

Partial Integration and Asset Specific Investment

by

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This paper investigates the bargaining problem that exists when a manufacturer is partially vertically integrated with one or more suppliers. A number of studies have explored how complete vertical integration can resolve the bargaining problem between vertically related firms in the presence of asset specific investment. These studies often suggest the bargaining problem results in firms making insufficient asset specific investments. Alternatively, other studies have found that vertical integration reduces asset specific investments, since the integrated firm is able to consolidate expenditures. This paper investigates these two competing theories. The empirical analysis utilizes a set of 758 input-output matched suppliers and buyers. The results find evidence of the existence of the bargaining problem when firms are partially integrated.

Introduction

Often when a supplier and a buyer have a vertical relationship they find it mutually beneficial to vertically integrate. Although there are a number of benefits associated with vertical integration, two of the most often cited are to resolve a bargaining problem that exists between the two firms or to take advantage of overlapping costs. The bargaining problem occurs when one party makes an asset specific investment and then is subject to the opportunistic behavior of another party.¹ An application of this problem is where a supplier and buyer bargain over the price of the input. If the buyer makes asset specific investments, then the supplier can potentially demand a price for the input that captures a portion of the quasi-rents generated from the specific investments. Since the buyer knows that the quasi-rents will be appropriated, this bargaining problem results in an insufficient amount of asset specific investment.² A solution to this problem is for the firms to vertically integrate. Often, however, complete vertical integration (where one firm acquires the other firm or the two firms form long-term contracts) is prohibited on antitrust grounds or is associated with prohibitively large costs.³ In this case the firms may choose to partially integrate. Partial integration occurs when a firm commits a large

¹ The asset specific investments referred to here have also been referred to as “system-specific investments” by Argyres (1995) or “systemic innovations” by Teece (1996). A characteristic of these investments is that the value of the investment is reduced substantially if both parties do not commit to a standard or if the innovation requires significant amount of design coordination or specialized installations.

² Standard references include Klien, Crawford, and Alchian (1978), and Williamson (1979, 1981).

³ The costs of vertical integration include; administration costs from internal control arising from coordination and communication problems, increased levels of slack, reduced strategic flexibility, a reduction of the firms ability to spread risks, and transaction costs of writing, monitoring and enforcing contracts.

fraction of its purchases or sales to another firm.⁴ In doing so, the firm avoids many of the costs of complete integration and eliminates the bargaining problem, which allows the other firm to freely make asset specific investments.

Alternatively, partial integration may provide firms with the opportunity to assign responsibilities so that each firm becomes more specialize in a particular aspect of production. This specialization will result in a reduction in the amount of asset specific investment as the firms eliminate a duplication of these expenditures.

This paper explores how partial integration effects the amount of asset specific investments made by buyers. Partial integration may lead to more asset specific investment if the bargaining problem is eliminated or less asset specific investment if the firms can consolidate duplicated expenditures. The remainder of this paper proceeds in the following manner. Section II reviews the vertical integration and asset specific investment literature, section III provides a discussion of the competing bargaining and cost consolidation theories. Section IV describes the data and methodology, section V analyses the results of the empirical work, and section VI concludes the paper with a summary.

II Literature Review

This paper investigates partial vertical integration as a solution to a bargaining problem and as a means of reducing duplicate expenditures.⁵ The relationship between

⁴ Similar to partial integration is quasi-integration in Masten (1984) and Monteverde and Teece (1982). Quasi-integration differs in that it occurs specifically when actual ownership of specialized equipment is retained by one firm although the equipment is used by another.

⁵ Other reasons for firms vertically integrating not discussed in this paper include; providing retailers for products, ensuring consistent supplies, reduction of input costs from suppliers with market power.

vertical integration and asset specific investment has received extensive attention in the literature. This work can be separated into cross-industry studies and industry specific studies. Typical of the cross-industry studies, Levy (1985) investigates the potential for firms to vertically integrate when specific investments create a bargaining problem.⁶ He looks at a cross-industry set of 69 firms. The study uses the ratio of value added to sales as a proxy for vertical integration and a variety of proxies for asset specific investment including; R&D divided by sales, and advertising divided by sales. Although he finds evidence that firms vertically integrate when investing in asset specific investments, the value added proxy for vertical integration changes with the firm's profitability and has therefore been the subject of criticism.⁷

Monteverde and Teece (1982), provide an example of an industry specific study by investigating vertical integration and specific investment in the automobile industry. Vertical integration occurs if a part is produced in-house instead of by a supplier. The two specificity proxies are; the degree of "know-how" needed to produce the part, and a dummy variable for whether or not the exact make and model of the car must be known before producing the part. Since significant switching costs exist if the manufacturer must find a supplier who can provide parts that are specific to a particular automobile, a potential bargaining problem exists. Both specificity proxies are found to be significant and positive in explaining vertical integration suggesting firms vertically integrate to eliminate the bargaining problem. Common to these industry specific studies, Monteverde and Teece are able to proxy vertical integration and asset specificity utilizing attributes

⁶ For additional cross-industry studies refer to Tucker and Wilder (1977), Buzzel R.G. (1983), and MacMillan, Hambrick and Pennings (1986).

⁷ In their criticism of the value added proxy Adelman (1955), Maddiglan (1981) and Martin (1986) have also noted that the value added measure will arbitrarily become smaller the further downstream the firm's stage of production.

that are particular to the industry under consideration, however, with this approach the results are limited to the specific industry studied.⁸

Alternatively, integration has also been found to be negatively associated with a reduction in costs as firms consolidate asset specific expenditures. In a study by D'Aveni and Ravenscraft (1994) line-of-business data is used to investigate the performance of integrated manufacturing industries. Using a partial integration proxy, they find evidence that industries vertically integrate to reduce their spending on assets with high transaction costs (specific assets). Specifically, they find that vertically integrated industries have lower selling, advertising, and R&D expenditures. In addition, the degree of the industry's forward and backward partial integration are each investigated separately. In these regressions they find that selling, advertising and R&D expenses were all negatively associated with forward and backward integration, but only selling and advertising expenses are statistically significant for firms that forward integrate. This paper differs from that of D'Aveni and Ravenscraft by using firm level data and focusing on effect of partial vertical integration on the asset specific investments of firms.

III. Discussion

This paper investigates how partial integration will effect the degree of firm asset specific investment. The firm will either increase its asset specific expenditures when the bargaining problem is resolved or the firm will decrease its asset specific investments through cost consolidation.

A buyer who has made asset specific investments is subject to the opportunistic of the supplier since the supplier can charge input prices that expropriate a portion of the quasi-rents generated by the specific assets. The larger the buyer's upstream integration

⁸ Additional industry specific studies include; Anderson and Schmittlein (1984), Masten (1984) Spiller (1985), Joskow (1987), Hennart (1988), Vickers and Waterson (1991), Lieberman (1991), Kerkvliet (1991), and Coles and Hesterly (1998).

or backwards integration, (backwards integration occurs when the buyer purchases a large portion of the total inputs needed from a particular supplier), the larger the dependency of the buyer on that supplier and the larger the potential bargaining problem. For this reason, the larger the backwards integration, the smaller the amount of buyer asset specific investment. The buyer decision to under allocate resources to asset specific investments (or utilize general assets) as a result of this bargaining problem will, however, also adversely effect the supplier. The supplier is adversely effected since the buyer will have larger costs in using assets not conforming to its standards. The supplier will therefore reduce this bargaining problem by making a credible commitment to the buyer that will align the interests of the supplier to those of the buyer. One method the supplier can use to make this credible commitment is by partially integrating downstream or forward integration (forward integration occurs when the amount the supplier sells to the one particular buyer is large relative to the total sales of the supplier).⁹ This commitment will be credible since once dependent on a particular buyer, the cost of changing to a different buyer will result in the supplier suffering large switching costs.¹⁰ The credible commitment will allow the buyer to now freely make asset specific investments.

The alternative effect of partial integration is for the firm to reduce its asset specific investment as it consolidates expenditures. This is particularly true for overlapping and duplicate expenditures that are vertically related. Selling expenses and research and development expenditures are both asset specific and commonly overlapping between vertical stages. Partial vertical integration will allow information to be exchanged more efficiently which will reduce the buyer's costs of informing the suppliers of the

⁹ Other than complete integration, Cavanaugh (1994) suggests that firms increase their debt holdings as their dependency increases as a solution to the bargaining problem. Since bankruptcy is costly, the debt will act as a credible commitment to reduce the bargaining problem.

¹⁰ Switching costs include the time and monetary costs involved in locating other viable suppliers as well as in informing the supplier of the buyers needs. A study by Monteverde and Teece (1982) finds that switching costs resulting from the transfer of transaction-specific know-how and skills determine if automobile manufacturers make or buy inputs.

particular needs of the buyer. Selling expenses and advertising will also be reduced for the supplier as partial integration eliminates the need for extensive marketing efforts. Partial integration will allow also the firms to combine their R&D efforts and share facilities.

Summary of Buyer's Asset Specific Investment Decision

Effects From Partial Integration

Integration Source	Dependency on Supplier	Commitment to Buyer	Cost Consolidation	Net effect
Supplier Forward Integration	No effect	Commitment increases causing bargaining problem to decrease and asset specific investment to increase.	Integration will reduce costs so asset specific investment will decrease.	Ambiguous effect on asset specific investment.
Buyer Backward Integration	Dependency increases causing bargaining problem to increase and asset specific investment to decrease.	No effect	Integration will reduce costs so asset specific investment will decrease.	Asset specific investment declines.

IV. Data and Methodology

The empirical testing uses firm level data of publicly traded firms over the ten years from 1988-1997. All the variables are taken from Compustat. Compustat is Standard and Poor's database of publicly traded firms listed on the New York and the American Stock Exchanges and other major exchanges. This data is compiled from a number of sources including the firm's annual reports, balance sheets and income statements.

The focus is on the partial integration of suppliers and buyers. Supplier forward integration occurs if the fraction of the supplier's total sales that go to the buyer is large. Buyer backward integration occurs if the fraction of the buyer's total production costs that come from that particular supplier is large. The sample consists of suppliers that provide a

significant amount of their total sales to a buyer, and the buyers associated with these suppliers. By law, firms supplying 10% or more of their total sales or total assets to one buyer are required to report the identity of the buyer and the amount of their sales going to the buyer.¹¹ The firms that reported this information are then matched with their largest buyer. For the year 1992, Compustat contains 1,947 of these suppliers. Of these 1,947 suppliers, 815 have buyers that can be identified on the Compustat database.¹² Since there can be a number of suppliers for one buyer, the 815 suppliers have 274 buyers. With the exception of the amount of sales going to the buyer, all the variables used are averages over the ten year period from 1988-1997.¹³ Any missing observations are the result of missing data in the Compustat file.

Descriptive Statistics

As a result of the data available and method of collection, this sample contains a non-random selection of supplying firms and buying firms. Specifically, this sample is characterized as having; multiple suppliers for one buyer, larger buyers than suppliers, and suppliers that are already highly integrated downstream.

The sample contains more suppliers than buyers. In Figure 1, the number of buyers for various numbers of suppliers are given. For example, there are 224 buyers with one supplier and 103 buyers that have more than one supplier.¹⁴

Figure 1

¹¹ This is required reporting under FASB #14.

¹² These firms were often government agencies. The U.S. Army, U.S. Navy, Medicare, NASA, Department of Defense and the Department of Education accounted for over 200 of the missing firms.

¹³ The results using only the 1992 data is consistent with the results obtained using the averaged data.

Number of Suppliers (Z)	Number of Buyers
Z=1	180
Z=2	42
Z=3	16
Z=4	10
Z=5	8
Z>5	18
Total	274

The buyers are also, on average larger than the firm supplying them. The average sales and total assets for the buyer are 9,040 and 10,596 million dollars respectively. This compares to average sales and total assets of 756 and 1,123 million dollars for the supplier.¹⁵ As a result of the criteria used in collecting the data, the suppliers in the sample provide a significant amount of their total sales to their buyers.¹⁶ The suppliers, on average, sell 13% of their total sales to their buyer or buyers. Figure 2 provides a breakdown of the number of suppliers that provide different fractions of their total sales to the buyer.

¹⁴ There are five suppliers with multiple buyers in the sample, and each of these suppliers have two buyers.

¹⁵ Although the number of suppliers is positively related to the size of the buyers, the size differential still exists for buyers in the sample with only one supplier. When looking at the buyers that have only one and more than one supplier, the average sales and total assets of the buyer are 4,530 and 4,717 million dollars compared to the sales and total assets of their suppliers of 403 and 537 million respectively.

¹⁶ The accounting rules stipulate that the supplier must report the identity of its large buyer but the rules do not force a buyer to identify its large suppliers. The sample therefore, consists of suppliers that sell a large portion of their total sales to the buyer but not necessarily buyers that are highly dependent on their suppliers.

Figure 2

Fraction of Total Sales Supplier Provides to Buyer (X)	Total Number of Suppliers
1	9
$1 > X > .75$	29
$.75 > X > .5$	40
$.5 > X > .25$	140
$.25 > X > .1$	431
$.1 > X > .05$	65
$.05 > X$	40
Total	758

Over the entire sample, the suppliers are found in 227 different four digit SIC industries or 52 different two digit SIC industries. Often the suppliers that provide inputs to the same buyer are from different SIC industries. When the buyer has multiple suppliers, there are on average 5.8 suppliers for each buyer. However, looking at only buyers with multiple suppliers, the average number of suppliers in each supplier SIC industry is only 1.5. So, although the buyer often has many suppliers the buyer may still be subject to a bargaining problem with a supplier in a specific SIC industry.

Methodology

The discussion above suggests that partially integrated buyers will either reduce their asset specific expenditures as a result of the bargaining problem or increase their asset specific expenditures due to cost consolidation. The following regression is estimated for the buyers,

$$\ln(\text{ASSET SPECIFICITY}) = b_0 + b_1 \ln(\text{SUPPLIER FORWARD INTEGRATION}) + b_2 \ln(\text{BUYER BACKWARD INTEGRATION}) + \text{Control Variables} .$$

The variable $\ln(\text{ASSET SPECIFICITY})$ is either the natural log of the ratio of the firm's R&D expenditures to sales or the natural log of the ratio of the firm's selling expenses to sales. The variable $\ln(\text{SUPPLIER FORWARD INTEGRATION})$ is a proxy for the amount supplier has integrated to the buyer and $\ln(\text{BUYER BACKWARD INTEGRATION})$ is a proxy for the amount the buyer has integrated to the supplier. Below, the dependent variables are discussed followed by the independent variables and the control variables for the supplier and buyer regressions.

ASSET SPECIFICITY

Asset specific investment occurs when a firm makes expenditures that can not easily be recovered if the assets are sold.¹⁷ Since this variable could not be obtained, both R&D and selling expense are used to proxy asset specific investments.

To the degree that the benefits from R&D can not be patented, the value from R&D expenditures may be difficult to determine. The “discovered” processes, designs or equipment will be difficult to sell since the buyer will pay for the discovery only after being told what the discovery is, but once told the buyer has obtained it with out paying.¹⁸ As a result of the buyer's problem appraising the value of the innovation it is difficult for the firm to recover its R&D expenditures.

In addition, both R&D expenditures and selling expenses, such as advertising, are associated with new and differentiated products. These products use nonstandard inputs

¹⁷ For further discussion on asset specificity refer to Williamson (1979, 1981).

¹⁸ This problem was noted by Arrow (1974) as the paradox of information.

and tend require investments in inventory and technologies that are specific to the firm. Since these investments are specific to the firm it will be difficult for the firm to recover these expenditures. Other authors that have used R&D and/or advertising to proxy asset specific investment include; Teece (1980), Wiess (1983), Martin (1983), and Bernstein and Nadiri (1988).

SUPPLIER FORWARD INTEGRATION

The proxy for SUPPLIER FORWARD INTEGRATION is the fraction of supplier's total sales the supplier provides to the buyer.¹⁹ When the buyer has multiple suppliers the computation of the SUPPLIER FORWARD INTEGRATION must be averaged over the firm's suppliers. The interpretation of the proxy remains the same but the averaging process considers the relative size of each of the suppliers within each input (SIC industry) and the relative size of each input.

With multiple suppliers, the buyer will consider the degree of partial integration of its average supplier before altering the amount of asset specific investment. This average is weighted by the relative size of the supplier of each input (in each SIC industry), and by the relative importance the input is to the buyer across all inputs. Looking across all of its suppliers, the buyer will place more weight upon the suppliers of each input that provide a large portion of the total supplied of that particular input. For example, a supplier that is highly integrated with the buyer (i.e. supplying 99% of its total sales to the buyer) may only provide a very small fraction of this input to the buyer. The buyer in this situation will not alter its asset specific investment amount since this supplier is so small. The other consideration of the buyer is the amount of the buyer's cost of goods sold that is coming from each of the supplier's inputs (SIC industries). If an input represents a large fraction

¹⁹ Both sales to the buyer, the total sales, and the cost of goods sold are for the year 1992.

of the buyer's total cost of goods sold, the buyer will place more weight upon the SUPPLIER FORWARD INTEGRATION of all suppliers that are providing this specific input. For example, when a set of suppliers that are supplying one input are highly integrated with the buyer (i.e. each of the suppliers in this SIC industry are supplying 99% of their total sales to the buyer), the buyer will not alter its amount of asset specific investment if the suppliers' total contribution to the buyers total cost of goods sold is small.²⁰ The bargaining problem will be reduced and the buyer will increase its asset specific investments if, however, the partial integration of the inputs provide by the suppliers account for a large portion of the buyer's cost of goods sold.²¹

As a result of taking into account the firm level integration and the importance of each input to the buyer, calculating the partial integration of the suppliers is a double weighted average. First, for each supplier the supplier's partial integration is weighted by the total amount provided by all suppliers of the same input. This is computed for each supplier as the fraction of sales going to the buyer weighted by the total amount supplied by all the suppliers in the same SIC industry (of the same input). This allows the partial integration of suppliers that provide a large amount of the input to have a greater weight within their SIC industry. Next, this amount is weighted across the inputs of the buyer or SIC industries. Industries that provide a larger amount of the buyer's total cost of goods sold will therefore receive a larger weight.²² The larger the suppliers forward integration

²⁰ If all of the suppliers are providing the same input (in the same SIC industry) then this step can be skipped. Since if all suppliers are providing the same input, the weight across inputs is 100%.

²¹ Since only the major suppliers in other SIC industries can be identified and subtracted out, the adjusted cost of goods sold is probably overstated or the supplier forward integration is understated.

²² The calculation of the supplier forward integration is a double weighted average. First the suppliers dependency is weighted by the amount the supplier provides of the industries total sales or Z where,

$$Z_i = \sum_F \left\{ \frac{\text{Sales to Buyer}_F}{\text{Total Sales of Supplier}_F} \right\} \left\{ \frac{\text{Sales to Buyer}_F}{\text{Total Sales of Industry}_i} \right\}, \text{ and the summation is over F, where F is all}$$

firms in the same industry. Then Z is weighted for the size of each industry so that the proxy for supplier

forward integration is equal to SFI, or $SFI = \sum_I (Z_i) \left\{ \frac{\text{Total Sales of Industry}_i}{\text{Buyer Costs of Goods Sold}_F} \right\}$, where, I, refers to

the smaller the bargaining problem for the buyer and the larger amount of asset specific investment made by the buyer. Alternatively, if costs are consolidated, the larger the suppliers forward integration the smaller the amount of asset specific investment. The regression results will determine which, if either, of these two effects is dominate.

BUYER BACKWARD INTEGRATION

The BUYER BACKWARD INTEGRATION proxy is measured as the ratio of the sales from the supplier over the cost of goods sold of the buyer. As in the case of the SUPPLIER FORWARD INTEGRATION, the calculation of the BUYER BACKWARD INTEGRATION proxy is complicated in the case of a buyer with multiple suppliers.

For the buyer regressions, BUYER BACKWARD INTEGRATION proxy will account for the level of dependence of each supplier providing the same input and the level of dependence on each input. The buyer will be highly integrated with a supplier who provides a large fraction of the buyer's cost of goods sold, only, if this represents a large amount of the total provided by all suppliers of a particular input (in the same SIC industry). The buyer will also consider the relative amount provided by its suppliers across all the inputs. If the buyer is highly integrated with all suppliers providing one input (i.e. the buyer has only two suppliers in the SIC industry) but these suppliers are providing a very small fraction of the total cost of goods sold of the buyer, than the buyer will not be subject to the bargaining problem and will not alter its specific investment expenditures. The small amount of the buyer's total cost of goods sold provided by the suppliers in that

each industry. Since the Total Sales of Industry is constant over all firms in the same industry, F, the calculation of SFI can be simplified to:
$$SFI = \sum_F \left\{ \frac{\text{Sales to Buyer}_F}{\text{Total Sales of Supplier}_F} \right\} \left\{ \frac{\text{Sales to Buyer}_F}{\text{Buyer Costs of Goods Sold}_F} \right\}$$

particular industry implies that the buyer is not highly integrated with these suppliers. The calculation of the BUYER BACKWARD INTEGRATION is a double weighted average.²³ First the amount provided to the buyer by each supplier in each SIC industry is weighted by the total amount supplied by the industry. Then this amount is weighted by the relative importance each input is to the buyer or the total supplied by the SIC industry divided by the total cost of goods sold of the buyer. If the bargaining effect is correct, asset specificity should decline as *BUYER BACKWARD INTEGRATION* increases. If the buyer is able to consolidate expenses the asset specificity should also decline as *BUYER BACKWARD INTEGRATION* increases.

Control Variables

Four control variables used in both the supplier and buyer regressions. They are HISTORY, GROWTH, TOTAL ASSETS, BUSINESS CONDITIONS, CONCENTRATION RATIO, and INDUSTRY DUMMY VARIABLES.

HISTORY is measured as the number of years the supplier has sold to the current buyer.²⁴ For the buyer's with multiple suppliers, HISTORY is weighted by amount the supplier provides of the buyer's cost of goods sold. HISTORY is used to capture for

²³ The calculation of the buyer backward integration is a double weighted average. First, the amount each firm contributes to the buyer's costs of goods sold coming from this input is weighted by the size of the contribution relative to the total sales from the industry. This amounts to the fraction of industry sales squared or is calculated as X, where, $X_i = \sum_F \left\{ \frac{\text{Sales to Buyer}_F}{\text{Total Sales of Industry}_i} \right\} \left\{ \frac{\text{Sales to Buyer}_F}{\text{Total Sales of Industry}_i} \right\}$, and, F, refers to each firm in the industry. The relative importance of the industries sales to the buyer is then calculated as BBI, where, $BBI = \sum_I (X_i) \left\{ \frac{\text{Total Sales of Industry}_i}{\text{Buyer Costs of Goods Sold}_F} \right\}$, and, I, refers to each industry.

²⁴ Compustat provides seven years of data on the firms major buyers. The names of all the buyers that are provided with at least 10% of the firms total sales are used for the years 1988-1997.

specific knowledge acquired over time. The longer a supplier and a buyer are in business together the more specific knowledge each has about the other party. It is likely that over this time period the suppliers and buyers will be able to consolidate costs so the asset specific investment will be lower as HISTORY increases. A longer time period working together also demonstrates a degree of commitment to each other. This commitment reduces the bargaining problem and allows the firms to increase their asset specific investments as HISTORY increases. For this reason, the expected sign on HISTORY is ambiguous.

GROWTH, a measure of the firm's growth, is measured using the firms average percentage change in operating income. $\ln(\text{TOTAL ASSETS})$, a proxy for firm size, is the measured as the natural logarithm of the total assets of the firm. BUSINESS CONDITIONS is a proxy for industry business conditions, is measured as the percentage change in sales for all firms in the same industry. The remaining control variables are used to account for industry specific differences in asset specific investment.

CONCENTRATION RATIO is the ratio of the total sales of the largest four firms in the industry divided by the total sales of all firms in the industry. INDUSTRY DUMMY VARIABLES is a dummy variable for each two digit SIC code industries.

For the regressions performed Table 1 contains a summary and definition of the variables used and table 2 provides the variable means and deviations.

Table 1--Variable Definitions

Variables	Definition*
ln(SELLING EXPENSE/SALES)	The natural logarithm of the buyer's average selling expenses from 1988-1997.
ln(R&D/SALES)	The natural logarithm of the average buyer's research and development expenses.
ln(SUPPLIER FORWARD INTEGRATION)	The natural logarithm of the fraction of the buyer's adjusted cost of goods sold provided by the supplier weighted by the supplier size and input size for 1992.
ln(BUYER BACKWARD INTEGRATION)	The natural logarithm of the fraction of the total sales of the supplier that go to the buyer weighted by supplier size and input size for 1992.
HISTORY	The number of years the supplier has provided 10% or more of its total sales to the buyer weighted across suppliers by the amount the supplier contributed to the buyers cost of goods sold.
GROWTH	Average percentage change in the buyer's operating income.
ln(TOTAL ASSETS)	The natural logarithm of average total assets of the buyer.
BUSINESS CONDITIONS	Average percentage change in sales for all firms in the same industry.
CONCENTRATION RATO	The four firm concentration ratio.
INDUSTRY DUMMY VARIABLES	Dummy variable that equals one for each two digit SIC code industry.

*Unless stated otherwise, all variables are averages from 1988-1997. There are 47 SIC industries for the buyers.

Table 2- Means and Deviations

Variables	Obs.	Mean	Std. Dev.	Min	Max
SELLING EXPENSE/SALES	259	.2170823	.1322033	.0139354	.6425864
ln(SELLING EXPENSE/SALES)	259	-1.744256	.7156895	-4.273321	-.4422541
R&D/SALES	208	.0491152	.1502164	0	2.050449
ln(R&D/SALES)	174	-3.63144	1.272687	-8.017614	.7180589
SUPPLIER FORWARD INTEGRATION	274	.0106968	.028114	1.11e-08	.3125405
ln(SUPPLIER FORWARD INTEGRATION)	274	-6.548728	2.414394	-18.31824	-1.163021
BUYER BACKWARD INTEGRATION	274	.0436065	.1075829	4.67e-06	.9644295
ln(BUYER BACKWARD INTEGRATION)	274	-4.883278	2.12623	-12.27357	-.0362185
HISTORY	274	.1160018	.4599413	.000014	6.751007
GROWTH	268	.3450992	1.745363	-8.837962	10.71761
ln(TOTAL ASSETS)	274	7.74086	2.055745	-.9775015	12.22413
TOTAL ASSETS	274	10595.81	25479.34	.37625	203643.6
BUSINESS CONDITIONS	272	.5082868	.9291739	-.047	11.951
CONCENTRATION RATIO	230	.7144213	.2107015	.275548	1

V Results

Tables 3 contains the regression results of the ln(SELLING EXPENSE/SALES) and ln(R&D/SALES) equations. The second regression (1.b and 1.c) for each set includes the dummy variables for each two digit SIC industry. The buyer is expected to make larger asset specific investments as the supplier commits to partially integrating with the buyer since the bargaining problem is reduced and costs can be consolidated. The positive and significant sign on ln(SUPPLIER FORWARD INTEGRATION), suggests that the reduction of bargaining problem is overwhelming any cost savings from consolidation. As the buyer becomes more integrated with the supplier

the bargaining problem is increases and costs can be consolidated. The negative sign on ln(BUYER BACKWARD INTEGRATION) suggests that the bargaining problem has increased so that buyers will spend less on R&D when they are more dependent upon their suppliers. The negative sign on ln(BUYER BACKWARD INTEGRATION) also supports the reduced asset specific investment as a result of costs consolidation. The only remaining variable that is consistently significant is ln(TOTAL ASSETS) which is negatively associated with asset specific investment in all but the ln(R&D/SALES) regression when the concentration ratio and the industry dummy variables are included.

Table 3: ln(SELLING EXPENSE/SALES) and ln(R&D/SALES) Results
(t statistics in parentheses)

Variables	ln(SELLING EXPENSE/SALES)		ln(R&D/SALES)	
	(1.a)	(1.b)	(2.a)	(2.b)
ln(SUPPLIER FORWARD INTEGRATION)	.0968*** (2.273)	.1048*** (2.703)	.3723*** (4.087)	.2547*** (2.989)
ln(BUYER BACKWARD INTEGRATION)	-.1114* (-2.099)	-.1514*** (-3.172)	-.2816** (-2.631)	-.2396** (-2.505)
HISTORY	.2781 (1.189)	.0699 (0.347)	-.1627 (-0.921)	-.0262 (-0.184)
GROWTH	-.056* (-2.176)	-.0386* (-1.681)	.0022 (0.038)	-.0092 (-0.180)
ln(TOTAL ASSETS)	-.0658*** (-2.699)	-.0932*** (-3.687)	-.0962* (-1.965)	.0436 (0.907)
BUSINESS CONDITIONS	-.0780* (-1.655)	3.97e-6 (.0000)	-.1058* (-1.175)	-.0111 (-.151)
CONCENTRATION RATIO	NO	.0431 (.163)	NO	-1.193** (-2.524)
INDUSTRY DUMMY VARIABLES	NO	YES	NO	YES
obs.	251	214	171	146
R ²	.08	.56	.15	.66

* Is significant at the .05 level.

** Is significant at the .01 level.

*** Is significant at the .005 level.

Using the log linear functional form in these regressions provides the elasticities of the dependent variables with respect to the integration proxies. Looking at equation (1.a), the coefficient on $\ln(\text{SUPPLIER FORWARD INTEGRATION})$, is .0968. This indicates that a 10% increase in $\text{SUPPLIER FORWARD INTEGRATION}$ will, on average, result in almost a 1% increase in $\text{SELLING EXPENSE/SALES}$. Since on average the major suppliers provide \$94.894 million to the buyers, an increase of \$9.489 million supplied (10% increase) by each supplier results in an additional \$19.627 million in the buyer's selling expense investment (1% increase).²⁵ By increasing the amount suppliers provide to the buyer the suppliers make a commitment to the buyer that reduces the bargaining problem. This allows the buyer to substantially increase the amount of asset specific investment. Similarly, the negative coefficient on $\ln(\text{BUYER BACKWARD INTEGRATION})$ of -.1114 means that on average a 10% increase in $\text{BUYER BACKWARD INTEGRATION}$ will result in approximately an a 1.1% decrease in $\text{SELLING EXPENSE/SALES}$. An 10% increase in the average amount buyers purchase from each of their major suppliers, or \$9.489 million, will result in a \$21.633 million reduction in the buyer's selling expense investment (1.1% decrease). Here the increased dependency of the buyer on the suppliers increases the bargaining problem and results in substantially lower amount of asset specific investment.

Similar results are found using the $\ln(\text{R\&D/SALES})$ proxy for asset specificity. In equation (2.a) the elasticities with respect to the SUPPLIER FORWARD and the $\text{BUYER BACKWARD INTEGRATION}$ imply a 10% increase in integration will result in an

²⁵ The average dollar amount suppliers provide to buyers is \$94.894 million and the average $\text{SUPPLIER FORWARD INTEGRATION}$ is .0107. The average total sales of the buyer is \$9040.381 million and the average $\text{SELLING EXPENSE/SALES}$ is .2171.

increase of 3.7% in R&D/ SALES and a decrease of 2.8% in R&D/ SALES respectively.²⁶

The same 10% increase in the amount the suppliers provide to buyers (\$9.489 million dollars) results in an additional \$16.430 million in the buyers' R&D investment (3.7% increase). A 10% increase in the amount buyers purchase from each of their suppliers (\$21.633 million) results in a decrease of \$12.434 million in the buyers' R&D investment (2.8% decrease). These results using R&D/SALES as a proxy for asset specific investment lend additional support for the existence of the bargaining problem.

Conclusion

This paper investigates the relationship between partial vertical integration and asset specific investment. Often firms vertical integrate to solve a bargaining problem that results in an under allocation of asset specific investments. This paper explores partial vertical integration as a solution to the bargaining problem as well as the possibility that partial integration allows for cost consolidation.

Partial vertical integration of the buyer to the supplier will increase the bargaining problem leading to a reduction in asset specific investment since the buyer becomes more dependent on the supplier for inputs. The supplier can eliminate the bargaining problem by partially integrating with the buyer, which will lead to an increase in the buyer's asset specific investments. An alternative possibility is that integrating firms will be able to consolidate expenditures. Duplicated asset specific expenditures, such as advertising and R&D, will be eliminated as firms integrate.

²⁶ The average R&D/SALES is .04912 and the average total sales of the buyer is \$9040.381 million.

Looking at a set of input-output matched and vertically integrated firms the empirical results suggest that the bargaining problem is reduced when the supplier integrates forward with the buyer and the bargaining problem is larger and/or costs savings result when the buyer integrates backwards with the supplier.

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