refer to the two groups of firms as narrowly diversified and widely diversified, respectively. From the table, we do not find observable differences between the two groups in the patterns of either the complementarity or the SIC-based measures. But the patterns of vertical relatedness are different between these two groups. The widely diversified firms, on average, have a higher level of vertical relatedness than the narrowly diversified firms have. The widely diversified firms have, on average, maintained a constant level of vertical relatedness over time since the mid-1980s (from 1984 to 1995). By contrast, the mean vertical relatedness of the narrowly diversified firms has gradually increased over time.

The above comparison reveals that there exist differences in both the level of and the change in vertical relatedness between widely diversified and narrowly diversified firms. Widely diversified firms maintain a higher degree of vertical relatedness and are slower in adjusting their vertical relatedness structures. Rumelt (1974) argues that vertically integrated firms are slow to restructure in response to low profitability. Following his view, one would expect that the negative valuation effect of vertical relatedness found in our sample to be caused mainly by the widely diversified firms.

To test this possibility, we separately examine the valuation effects of relatedness for firms with different numbers of segments. We define two dummy variables, SEG(2,3) and SEG(> = 4). SEG(2,3) equals one if the firm has two or three segments, and zero otherwise. SEG(> = 4) equals one if the firm has at least four segments or else zero. In the excess value regressions, we allow each of the two dummy variables to interact with the relatedness variables.

We employ the random effect models in the regressions. The results are presented in table 11. Across the equations, the estimated coefficients of SEGN and SIZE are of the expected signs. From the full-sample results in equation (1) of table 11, the estimated coefficient of $V \times$ SEG(> = 4) is negative and significant at the 1% level. The subsample analysis reported in equations (3), (5), (7), and (9) in table 11 shows that the negative effect is persistent through the four subperiods. In contrast, the estimated coefficient of $V \times$ SEG(2,3) in the full-sample regression is insignificantly different from zero. The subsample results show that the estimated coefficient of $V \times$ SEG(2,3) is significantly negative in the first period (1979–82) but is insignificant in the latter three periods. Consistent with our conjecture, the negative valuation effect of vertical relatedness can be attributed mainly to firms with more segments. In contrast, value is unaffected by vertical relatedness if firms are narrowly diversified, that is, they maintain a small number of industry segments. One remaining question is why the adjustment rigidity and the associated poor performance of widely diversified firms persist for such a long period. Our results suggest that this is not generally the case. As shown in the last two columns of table 4, over 13% of the COMPUSTAT firms were widely diversified (had more than three segments) during 1979 through 1982. The percentage dropped to under 5% during the more recent period of 1993 through 1997. The evidence indicates that a significant number of widely diversified firms have restructured or downsized over time. Vertical relatedness hurts

TABLE 11 Relatedness, the Breadth of Diversification, and Excess Value

	1979–97 Equations		1979–82 Equations		1983–87 Equations		1988–92 Equations		1993–97 Equations	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept	−.27***	−.30***	−.23***	−.20***	−.30***	−.34***	−.33***	−.37***	−.27***	−.29***
	(−15.28)	(−17.94)	(−6.17)	(−5.67)	(−8.31)	(−10.41)	(−10.13)	(−12.79)	(−7.32)	(−9.02)
SIC2 × SEG(2,3)		−.00		−.00		.02		−.00		−.03*
		(−.56)		(−.50)		(1.51)		(−.26)		(−1.74)
SIC2 × SEG(≥4)		.03*		.04		.03		.05		−.02
		(1.67)		(1.42)		(1.01)		(1.22)		(−.54)
V × SEG(2,3)	−.15		−.60***		.06		.12		.10	
	(−1.57)		(−3.16)		(.31)		(.61)		(−.52)	
V × SEG(≥4)	−.98***		−.92***		−.65***		−1.00***		−1.91***	
	(−6.76)		(−3.21)		(−2.74)		(−3.13)		(−5.42)	
C × SEG(2,3)	−.01		.09***		−.05*		.04		−.07**	
	(−1.24)		(−3.20)		(−1.72)		(−1.57)		(−2.38)	
C × SEG(≥4)	.16***		.19***		.14***		.20***		.13**	
	(6.81)		(4.20)		(3.12)		(3.71)		(2.46)	
SEGN	−.08***	−.07***	−.08***	−.08***	−.08***	−.07***	−.07***	−.06***	−.06***	−.05***
	(−20.65)	(−20.00)	(−12.11)	(−12.87)	(−11.94)	(−11.06)	(−8.42)	(−7.71)	(−7.12)	(−6.97)
SIZE	−.05***	−.05***	−.04***	−.04***	−.05***	−.05***	−.06***	−.06***	−.05***	−.05***
	(25.67)	(24.82)	(10.72)	(10.03)	(13.48)	(13.07)	(15.02)	(14.78)	(11.91)	(11.36)
−Residual log likelihood	30,733	30,808	8,738	8,771	8,349	8,363	6,740	6,760	6,921	6,955
Observations	20,486	20,486	5,712	5,712	5,676	5,676	4,488	4,488	4,610	4,610

NOTE.—This table presents the regressions results of the interactive effects on relatedness and segment number on firm value. The dependent variable is the natural logarithm of excess value (Berger and Ofek 1995). The independent variables are defined as follows: SIC2 is the SIC-based relatedness measure; *V* and *C* are the vertical relatedness and complementarity measures; SEG(2,3) is a dummy variable equal to one if the firm reports two or three segments and otherwize zero; SEG(> = 4) is a dummy variable equal to one if the firm reports at least four segments and otherwise zero; SEGN is the number of segments; SIZE is the natural logarithm of the constant dollar assets value. The regressions adjust for within-firm intertemporal correlations of error terms using one-way random effect models (Fuller and Battese 1974). The sample includes all multisegment firms in COMPUSTAT with sufficient data to construct the empirical measures. SIC = Standard Industry Classification systems. Firms in the finance sector (SIC 6,000–6,999) are deleted. Observations with extreme excess value (excess value >4 or <0.25) are also deleted. The *t*-statistics are in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

** Significant at the 1% level.

value only for firms that remain widely diversified, which suggests that these firms are subject to the adjustment rigidity described by Rumelt (1974).

The estimated coefficient of $C \times$ SEG($> = 4$) is positive and significant in the full sample period as well as in each of the four subperiods. In contrast, the estimated coefficient of $C \times$ SEG(2,3) is significantly positive only in the first period and becomes neutral to weakly negative in the following three periods. The evidence suggests that when firms diversify into wide arrays of industry segments, complementarity among the segments improves firm value. But for narrowly diversified firms, such a positive valuation effect existed only in the late 1970s.

Why does complementarity preserve value when firms are widely diversified? Prior studies by Scharfstein (1998), Rajan et al. (1997), and Shin and Stulz (1998) show that the diversified firms are more likely to misallocate capital when the heterogeneity in investment opportunities across the firms' segments is high. Our evidence is consistent with the notion that higher segmental complementarity implies lower heterogeneity in procurement and marketing and therefore enhances the economy of scale effect of diversification.

Finally, the interaction effects between the segment dummy variables and the SIC-based relatedness variables are generally weak, as shown in the even number equations in table 11. This suggests that the SIC-based measure is inferior to the IO-based measures in detecting the valuation effects.

V. Conclusion

In this article, we develop interindustry and intersegment measures of vertical relatedness and complementarity based on the commodity flow information from IO tables. At the industry level, we document that the two IO-based measures provide richer description of firms' relatedness structures than traditional SIC-based measures. At the firm level, we document the relatedness patterns of U.S. firms during 1979 through 1997. We report that both vertical relatedness and complementarity of the firms' segments have increased over time. These patterns are robust, as they are not sensitive to the different weighting methods of the relatedness measures and the accounting reporting changes in the sample. After taking into account the effects of the different IO tables employed, the increasing patterns still hold.

We also examine the valuation effects of relatedness. The empirical findings reject the hypothesis that relatedness always enhances firm performance. Strikingly, vertical relatedness is, on average, associated with poor performance. Complementarity is positively associated with firm value, but this effect existed only during the 1970s and early

1980s. We compare the valuation effects of relatedness between firms diversifying into broad industry segments and firms narrowly diversifying into fewer segments. We find that vertical relatedness is associated with the negative valuation effect when firms operate in large numbers of industry segments. We also find that complementarity increases firm value when firms operate in large numbers of segments. Overall, relatedness affects value when firms pursue wide diversification strategies.

The two relatedness measures proposed in this study can be useful for research in other areas. For example, we could reexamine mergers and acquisitions to check how relatedness enters the decisions and how it determines the wealth effects of these events. We could also examine the role of relatedness in the long-term success of acquisitions and the likelihood of their subsequent divestitures. The relatedness measures may also provide a catalyst for research in other unexplored areas. To facilitate future research using these relatedness measures, we make the interindustry and intersegment vertical and complementary measures available from the web page at http://home.ust.hk/~pjfan/relatedness.htm.

Although we document the patterns of relatedness and the accompanying valuation effects, we have not addressed what causes firms to diversify in the first place. In particular, it is necessary to examine the motivation for related diversification at the firm level and also to look into the operating process of how a related diversification diminishes or improves value. A good start would be to look into the microlevel diversification decision for a specialized firm. In doing so, we can present an ideal lab test on why a specialized firm diversifies. Continuing research along this dimension warrants more attention and resources.

TABLE A1 Constructing the Industry-Level Vertical Relatedness and Complementarity Coefficients: An Illustration from the Plastics Industry

Industry j	Bags, Except Textile	Electric Utilities	Paperboard Containers and Boxes	Glass and Glass Products
Input-output code	240,702	680,100	250,000	350,100
Standard industry classification code	2,673, 2,674	4,900–4,919, 4,930–4,939, 4,991	2,650–2,659	3,200–3,219, 3,229–3,239
Plastics used by industry j($millions); a_{ij}	1,259	0	151	0
Total output of industry j ($millions); Q_j	8,389	170,896	31,938	12,911
Value of plastics used to produce $1 of j's output; $v_{ij} = a_{ij}/Q_j$	.1500	.0000	.0047	.0000
Industry j's output used by the plastics industry ($millions); a_{ji}	10	652	133	7
Total plastics output ($millions); Q_i	31,502	31,502	31,502	31,502
Value of j's output used to produce $1 of plastics; $v_{ji} = a_{ji}/Q_i$	.0003	.0206	.0042	.0002
Vertical relatedness between plastics and jth industries; $V_{ij} = 1/2\ (v_{ij} + v_{ji})$	.0751	.0103	.0044	.0001
Plastics and jth industries' output flows correlation; corr(b_{ik}, b_{jk}); $k = 1 \ldots n$, except i, j	.0109	.0909	.294	.2649
Plastics and jth industries' output flows correlation; corr(v_{ki}, v_{kj}); $k = 1 \ldots n$, except i, j	.1128	.0386	.0384	.6272
Complementarity between plastics and jth industries; $C_{ij} = 1/2[\text{corr corr}(b_{ik}, b_{jk}) + \text{corr}(v_{ki}, v_{kj})]$	.0619	.0648	.1662	.4461

SOURCE.—The 1992 "Use Table" provided by the Bureau of Economic Analysis.

TABLE A2 Measuring Vertical Relatedness and Complementarity between Multisegment Firms' Primary and Secondary Businesses

Segment Name	SIC Code	Sales ($ millions)	w_j	v_{ij}	v_{ji}	V_{ij}	corr(v_{ki}, v_{kj})	corr(b_{ik}, b_{jk})	C_{ij}
Air Products and Chemicals:									
Industrial gases*	2,813	2,674							
Chemicals	2,869	1,448	.74	.2348	.2348	.2348	1.0000	1.0000	1.0000
Equipment and services	3,559	515	.26	.0024	.0072	.0048	.2107	.5874	.3991
Relatedness measure						V = .1744			C = .8420
Allegheny Teledyne Inc:									
Specialty metals*	3,312	1,934							
Aerospace and electronics	3,721	927	.51	.0061	.0000	.0008	−.0134	.0943	.0404
Industrial products	3,540	532	.30	.0263	.0000	.0132	.1903	.4993	.3448
Consumer products	3,634	254	.14	.0349	.0000	.0175	.0565	.2908	.1736
Vocational training	8,331	98	.05	.0029	.0000	.0015	−.0004	.1646	.0821
Relatedness measure						V = .0068			C = .1508
Gillette Company:									
Blades and razors*	3,421	2,881							
Batteries	3,692	2,478	.34	.0000	.0000	.0000	.0382	.5094	.2738
Appliances	3,634	1,744	.24	.0000	.0000	.0000	.5231	.7084	.6157
Toiletries and cosmetics	2,844	1,410	.20	.0000	.0000	.0000	.7644	.6538	.7091
Stationery products	3,951	924	.13	.0000	.0000	.0000	.3066	.6527	.4796
Oral care	3,991	624	.09	.0000	.0000	.0000	.1313	.7167	.4240
Relatedness measure						V = .0000			C = .4819
W. R. Grace and Company:									
Catalysts*	2,819	712							
Construction materials	2,899	478	.64	.1616	.0047	.0832	.3098	.6324	.4711
Container sealants	2,891	264	.36	.1605	.0000	.0803	.4358	.4800	.4579

TABLE A2 (*Continued*)

Segment Name	SIC Code	Sales ($millions)	w_j	v_{ij}	v_{ji}	V_{ij}	corr(v_{ki}, v_{kj})	corr(b_{ik}, b_{jk})	C_{ij}
Relatedness measure						V = .0821			C = .4664
Raytheon Company:									
Electronics*	3,812	8,194							
Engineering and construction	8,711	3,033	.55	.0000	.0037	.0019	.0011	.1044	.0528
Aircraft	3,721	2,446	.45	.0608	.0000	.0304	.0062	.1156	.0609
Relatedness measure						V = .0146			C = .0564
Time Warner Inc.:									
Publishing*	2,721	4,290							
Music	3,652	3,691	.40	.0000	.0000	.0000	.1996	.1675	.1836
Cable network	4,833	2,900	.32	.0002	.0000	.0001	.0460	.0571	.0515
Filmed entertainment	7,812	1,531	.17	.0002	.0004	.0003	.0622	.4000	.2311
Cable	4,841	997	.11	.0002	.0000	.0001	.1142	.1797	.1470
Relatedness measure						V = .0005			C = .1455
Union Camp Corporation:									
Paper and paperboard*	2,621	1,337							
Packaging products	2,631	1,325	.43	.0098	.0098	.0098	1.0000	1.0000	1.0000
Chemical	2,869	759	.24	.0001	.0614	.0308	.0022	.4932	.2477
Real estate	6,552	730	.23	.0003	.0000	.0002	−.0028	.2460	.1216
Wood products	2,421	326	.10	.0001	.0376	.0189	−.0174	.5448	.2637
Relatedness measure						V = .0135			C = .5374

NOTE.—This appendix table presents illustrative examples of constructing the firm-level vertical relatedness and complementarity measures. The firms are selected from the 1997 COMPUSTAT Industry Segment database. The asterisks denote the primary segment; w_j is the sales weight equal to the ratio of the jth secondary segment sales to the total sales of all secondary segments; v_{ij} measures the dollar value of ith output required to produce 1 dollar's worth of industry j's output; corr(v_{ki}, v_{kj}) measures the simple correlation coefficient across the industry structure; corr(b_{ik}, b_{jk}) measures simple correlation coefficient across the industry output structure; V_{ij} and C_{ij} are the vertical relatedness and complementarity coefficients at the industry level; and V and C are the vertical relatedness and complementarity measures at the firm level. SIC = Standard Industry Classification system.

References

Barber, Benjamin R. 1995. From Disney World to Disney's world. *New York Times* (August 1).

Berger, P. G., and Ofek, E. 1995. Diversification's effect on firm value. *Journal of Financial Economics* 37 (January): 39–65.

Berry, C. H. 1974. Corporate diversification and market structure. *Bell Journal of Economics and Management Science* 5 (Spring): 6–204.

Campbell, J. Y. 1996. Understanding risk and return. *Journal of Political Economy* 104 (April): 298–345.

Caves, R. E., and Bradburd, R. M. 1988. The empirical determinants of vertical integration. *Journal of Economic Behavior and Organization* 9 (April): 265–79.

Caves, R. E.; Porter, M. A.; and Spence, A. M. 1980. *Competition in the Open Economy.* Cambridge, Mass.: Harvard University Press.

Coase, R. H. 1937. The nature of the firm. *Economica* 4: 386–405.

Comment, R., and Jarrell, G. A. 1995. Corporate focus and stock returns. *Journal of Financial Economics* 37 (January): 67–87.

Davis, S. W., and Morris, C. 1995. A new index of vertical integration: Some estimates for U.K. manufacturing. *International Journal of Industrial Organization* 13 (June): 151–77.

Denis, D. J.; Denis, D. K.; and Sarin, A. 1997. Agency problem, equity ownership, and corporate diversification. *Journal of Finance* 52 (March): 135–60.

Dutz, M. A. 1989. Horizontal mergers in declining industries: Theory and evidence. *International Journal of Industrial Organization* 7 (March): 11–33.

Fauver, L.; Houston, J.; and Naranjo, A. 1998. Capital market development, legal systems and the value of corporate diversification: A cross-country analysis. Working paper. Gainesville: University of Florida.

Fuller, W. A., and Battese, G. E. 1974. Estimation of linear models with cross-error structure. *Journal of Econometrics* 2 (February): 67–78.

Harris, M. S. 1998. The association between competition and managers' business segment reporting decisions. *Journal of Accounting Research* 36 (Spring): 111–28.

Hayes, R. M., and Lundholm, R. 1996. Segment reporting to the capital market in the presence of a competitor. *Journal of Accounting Research* 34 (Autumn): 261–79.

Healthcare Financial Management. Evaluating integrated healthcare trends: An interview with Dean Coddington. 1997. *Healthcare Financial Management* 51, no. 9 (September): 40–42.

Jacquemin, A. P., and Berry, C. H. 1979. Entropy measure of diversification and corporate growth. *Journal of Industrial Economics* 27 (June): 359–69.

Jensen, Elizabeth. 1995. What's up DOC? Vertical integration. *Wall Street Journal* (October 16).

Karrer-Rueedi, Erna. 1997. Adaptation to change: Vertical and horizontal integration in the drug industry. *European Management Journal* 15, no. 4 (August): 461–69.

Klein, B.; Crawford, G.; and Alchian, A. A. 1978. Vertical integration, appropriable rents, and the competitive contracting process. *Journal of Law and Economics* 21 (October): 297–326.

Lang, L. H. P., and Stulz, R. M. 1994. Tobin's *q*, corporate diversification, and firm performance. *Journal of Political Economy* 102 (December): 1248–80.

Lawson, A. M. 1997. Benchmark input-output accounts for the U.S. economy, 1992. *Survey of Current Business* 77, no. 11 (November): 36–71.

Lemelin, A. 1982. Relatedness in the patterns of inter-industry diversification. *Review of Economics and Statistics* 64 (November): 646–57.

Lins, K., and Servaes, H. 1999. International evidence on the value of corporate diversification. *Journal of Finance* 54, no. 6 (December): 2215–39.

Maddigan, R. J. 1981. The measurement of vertical integration. *Review of Economics and Statistics* 63 (August): 328–35.

McGuckin, R. H.; Nguyen, S. V.; and Andrews, S. H. 1991. The relationships among acquiring and acquired firms' product lines. *Journal of Law and Economics* 34 (October): 477–502.

Morck, R.; Shleifer, A.; and Vishny, R. W. 1990. Do managerial objectives drive bad acquisitions? *Journal of Financial Economics* 45 (March): 31–48.

Morris, Gregory D. L. 1998. Competitiveness narrows gaps among producers. *Chemical Week* 160, no. 32 (August 26–September 2): 70–71.
Morse, M. H. 1998. Vertical mergers: Recent learning. *Business Lawyer* 53 (August): 1217–48.
Ó hUallacháin, B. 1996. Vertical integration in American manufacturing: Evidence for the 1980s. *Professional Geographer* 48 (November): 343–56.
Palepu, K. 1985. Diversification strategy, profit performance and the entropy measure. *Strategic Management Journal* 6 (May–June): 239–55.
Penrose, E. T. 1959. *The Theory of Growth of the Firm.* Oxford: Blackwell.
Rajan, R.; Servaes, H.; and Zingales, L. 1997. The cost of diversity: The diversification discount and inefficient investment. Working Paper. Chicago: University of Chicago.
Rumelt, R. P. 1974. *Strategy, Structure, and Economic Performance.* Boston: Harvard Business School, Division of Research.
Rumelt, R. P. 1982. Diversification strategy and profitability. *Strategic Management Journal* 3 (October/November): 359–69.
Scharfstein, D. S. 1998. The dark side of internal capital markets II: Evidence from diversified conglomerates. Working Paper no. 6352. Boston: National Bureau of Economic Research.
Servaes, H. 1996. The value of diversification during the conglomerate merger wave. *Journal of Finance* 51 (September): 1201–25.
Shin, H. H., and Stulz, R. M. 1998. Are internal capital markets efficient? *Quarterly Journal of Economics* 113 (May): 531–52.
Stein, J. C. 1997. Internal capital markets and the competition for corporate resources. *Journal of Finance* 52 (March): 111–33.
Teece, D. J. 1980. Economics of scope and the scope of the enterprise. *Journal of Economic Behavior and Organization* 1 (March): 223–47.
Teece, D. J. 1982. Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior and Organization* 3 (March): 39–63.
Wernerfelt, B., and Montgomery, C. A. 1988. Tobin's q and the importance of focus in firm performance. *American Economic Review* 78 (March): 246–50.
Williamson, O. E. 1971. The vertical integration of production: Market failure consideration. *American Economic Review* 61 (May): 112–23.
Williamson, O. E. 1979. Transaction cost economies: The governance of contractual relations. *Journal of Law and Economics* 22 (October): 233–61.