4-29-2009

Essay 1: 'An Examination of the Efficiency, Foreclosure, and Collusion Rationales for Vertical Takeovers' Essay 2: 'Determinants of Firm Vertical Boundaries and Implications for Internal Capital Markets'

Jaideep Ranjal Shenoy

Permission to Borrow

In presenting this dissertation as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, or to publish this dissertation may be granted by the author or, in his/her absence, the professor under whose direction it was written or, in his absence, by the Dean of the Robinson College of Business. Such quoting, copying, or publishing must be solely for scholarly purposes and does not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential gain will not be allowed without written permission of the author.

Jaideep Shenoy

____

Signature of author

Notice to Borrowers

All dissertations deposited in the Georgia State University Library must be used only in accordance with the stipulations prescribed by the author in the preceding statement.

The author of this dissertation is:

Jaideep Shenoy
Finance and Economics Department
A.B. Freeman School of Business
Tulane University
New Orleans, LA 70118

The director of this dissertation is:

Omesh Kini
Department of Finance
J. Mack Robinson College of Business
Georgia State University
P.O. Box 3991
Atlanta, GA 30302-3991

Users of this dissertation not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulations by signing below. Libraries borrowing this dissertation for the use of their patrons are required to see that each user records here the information requested.

Name of User	Address	Date

TITLE OF DISSERTATION

BY

JAIDEEP SHENOY

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree
of
Doctor of Philosophy
in the Robinson College of Business
of
Georgia State University

GEORGIA STATE UNIVERSITY
ROBINSON COLLEGE OF BUSINESS
2009

ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor in Philosophy in Business Administration in the Robinson College of Business of Georgia State University.

H. Fenwick Huss
Dean
Robinson College of Business

Dissertation Committee:

Omesh Kini (Chairman)
Gerald Gay
Jayant Kale
Harley E. Ryan
Husayn Shahrur

ACKNOWLEDGEMENTS

I am grateful for the meticulous guidance from my advisor Omesh Kini during the process of writing this dissertation. I am thankful to my other committee members Gerald Gay, Jayant Kale, Chip Ryan, and Husayn Shahrur for their insightful comments and suggestions. I acknowledge the helpful comments from Arnie Cowan, Espen Eckbo, William Elliott, Joseph Fan, Vidhan Goyal, Dermot Hayes, Harold Mulherin, Gordon Phillips, Paul Spindt, Venkat Subramaniam, Chad Syverson, Shawn Thomas, Sheri Tice, Anand Venkateswaran, as well as the seminar participants at 2009 American Finance Association Meetings in San Francisco, the 5th International Industrial Organization Conference at Savannah, the 2007 and 2008 Financial Management Association Meetings, California State University-Fullerton, Georgia State University, Iowa State University, Tulane University, and Virginia Commonwealth University. Finally, I am indebted to my wife Pareen Shenoy for the numerous discussions about the dissertation and the pains she has gone through to proof read several versions of the document. I am deeply grateful to my parents and my in-laws for their countless love and blessings. All remaining errors and omissions are mine.

ABSTRACT

Essay 1: An Examination of the Efficiency, Foreclosure, and Collusion Rationales for Vertical Takeovers

Essay 2: Determinants of Firm Vertical Boundaries and Implications for Internal Capital Markets

by

Jaideep Shenoy

03/25/2009

Committee Chair: Dr. Omesh Kini

Major Department: Finance

Essay 1: An Examination of the Efficiency, Foreclosure, and Collusion Rationales for Vertical Takeovers

We investigate the efficiency, foreclosure, and collusion rationales for vertical integration using a large sample of vertical takeovers. The efficiency rationale posits that vertical integration prevents future holdup between non-integrated suppliers and customers. In contrast, the foreclosure and collusion rationales suggest that vertical integration harms competition. To distinguish between these hypotheses, we examine the wealth effects of the merging firms, acquirer rivals, target rivals, and corporate customers on announcement of vertical takeovers. Our univariate and cross-sectional results suggest that firms alter their vertical boundaries in a manner that is consistent with the efficiency rationale. Our tests do not find evidence supportive of the anti-competitive rationales for vertical integration.

Essay 2: Determinants of Firm Vertical Boundaries and Implications for Internal Capital Markets

In this paper, we investigate the determinants of vertical relatedness between business segments of multi-segment firms and how vertical relatedness affects the internal allocation of capital. Consistent with theory, we observe a higher degree of vertical relatedness between segments in environments likely to involve contracting problems. Further, there is a greater tendency for investments to flow towards segments with better investment opportunities as the degree of vertical relatedness between business segments in the firm increases. This indicates that internal capital markets function better in the presence of significant vertical relatedness between segments. This finding supports the Stein (1997) model, which suggests that the headquarters is able to do a better job of "winner-picking" when firms operate in related lines of businesses.

An Examination of the Efficiency, Foreclosure, and Collusion Rationales for Vertical Takeovers

1. Introduction

The decision to vertically integrate is of fundamental importance to firms. Vertical integration provides common ownership over successive stages of production and facilitates internal exchange instead of market or contractual exchange. Since the seminal work of Coase (1937), the literature has developed several theories that explain what determines the vertical boundaries of a firm.[1] The efficiency rationale, as studied under the Transaction Cost Economics and Property Rights theories, suggests that vertical integration reduces transaction costs by mitigating contractual inefficiencies between non-integrated suppliers and customers and provides incentives to make relationship-specific investments. These contractual inefficiencies are also referred in the literature as “holdup” (Williamson (1971, 1979), Klein, Crawford, and Alchian (1978), Grossman and Hart (1986), and Hart and Moore (1990)).

In addition to the efficiency argument, the extant literature proposes two distinct anti-competitive rationales for vertical integration. The foreclosure argument suggests that a vertical takeover with a supplier (customer) enhances the market power of the integrated firm since it can deny access of the input (outlet) to its non-integrated rivals (Salinger (1988), Hart and Tirole (1990), and Ordover, Saloner, and Salop (1990)). The collusion argument suggests that a vertical takeover with a supplier (customer) enables better coordination between the integrated firm and its non-integrated acquirer rivals since the rivals need access to the input (outlet) being controlled by the integrated firm (Chen (2001) and Nocke and White (2007)).[2]

In this paper, we investigate the efficiency, foreclosure, and collusion rationales for vertical integration in a sample of 453 successful vertical takeovers over the period 1981-2004.

---

[1] Perry (1989), Joskow (2005), and Lafontaine and Slade (2007) provide extensive surveys of the literature on vertical integration.

[2] In contrast, in horizontal takeovers, collusion occurs due to a reduction in the number of producers in the takeover industry.

Our paper provides the first large sample study that attempts to disentangle the above three rationales for vertical takeovers. To test the three hypotheses, we first examine the wealth effects of the acquirer and target rivals on announcement of vertical takeovers. This is consistent with the suggestion made in Eckbo (1983) that a test of collusion in vertical takeovers should examine rivals in industries of both merging partners. We build upon this approach by also investigating the announcement period wealth effects of corporate customers. These customers are identified as firms that buy the output of the downstream industry in the vertical takeover. The analysis of customer firms enhances our ability to differentiate the efficiency hypothesis from anti-competitive rationales and gives a more complete picture of the overall welfare effects of vertical takeovers. Our research design also allows us to differentiate between foreclosure and collusion – an issue that is potentially important from a merger policy standpoint but which the extant literature has not addressed.

We distinguish between the three hypotheses by first developing and testing univariate predictions on the announcement period wealth effects to the merging firms, rivals, and customer firms, and then by investigating the cross-sectional determinants of these wealth effects. The reduced transaction costs (under efficiency) or the increase in market power (under foreclosure and collusion) both predict a positive combined wealth effect (CWE) for the merging firms in vertical takeovers.[3] Under the efficiency hypothesis, the announcement period wealth effect of the non-integrated acquirer and target rivals is unrestricted in sign as there could be two opposing forces at work here. The non-integrated rivals could implement similar vertical acquisitions since the announcement disseminates information about possible efficiency gains from vertical integration (better information view). On the other hand, they could be at a competitive disadvantage since they might be subject to inefficiencies when compared to the

[3] Vertical takeovers can be backward takeovers, where the acquirer is downstream and the target is upstream in the supply chain, or forward takeovers, where the acquirer is upstream and the target is downstream in the supply chain.

vertically integrated firm (competitive advantage view). Under the efficiency hypothesis, we expect the customers to experience a zero or positive wealth effect based on how much of the benefits due to reduced transaction costs are passed on to customers through lower prices.

Under the foreclosure hypothesis, the effect on both the non-integrated acquirer and target rivals is negative on account of the increased market power of the vertically integrated firm. Specifically, the vertically integrated firm can squeeze the margins of the non-integrated rivals (both upstream and downstream) by foreclosing them from input supplies or from a potential source of outlet. Under the collusion hypothesis, the effect on the non-integrated acquirer rivals is positive, whereas the effect on the non-integrated target rivals is negative. Specifically, the non-integrated acquirer rivals gain because of the increased coordination with the vertically integrated firm since the acquirer rivals need access to the input (backward takeovers) or a source of outlet (forward takeovers) controlled by the integrated firm. On the other hand, the non-integrated target rivals lose since the ensuing collusion between the non-integrated acquirer rivals and the integrated firm leads to a reduced demand for their output (backward takeover) or higher input prices being charged to them (forward takeover). Finally, under both the foreclosure and collusion hypotheses, we expect customer firms to experience a negative wealth effect on account of the increased market power of the vertically integrated firm.

To identify vertical relations between acquirer and target firms, we use the dollar value of commodity flows between different industries provided by the benchmark input-output accounts of the U.S. economy (Fan and Lang (2000), Shahrur (2005), and Fan and Goyal (2006)). These benchmark input-output accounts also help us identify customer industries for each vertical takeover. In the spirit of Fan and Goyal (2006), we calculate the vertical relatedness coefficient, which captures the extent of the commodity flow between the acquirer and target industries. Our final sample of 453 successful vertical takeovers is based on a vertical relatedness coefficient of

1% or greater.[4] We find that vertical takeovers create value to the merging firms since they are associated, on average, with a positive CWE to the merging firms. This finding is consistent with the extant takeover literature (Fan and Goyal (2006)).

For the overall sample of vertical takeovers, we find that the acquirer rivals, target rivals, and customers are associated with insignificant average abnormal returns. The insignificant returns to the rivals and customers are weakly consistent with the efficiency hypothesis. To further explore the hypotheses, we sub-divide our sample based on whether the takeover generates a positive or negative CWE to the merging firms. We expect that the efficiency, foreclosure, and collusion hypotheses would be more prominent in takeovers with a positive CWE to the merging firms.[5]

In the sub-sample of takeovers with a positive CWE to the merging firms, we find that the non-integrated acquirer and target rivals are associated with positive and significant abnormal returns. This positive effect on acquirer and target rivals is consistent with the better information view of the efficiency hypothesis and inconsistent with the foreclosure hypothesis. The positive effect on the acquirer rivals is also consistent with the collusion hypothesis, but the positive effect on target rivals is, however, inconsistent with this hypothesis. We also find that customer firms that are most dependent on inputs from the downstream industry in the takeover experience positive and significant abnormal returns. This positive effect on dependent customer firms is inconsistent with the foreclosure and collusion rationales and consistent with the efficiency hypothesis. Summing up, our univariate results in the positive CWE sub-sample are consistent with the efficiency hypothesis and inconsistent with both the anti-competitive rationales.

[4] In robustness tests, we also use higher cutoffs for the vertical relatedness coefficient to identify vertical takeovers.
[5] This approach is consistent with the methodology in Shahrur (2005). The analysis based on the positive-negative CWE split is only one piece of evidence we provide. We complement this with cross-sectional analyses which do not rely on this split and where we include economic variables to capture each of our hypotheses.

In the sub-sample of takeovers with a negative CWE to the merging firms, we expect that motives such as agency problems in acquirers (Morck, Shleifer, and Vishny (1990)), overvaluation of acquirer's equity due to stock financing of the takeover (Travlos (1987)), or the negative prospects facing the acquirer's industry causing it to diversify into the supplier or customer industry (Mitchell and Mulherin (1996)) are more dominant than the efficiency, foreclosure, and collusion rationales. In this sub-sample, we find that acquirer rivals and customer firms experience significantly negative abnormal returns, whereas target rivals experience insignificant abnormal returns. The negative response of the acquirer rivals could either be due to the takeover announcement providing new information that the acquirer industry faces bad prospects or due to industry-wide overvaluation conveyed by the announcement of stock financed takeovers. The negative response of customers indicates that value destroying vertical takeovers have negative spillover effects on the customer industry also.

Next, we conduct cross-sectional analyses in an attempt to corroborate the implications of our univariate findings. This analysis provides cleaner tests to distinguish between the efficiency, foreclosure, and collusion hypotheses for the following reasons. First, we include the entire sample of vertical takeovers and not rely on the split based on positive-negative CWE to the merging firms. Second, by including economic variables related specifically to the efficiency, foreclosure, and collusion hypotheses we are able to account for the view that these hypotheses may not be mutually exclusive. We also include control variables for other motives that the extant literature has shown to be causing a negative CWE for the merging firms.

First, we examine the determinants of the CWE to the merging firms. Under the efficiency hypothesis, firms are wary of making relationship-specific investments (RSI) because they foresee future holdup. If the vertical takeover was indeed motivated to solve future holdup, we would expect a higher intensity of RSI post-merger. Based upon this notion, we posit that the RSI of the integrated firm less the pre-merger asset-weighted RSI of the acquirer and target captures the extent of the holdup problem. Prior studies have employed R&D intensity to measure RSI (Levy (1985), Allen and Phillips (2000) and Kale and Shahrur (2007)). Based on this literature, we use the industry-adjusted change in R&D intensity of the merging firms around the year of takeover announcement as a proxy for the extent of the holdup problem. We find that this proxy is positively related to the CWE of the merging firms suggesting that the gains from vertical integration are higher when the extent of the future holdup problem is severe.

As a measure of potential foreclosure, we include the market share of the target (acquirer) since the higher the market share of the target (acquirer), the greater is the ability of the integrated firm to foreclose non-integrated acquirer (target) rivals. Similarly, we use the acquirer industry concentration as a measure for potential collusion, since the higher the concentration in acquirer industry, the higher is the likelihood of the integrated firm colluding with the non-integrated acquirer rivals. Inconsistent with the anticompetitive rationales, we find that the acquirer/target market share and acquirer industry concentration do not affect the CWE to the merging firms.

We next examine the determinants of the wealth effects of the acquirer rivals, target rivals, and customer firms. We find that the CWE of the merging firms is positively related to the wealth effect of the non-integrated acquirer and target rivals. This is inconsistent with the foreclosure hypothesis, where we expect a negative relation between the returns to the merging firms and rivals. In addition, the CWE of the merging firms is positively related to the wealth effect of the customer firms. This goes against the foreclosure and collusion hypotheses, where we expect a negative relation between returns to the merging firms and customer firms. Further, we find that acquirer industry concentration does not affect the wealth effect of the non-integrated rivals and customer firms. This is inconsistent with the collusion hypothesis. Finally, the acquirer and target market share affect the customer returns in a manner that contradicts the predictions of foreclosure hypothesis. Overall, our cross-sectional analyses provide additional evidence supporting the efficiency hypothesis.

Our study contributes to the extant literature in the following ways. First, we provide the first comprehensive and large sample study that attempts to disentangle the efficiency, foreclosure, and collusion rationales for vertical takeovers. Second, our univariate and cross-sectional findings indicate that vertical takeovers are motivated by efficiency improvement rather than anti-competitive rationales. Our findings build upon the work in Eckbo (1983) and Rosengren and Meehan (1994) which does not find evidence supporting anti-competitive effects in vertical takeovers challenged by the Federal Trade Commission (FTC) and Department of Justice (DOJ) prior to 1978. Our evidence also advances the industry-specific case studies which find that vertical integration is efficiency enhancing (Mullin and Mullin (1997), Chipty (2001), and Hortaçsu and Syverson (2007)). Third, in the 1990's the FTC and DOJ have shown substantial interest in vertical takeovers on the grounds of foreclosure or collusion motives leading to several challenges (Morse (1998) and Warren-Boulton (2002)). In this regard, our analysis of rivals and, in particular, the customer firms may be of interest to the regulators since it provides information on the welfare effects of a large sample of vertical takeovers. Finally, our paper complements similar studies that investigate the sources of gains in horizontal takeovers (Eckbo (1983, 1990, 1992), Fee and Thomas (2004), and Shahrur (2005)).

The remainder of the paper proceeds as follows. In Section 2, we discuss the literature and develop our univariate predictions. In Section 3, we describe our data and empirical methodology for univariate predictions and also present the univariate results. In Section 4, we present our cross-sectional predictions and results. Finally, we conclude the paper in Section 5.

2. Univariate Predictions

Vertical takeovers can be of two main types: (i) backward takeovers, where the acquirer is downstream and the target is upstream in the supply chain, and (ii) forward takeovers, where the acquirer is upstream and the target is downstream in the supply chain. Corporate customers are identified as firms that buy the output of the downstream industry in the vertical takeover (see Figure 1 for a schematic diagram). We disentangle the efficiency, foreclosure, and collusion rationales by first developing univariate predictions on the signs of the abnormal returns to the merging firms, acquirer rivals, target rivals, and corporate customers on announcement of vertical takeovers. Our predictions are identical for both forward and backward takeovers. A summary of our univariate predictions is presented in Table I.

2.1. Efficiency hypothesis

The Transaction Cost Economics (TCE) and Property Rights (PR) theories argue that vertical integration reduces transaction costs that arise due to contractual inefficiencies between customers and suppliers (Klein, Crawford, and Alchian (1978), Williamson (1971, 1979), Grossman and Hart (1986), and Hart and Moore (1990)). These theories posit that contracts are incomplete and hence lead to situations where the contracting parties may take advantage of the ambiguities in contracts and behave opportunistically in their own interests.[6] Such opportunistic behavior is termed as "holdup" and leads to sub-optimal relationship-specific investments (RSI). Vertical integration provides common ownership, prevents future holdup behavior, and provides flexibility to make RSI. Using the above arguments, we expect the merging firms in vertical takeovers to experience a positive wealth effect since they improve productive efficiency by undertaking optimal RSI.

Based on the extant literature, we use the better information and competitive advantage views to explain the wealth effects of the non-integrated acquirer and target rivals (Eckbo (1983, 1990) and Rosengren and Meehan (1994)). Under the better information view, the vertical takeover disseminates valuable information about possible efficiency gains from vertical

---

[6] Whinston (2003) argues that the predictions of PR theory are different from those of TCE theory. Tests to differentiate between the TCE and PR theories are beyond the scope of this paper.

integration. The non-integrated acquirer and target rivals can also improve their efficiency by undertaking vertical integration, and therefore experience a positive announcement period wealth effect. In contrast, under the competitive advantage view, the non-integrated acquirer and target rivals are at a competitive disadvantage compared to the integrated firm since they are still subject to inefficiencies, and therefore experience a negative wealth effect. Overall, due to the opposing effects of the above two views, we expect the sign of the announcement period wealth effect of the non-integrated acquirer and target rivals to be unrestricted.

The wealth effect of the customer firms enhances our ability to separate the efficiency hypothesis from the anti-competitive rationales. In each vertical takeover, we identify customers as firms that buy the product of the downstream industry in the vertical takeover. If vertical integration reduces transaction costs, then it is likely that at least some of these benefits would be passed on to the customers through lower prices.[7] We therefore expect the customer firms to experience a zero to positive wealth effect based on how much benefits are passed on by the integrated firm.

In prior research, Spiller (1985) investigates if asset specificity can explain gains to merging firms in vertical mergers. Spiller argues that the smaller the distance between plants of acquirer and target firms the larger would be the extent of asset specificity. He uses a sample of 32 vertical mergers challenged by FTC prior to 1978 and finds that the gains to the merging firms are larger when the distance between plants is smaller. This is consistent with the predictions of the Transaction Cost Economics theory. He does not investigate foreclosure and collusion rationales for vertical integration.

---

[7] Apart from the reduced transaction costs, the other benefits of vertical integration advanced in the literature are the elimination of double marginalization (Perry (1989) and Joskow (2005)), a reduction in supply uncertainty (Arrow (1975)), and better coordination in design (Perry (1989)).

In summary, under the efficiency hypothesis, the combined wealth effect (CWE) of the merging firms is positive, the wealth effect of the non-integrated acquirer/target rivals is unrestricted in sign, and that of the customer firms is zero to positive (Table I).

2.2. Foreclosure Hypothesis

A large body of theoretical literature (post-Chicago school) shows that vertical takeovers can harm competition by disadvantaging the upstream/downstream rivals (Salinger (1988), Hart and Tirole (1990), Ordover, Saloner, and Salop (1990), and Rey and Tirole (2006)). Under foreclosure, a firm acquires an essential facility in either its supplier or customer industry and finds it profitable to deny access of this facility to its non-integrated rivals. This leads to a reduction in the margins of the rivals and increases the likelihood of their exit from the industry. Further, foreclosure increases the barriers to entry since a likely entrant would require segments in both upstream and downstream industries to compete effectively with the integrated firm.

Foreclosure can mainly be of two types: input foreclosure and customer foreclosure. Input foreclosure occurs when a vertically integrated firm restricts supply of the input or raises costs of the input that it controls to its non-integrated downstream rivals. Customer foreclosure occurs when a vertically integrated firm reduces the revenues of the non-integrated upstream rivals by not purchasing their output (Church (2004)).

Under the foreclosure hypothesis, we expect the non-integrated acquirer and target rivals to experience a negative wealth effect due to the increased market power of the vertically integrated firm. Specifically, in a backward takeover, the margins of the non-integrated acquirer rivals are reduced due to the higher price of inputs from the integrated firm and the revenues of the non-integrated target rivals decline since they can no longer sell their output to the integrated firm. Similarly, in a forward takeover, the revenues of the non-integrated acquirer rivals decline since they can no longer sell their output to the integrated firm and the margins of the non-integrated target rivals are reduced due to the higher price of inputs from the integrated firm. The increased barriers to entry and the unfair advantage over the non-integrated rivals enable the vertically integrated firm to charge higher prices to customer firms. This suggests that customer firms would experience a negative wealth effect.

The 1984 non-horizontal merger guidelines of the FTC and DOJ recognize foreclosure effects of vertical takeovers.[8] The U.S. antitrust regulators have scrutinized several vertical takeovers on account of foreclosure, for example, the 1995 takeover of Wavefront Technologies, a developer of graphics software, by Silicon Graphics (SGI), a manufacturer of graphics workstations. FTC challenged this acquisition contending that it could lead to the foreclosure of other workstation manufacturers by increasing the costs of obtaining graphics software from Wavefront. Another concern was the foreclosure of the competitors of Wavefront due to the increased costs in developing software for SGI workstations. FTC required that SGI maintain an open architecture so that independent software developers could sell their product for use on SGI computers (Morse (1998)).[9]

The extant literature provides industry-specific case studies and experimental studies that investigate foreclosure. For example, Mullin and Mullin (1997) find that U.S. Steel's acquisition of Northern Iron Ore properties promoted RSI and resulted in lower steel prices to the customers. Chipty (2001) finds that customers of integrated cable operators are not worse-off when compared to customers of non-integrated cable operators. Hortaçsu and Syverson (2007) use plant-level data on cement and ready-mixed concrete producers and find a reduction in prices when plants became more integrated. The evidence in the above case studies is generally inconsistent with the foreclosure hypothesis. In contrast, Hastings and Gilbert (2005) find that mergers in the gasoline industry that increase the extent of vertical relatedness increased the

---

[8] For an overview of the guidelines refer http://www.usdoj.gov/atr/public/guidelines/2614.htm. These guidelines also recognize the possibility of collusion arising in vertical takeovers.
[9] The takeover of Time Warner by AOL in 2000 was also challenged by the FTC on account of foreclosure (Schlossberg (2004)).

wholesale prices on account of increased cost to the rivals. Martin, Normann, and Snyder (2001) and Normann (2007) provide experimental evidence consistent with foreclosure. Finally, Rosengren and Meehan (1994) investigate foreclosure by studying the stock performance of acquirer and target rivals on announcement of 19 vertical takeovers investigated by FTC between 1963 and 1982. They find that the rivals experience statistically insignificant abnormal returns around the dates of announcement and challenge, which is inconsistent with foreclosure.[10]

Summing up, under the foreclosure hypothesis, the CWE to the merging firms is positive, whereas the wealth effects of the non-integrated acquirer rivals, non-integrated target rivals, and customer firms are negative (Table I).

2.3. Collusion Hypothesis

Several research studies have examined the possibility that horizontal takeovers create an environment conducive to collusion amongst rival producers (Eckbo (1983, 1985), Fee and Thomas (2004), and Shahrur (2005)). Horizontal takeovers reduce the number of producers in the takeover industry and therefore increase the likelihood of collusion. There is less reason to believe that vertical takeovers are associated with collusion since they do not alter the upstream/downstream industry structures. However, there has been a substantial interest by the FTC and DOJ regarding collusion due to vertical integration as evidenced in their non-horizontal merger guidelines. In 1995, the FTC challenged the proposed takeover of PCS Health Systems, a pharmacy benefits management company, by Eli Lilly, a drug manufacturer. Prior to the merger, PCS' formulary included products of Eli Lilly's rivals. The FTC required a firewall to prevent the passing of confidential information on the pricing structure of other drug manufacturers from PCS to Lilly, which may have facilitated collusion between Lilly and its rivals (Morse (1998)).[11]

[10] Our study is a large sample study and over a different period from Rosengren and Meehan. Besides, we provide tests to disentangle the hypotheses by studying the customer wealth effects and performing cross-sectional analyses.
[11] Another example of antitrust intervention on grounds of collusion due to vertical integration is the challenge by DOJ of the merger between AT&T Corporation and McCaw Cellular Communications in 1994 (Morse (1998)).

Recent theoretical work adds further support to the view that vertical integration increases the likelihood of collusion (Chen (2001) and Nocke and White (2007)). Chen (2001) shows that backward takeovers increase the likelihood of downstream collusion. In his model, the upstream and downstream industries are oligopolies with two firms at each level. Both downstream firms bid to acquire the supplier with the lower marginal cost but only one of them succeeds. Chen shows that the takeover creates incentives for the unsuccessful bidder to strike a deal with the integrated firm for input supply. The integrated firm supplies input at a price above its marginal cost but now has incentive to compete less aggressively in the downstream market since its profits depend on the input sold to the rival. The ensuing collusion between the integrated firm and the downstream rivals enables them to extract rents from customer firms.

Therefore, we posit that, in backward takeovers, the merging firms and the non-integrated acquirer rivals would experience a positive wealth effect since there is a higher likelihood of collusion after the vertical takeover. On account of this downstream collusion, the non-integrated target rivals now have a reduced demand for their output and would experience a negative wealth effect.[12] Finally, the customer firms would experience a negative wealth effect since they face higher input prices on account of collusion.

Nocke and White (2007) argue that forward takeovers increase the likelihood of upstream collusion. Specifically, the vertical takeover of a downstream target by an upstream acquirer facilitates collusion through the 'outlets effect', where the non-integrated upstream rivals cannot sell to the downstream segment of the integrated firm if they defect from collusive agreements, or the 'reactions effect', where the vertically integrated firm is better equipped to punish defections of upstream rivals by competing more aggressively in the downstream market.

[12] Since the acquirer initiates the acquisition it is likely that the intent is to collude at the acquirer's industry level. Our predictions for the acquirer/target rivals under the collusion hypothesis are based on the assumption that collusion occurs at the acquirer's industry level.

Therefore, we posit that, in forward takeovers also, the merging firms and the non-integrated acquirer rivals experience a positive wealth effect. On account of the upstream collusion, the non-integrated target rivals experience a negative wealth effect since they receive inputs at a higher price. The customer firms, who are buyers of the product of the downstream industry in the vertical takeover, also experience a negative wealth effect if some of the harmful effects of collusion experienced by the non-integrated target rivals are passed on to the next level in the supply chain.

There is very little empirical evidence regarding the collusion rationale of vertical takeovers. Eckbo (1983), who primarily investigates collusion in challenged horizontal takeovers, also investigates the stock price response of the target rivals in challenged vertical takeovers. He finds that target rivals experience largely insignificant abnormal returns both at the announcement of proposal and the antitrust complaint. Consistent with the suggestion in Eckbo (1983), we study rivals in the industries of both merging partners since the collusive effects can be experienced at both the upstream and downstream levels. Further, our study is the first to examine the effect of collusion on customers in vertical takeovers.

Summing up, under the collusion hypothesis, the CWE to the merging firms and the wealth effect of the non-integrated acquirer rivals is positive, whereas the wealth effect of the non-integrated target rivals and customer firms is negative (Table I).

3. Sample Selection and Univariate Results

3.1. Takeover sample

We use the Worldwide Mergers & Acquisitions section of the Securities Data Company (SDC) database between 1981 and 2004 to construct the takeover sample. We include deals which meet the following characteristics in our sample: (i) the deal should not be classified as a spin-off, repurchase, recapitalization, divestiture, leveraged buyout, or self-tender offer and (ii) the ‘form’ of the deal should not be classified as “Acquisition of remaining interest”, "Acquisition of assets" or "Buyback". We define a contest for each target to include all bids for that target such that the period between two consecutive bids is less than a year. Consistent with Kale, Kini, and Ryan (2003), successful bids are identified as those where the acquirer owned less than 50% of the target shares prior to deal announcement and acquired at least 15% of the target shares during the contest.[13] We only include those contests where both the acquirer and target are U.S. public firms. We also exclude contests where the acquirer or target is a financial firm (four-digit Standard Industrial Classification (SIC) codes between 6000 and 6999). For each contest, we obtain the following dates: (i) the announcement date of the first bid in the contest, (ii) announcement date of the first bid by the successful acquirer, and (iii) the announcement date of the successful bid.

3.2. Identifying vertical takeovers

Kahle and Walkling (1996) find that firms change their industry classifications over time and recommend using the historical SIC instead of the current SIC to identify the primary industry classification of a firm. For each successful bid in our sample, we find the historical SIC code (Compustat data item 324) for the acquirer and target during the year of takeover announcement. Since Compustat provides the historical SIC code only beginning 1987, for takeovers prior to 1987, we use the SIC code of the segment with the highest sales during the announcement year.[14] We exclude horizontal takeovers from our sample by dropping takeovers where the acquirer and target have the same four-digit SIC code.

To identify vertical relations, we use the benchmark input-output accounts for the U.S. economy published by the Bureau of Economic Analysis every five years. The *Use Table* from the benchmark accounts provides a matrix of commodity flows between different pairs of input-

[13] The choice of 15% target shares was originally proposed by Bradley, Desai, and Kim (1983). However, to account for the possibility that our sample may be picking up stake purchases rather than acquisitions, we alternatively define successful takeovers as those where the bidder acquires 100% of the target shares in the contest. The results for this sample are qualitatively similar to those reported in the paper.

[14] For takeovers prior to 1987, if the SIC of the segment with the highest sales is missing, we use the 1987 historical SIC.

output (IO) industries. For example, for a given IO industry 'i', we can obtain the dollar amount of commodity flow from IO industry 'j' required to produce the total output of industry 'i'. We use the SIC-IO concordance table of Fan and Lang (2000) to map the four-digit SIC codes of the acquirers and targets to their six-digit IO codes. We retain takeovers where both the acquirer and target have same six-digit IO codes since prior research argues that significant opportunities for vertical integration exist within IO industries (Fan and Goyal (2006)).

Since it is likely that input-output relations change over time, we use the 1982, 1987, 1992, and 1997 *Use* tables for takeovers taking place during the periods 1981 to 1985, 1986 to 1990, 1991 to 1997, and 1998 to 2004 respectively. The 1997 benchmark input-output accounts incorporate the NAICS system instead of the SIC system of industry classification. Hence, for takeovers during 1998 to 2004, we first map the four-digit SIC codes of acquirers and targets to their six-digit NAICS codes using the Bridge tables provided by the Bureau of Census. We then find their respective IO industries using the NAICS-IO concordance table provided in the 1997 benchmark input-output accounts.

As our measure for vertical relations, we calculate the vertical relatedness coefficient (VRC) for each pair of acquirer-target IO codes. Our approach is in the spirit of Fan and Goyal (2006). For every takeover, we calculate the VRCs as follows: (i) For every dollar of the acquirer industry total output, find the dollar flow from the acquirer to the target industry ($V_{1,AT}$) and the dollar flow from the target to the acquirer industry ($V_{1,TA}$), and (ii) For every dollar of the target industry total output, find the dollar flow from the acquirer to the target industry ($V_{2,AT}$) and the dollar flow from the target to the acquirer industry ($V_{2,TA}$). Then, the vertical coefficient under the first approach is calculated as Max ($V_{1,AT}$, $V_{1,TA}$) and is called *ACQVRC*, whereas the VRC under the second approach is calculated as Max ($V_{2,AT}$, $V_{2,TA}$) and is called *TARVRC*. We classify a takeover as vertical if either *ACQVRC* or *TARVRC* is greater than 1%. Using both approaches is important since if the acquirer (target) industry output is large compared to the target (acquirer) industry output, it is possible that a takeover would not meet the cutoff under the first (second) approach.

Based on the above sample selection criteria, we identify 453 successful vertical takeovers over the period 1981-2004.[15] Table II presents the descriptive statistics for our sample. About 67% of the vertical takeovers are structured as mergers and the remaining 33% as tender offers. About 27% of the vertical takeovers in our sample are financed with equity only, 35% are financed with cash only, and the remaining 38% are financed with a combination of cash and equity. The market capitalization of the acquirers is significantly larger than the market capitalization of the targets. Specifically, the mean (median) market capitalization of acquirer firms is $15,659 million ($2,014 million) and that of target firms is $669 million ($129 million).

The mean value of $V_{1,AT}$ is 0.07, which indicates that seven cents worth of commodities flow from the acquirer industry to the target industry for every dollar of output produced by the acquirer industry. Similarly, the mean value of $V_{1,TA}$ is 0.08, which indicates that eight cents worth of commodities flow from the target industry to the acquirer industry for every dollar of output produced by the acquirer industry. The mean value of *ACQVRC* is 0.09, which indicates that the extent of commodity transfer between the acquirer and target industries is nine cents for every dollar of the acquirer industry total output. Similar numbers are obtained for $V_{2,AT}$, $V_{2,TA}$, and *TARVRC*, which are based on target industry total output.

In Appendix A, we provide pairs of acquirer and target industries that display significant vertical relationships based on $V_{1,AT}$ or $V_{1,TA}$. Petroleum, chemicals, food, television and radio broadcasting, motion pictures, and semiconductor manufacturing are some of the industries that display significant vertical relationships. In unreported results, we find that acquirer and target two-digit SIC industries such as business services (SIC=73), chemicals and allied products

[15] Using higher cutoffs leads to a significant decrease in our sample size. Use of a 5% cutoff gives a sample of 225 vertical takeovers. The results for this sample are qualitatively similar to the sample based on the 1% cutoff.

(SIC=28), communications (SIC=48), electronic and electrical equipment (SIC=36), and industrial and commercial machinery (SIC=35) account for more than 50% of our takeover sample. We also find significant vertical takeover activity during 1996-2000, which accounts for roughly 36% of our sample (164 takeovers).

Since we identify our sample based on primary SIC codes, it is important that we investigate how the sales of the primary segment compared to the overall sales of the acquirers and targets in our sample. We find that the primary segment accounted for, on average, roughly 80% of the overall sales of acquirers and roughly 92% of the overall sales of targets. This indicates that the primary segment accounted for a significant proportion of sales in both acquirers and targets. Further, if horizontal relations exist between the acquirer and target firms in the secondary segments, it is possible that our results are contaminated due to the inclusion of takeovers with horizontal relations. To allay this concern, we use segment data of the acquirers and targets and find 58 vertical takeovers that display horizontal relations at the secondary segment level. Our results are robust to exclusion of these takeovers from our sample.

3.3. Event Study Methodology

We use the market model to calculate the parameter estimates of the return generating process of the acquirer and target. We use the daily returns for 240 trading days beginning 300 days before the announcement of the first bid by the successful acquirer as the estimation period. Further, we require a minimum of 200 daily return observations during estimation period. We then calculate the cumulative abnormal returns for the acquirer and target over the windows of (-5, +5) and (-10, +10) trading days around the period between the announcement of the first bid by the successful acquirer and the announcement of the successful bid in the contest.

$$Market\ Model$$
$$R_{it} = \alpha_i + \beta_i * R_{mt} + \varepsilon_{it} \qquad for\ t = -300, \ldots\ldots\ldots\ldots, -60$$

$$Cumulative\ Abnormal\ Return$$
$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i * R_{mt}$$
$$TCAR_i = \sum_{t=firbidat-n}^{t=sbidann+n} AR_{it}$$
$$ACAR_i = \sum_{t=firbidat-n}^{t=sbidann+n} AR_{it}$$

$where$:
$sbidann = Date\ of\ successful\ bid\ in\ contest$
$firbidat = Date\ of\ first\ bid\ by\ successful\ acquirer$

Consistent with Bradley, Desai, and Kim (1988), we measure the combined wealth effect (CWE) of the takeover as the value-weighted cumulative abnormal return to the acquirer (ACAR) and target (TCAR). The weights are the market capitalizations of the acquirer and target fifteen trading days prior to the announcement of the first bid by the successful acquirer.

3.4. Acquirer rivals, target rivals and corporate customers

We identify non-integrated acquirer rivals as all firms on Compustat with the same primary SIC code as the acquirer provided they did not have a segment in the target's primary SIC code. Similarly, we identify non-integrated target rivals as all firms on Compustat with the same primary SIC code as the target provided they did not have a segment in the acquirer's primary SIC code. Multi-segment firms that may have segments unrelated to the primary SIC codes of the merging firms may create noise in the measurement of the abnormal returns. Hence, as a robustness check, we construct the acquirer and target rival portfolios using single segment firms alone. We find qualitatively similar results under this approach.

We identify the customer firms for each vertical takeover as follows. First, we identify the downstream industry in the vertical takeover. Specifically, if the takeover is backward, the downstream industry in the vertical takeover is the acquirer's input-output (IO) industry; and if the takeover is forward, the downstream industry in the vertical takeover is the target's IO industry. Second, we find the industry that buys the highest proportion of the total output produced by the downstream industry in the vertical takeover (Main Customer Industry), and the industry that obtains the highest proportion of its inputs from the downstream industry in the vertical takeover for production of its total output (Dependent Customer Industry). Further, to account for low input-output relationships between the downstream industry in the vertical takeover and the main/dependent customer industry, we consider the main/dependent customer industry only if the proportion (as identified above) is at least 1%. Finally, we identify single segment firms on Compustat that belong to the main and dependent customer industries during the year of takeover announcement. We consider only single-segment firms for customer portfolios because each six-digit customer IO industry typically includes multiple four-digit SIC codes, and including multi-segment firms also would create a noisy proxy for customer returns.

For every vertical takeover, we combine the acquirer rivals, target rivals, main and dependent customers into separate equally weighted portfolios to account for the contemporaneous cross-correlation in returns. The equally weighted portfolio approach is consistent with Eckbo (1983), Song and Walkling (2000), Fee and Thomas (2004), and Shahrur (2005). We calculate the abnormal returns to the acquirer rival, target rival, main customer, and dependent customer portfolios for windows of (-1, +1), (-2, +2), (-5, +5) and (-10, +10) trading days around the announcement of the first bid by the successful acquirer.

3.5. Wealth effects of the merging firms, rivals, and customers

For the overall sample of 453 vertical takeovers, we find that the average acquirer cumulative abnormal return (CAR) is -1.11% and the average target CAR is 28.94% when measured over the window of (-10, +10) trading days around the period between the announcement of the first bid by the successful acquirer to the announcement of the successful bid in the contest. Over the (-5, +5) window, the average acquirer CAR is -0.83% and the average target CAR is 26.51%. For both the windows, the acquirer CAR is statistically indistinguishable from zero, whereas the target CAR is statistically significant at the 1% level. The average CWE to the acquirer and target firms is 2.21% and 2.13% over the (-10, +10) and (-5, +5) windows and are both statistically significant at the 1% level. This finding is consistent with Fan and Goyal (2006), who also find that vertical takeovers create value for the merging firms.

In Panel A of Table III, we report the announcement period abnormal returns of the acquirer rivals, target rivals, main customers, and dependent customers for our entire vertical takeover sample. Consistent with the extant literature, we use the Patell Z-score to test the statistical significance of abnormal returns (Eckbo (1983) and Song and Walkling (2000)). We apply the Mikkelson and Partch (1988) correction to adjust for serial dependence. We perform a generalized sign test for the statistical significance of the percentage of portfolios with positive CARs. For the overall sample, we find that the average announcement period abnormal returns to the acquirer rivals, target rivals, main customers, and dependent customers are statistically insignificant for most of the windows. The insignificant performance of the acquirer/target rivals is weakly consistent with the efficiency hypothesis, where we expected an unrestricted wealth effect. Similarly, the insignificant performance of the customer firms indicates that none of the efficiency gains due to vertical integration are passed on to the customers.

The efficiency, foreclosure, and collusion hypotheses, all suggest that the takeover created value for the acquirer and target firm. Hence, to improve the power of our tests, we sub-divide our sample based on whether the takeover generates a positive or negative CWE to the merging firms. We expect the efficiency, foreclosure, and collusion rationales to be more prominent in the positive sub-sample.

We find that about 51% of the takeovers have a positive CWE for the merging firms over the (-10, +10) window. For the positive CWE sub-sample, which is reported in Panel B of Table

III, we find that the acquirer rivals experience, on average, a positive and significant abnormal return at least at the 5% level in all four windows. For example, the average abnormal return of acquirer rivals over the (-10, +10) window is 1.20% and is statistically significant at the 1% level. The proportion of positive CARs is statistically significant at the 10% level only over the (-10, +10) window. However, the z-statistic for the difference in means and the difference in proportions between the positive and negative sub-samples is statistically significant for all windows. The generally positive average stock price response of the acquirer rivals is inconsistent with competitive advantage or foreclosure hypotheses but is consistent with better information or collusion hypotheses.

Further, we find that target rivals experience, on average, a positive and significant abnormal return at least at the 5% level in three of the four windows examined. For example, the average abnormal return to target rivals over the (-10, +10) window is 0.86% and is significant at the 5% level. The proportion of portfolios with a positive CAR is statistically significant for the (-1, +1) and (-2, +2) windows. The z-statistic for the difference in means between the positive and negative sub-samples is statistically insignificant for all windows, whereas the z-statistic for the difference in proportions is significant for two of the four windows. The weakly positive average response for the target rivals is in the direction predicted by the better information hypothesis, and is inconsistent with the competitive advantage, foreclosure, or collusion hypotheses.[16]

In the positive CWE sub-sample, we also find that the main customer firms experience, on average, a positive and significant abnormal return of 0.93% over the (-10, +10) window. The abnormal returns over the other three windows are, however, insignificant. The proportion of main customer portfolios with positive CARs is found to be insignificant over all event windows.

---

[16] The positive response to target rivals is also consistent with the acquisition probability hypothesis of Song and Walkling (2000) which suggests that unexpected acquisition attempts increase the likelihood of target rivals being targets in future acquisitions. We control for this possibility in our cross-sectional analyses.

However, the z-statistic for the difference in means and the difference in proportions between the positive and negative sub-samples is statistically significant for at least one window examined. While the evidence that the abnormal returns to main customers are positive can be characterized as weak, the picture that clearly emerges is that the main customers do not appear to be harmed as a result of foreclosure or collusion. Additionally, this evidence in conjunction with the positive abnormal returns to the acquirer rivals and target rivals is consistent with the presence of efficiency gains with the caveat that only a small part, if at all, of these efficiency gains are being passed down to the main customers.

We expect the efficiency and anti-competitive effects of vertical takeovers to be more pronounced for dependent customers rather than main customers since these are firms that depend most on inputs supplied by the downstream industry in the vertical takeover. Consistent with this expectation, we find that the dependent customer firms experience, on average, a positive and significant abnormal return over all four event windows. For example, the average abnormal return for dependent customers over the (-10, +10) window is 2.98% and significant at the 1% level. Further, the proportion of portfolios with positive CARs is statistically significant for the (-5, +5) and (-10, +10) windows. The z-statistic for the difference in means and the difference in proportions between the positive and negative sub-samples is statistically significant for at least three of the four event windows. The positive abnormal returns of dependent customers support the efficiency hypothesis and complement our results of the acquirer and target rivals in rejecting foreclosure and collusion hypotheses.

In Panel C of Table III, we report the results of the sub-sample where the merging firms experience a negative CWE. While it is possible that the efficiency, foreclosure, and collusion rationales are valid in this sub-sample also, the negative CWE to the merging firm suggests that there could be other more dominating motives. First, these takeovers could be driven by agency problems prevalent in acquirer firms (Jensen (1986) and Morck, Shleifer, and Vishny (1990)).

Second, these takeovers may be stock financed and, hence, could indicate overvaluation of the acquirer's equity (Travlos (1987)). Finally, the acquirer expands into the supplier or customer industry because its own industry faces negative prospects and the announcements of such takeovers is perceived as new bad news regarding the acquirer firms and its industry (Mitchell and Mulherin (1996)).

For the sub-sample with a negative CWE to the merging firms, we find that acquirer rivals experience negative and significant abnormal returns over all event windows. The negative response could indicate that the takeover is an attempt by the acquirer to expand into its supplier or customer industry due to the bad prospects facing its own industry, and thereby conveys negative information regarding all firms in the acquirer industry. Alternatively, if the negative CWE suggests overvaluation of acquirer's equity, then the negative response to rivals means the overvaluation could be industry-wide. Further, we find that the main and dependent customer firms experience generally negative average abnormal returns. This result indicates that value destroying vertical takeovers could have potentially harmful effects on firms that buy product of the downstream industry of the vertical takeover. Finally, we find that target rivals experience negative average abnormal returns but are statistically insignificant over most windows. These weak results are consistent with the acquisition probability hypothesis of Song and Walkling (2000) since the target rivals in value destroying takeovers could also be potential future targets.

As argued above, the announcement period wealth effects of the acquirer rivals, target rivals, and customer firms in the positive CWE sub-sample are supportive of the efficiency hypothesis. An alternative explanation, however, could be that these returns are not due to the implied efficiency gains in the merger, but rather by a positive news regarding the industries involving the merging firms which lead to a upward trend in these industries.[17] To test this explanation, we investigate the abnormal returns to the rivals and customers in the "pre-

[17] We thank Chad Syverson for pointing this issue.

announcement" period. If the announcement period wealth effects are an artifact of a general trend in the industries involved in the merger, it is likely that we observe similar wealth effects in the "pre-announcement" period also.

We use a "pre-announcement" period of (-40, -10) days and randomly assign this period into windows of 5 days each. We then compute the abnormal returns to the acquirer/target rivals and customer firms over each of these windows. In the sub-sample of deals with a positive CWE, we find that abnormal returns to acquirer rivals are insignificant for 81% of the pre-announcement windows, abnormal returns to target rivals are insignificant for 67% of the pre-announcement windows, abnormal returns to main customer firms are insignificant for 74% of the pre-announcement windows, and abnormal returns to dependent customers for 93% of the pre-announcement windows. Similar insignificant wealth effects are also observed for a majority of the "pre-announcement" windows in the sub-sample of deals with a negative CWE. The generally insignificant wealth effects in the pre-announcement windows further support the view that the observed announcement period wealth effects are not due to an industry trend but are indeed driven by the implied efficiency gains in the takeover.

In summary, the above described univariate results uncover the following findings: (i) In the sub-sample of takeovers where the merging firms experience a positive CWE, the acquirer and target rivals tend to gain, main customer firms do not lose, and dependent customer firms gain, and (ii) In the sub-sample of takeovers where merging firms experience a negative CWE, the acquirer rivals lose, the main and dependent customer firms lose, whereas target rivals have insignificant abnormal returns. The evidence in the positive CWE sub-sample is inconsistent with foreclosure or collusion hypotheses, and, on balance, suggests that vertical takeovers are likely to be driven by efficiency gains.[18]

---

[18] We perform the following test to investigate the robustness of our univariate results. Use of the first bid by the successful acquirer may understate target returns since the target is in play since the announcement of the first bid in

3.6. Additional tests for foreclosure and collusion

The rival/customer portfolios are based on all Compustat firms and therefore can include firms that operate anywhere in the United States. If the merging firms do not operate nationally, it is unlikely that rivals and customers that are distant from the geographic regions of the merging firms will register any wealth effects. As a robustness check, we repeat our tests using rivals and customers that are geographically "closer" to the merging firms. Specifically, we form acquirer (target) rival portfolios based on firms with the same headquarter state as the acquirer (target) and customer portfolios based on firms with the same headquarter state as either the acquirer or target. The wealth effects for rival/customer portfolios based on only the regional firms are largely similar to those based on all Compustat firms. In the positive CWE sub-sample, which is of main interest, we find that the acquirer rivals and target rivals gain, main customer firms do not lose, and dependent customer firms gain. The results for the overall sample and negative CWE sub-sample are qualitatively similar to those reported in Panels A and C of Table III. Therefore, while using only the regional firms, our evidence is still inconsistent with the foreclosure and collusion rationales.

As an additional test for the anti-competitive rationales, we identify sub-samples where foreclosure and collusion are more likely to occur. For this purpose, we use the non-horizontal merger guidelines of the U.S. antitrust authorities that are used to categorize vertical takeovers as anti-competitive.[19] The guidelines state that vertical takeovers where the acquirer industry concentration exceeds 1,800 can be challenged on grounds of collusion or where the target market share exceeds 20% can be challenged on grounds of foreclosure. We expect foreclosure and collusion would at least appear in the sub-samples identified by the above criteria.

the contest. Therefore, we compute the target CAR for the window of (-10, +10) days around the period between the announcement of the first bid in the contest to the announcement of successful bid in the contest. Acquirer CAR is still measured for the window of (-10, +10) days around the period between the announcement of the first bid by the successful acquirer and the announcement of the successful bid. The wealth effects of the rivals/customers under this approach are qualitatively similar to those reported in Table III.

[19] For an overview of the criteria refer http://www.usdoj.gov/atr/public/guidelines/2614.htm

We identify two sub-samples to perform our tests: (i) all takeovers with a positive CWE to the merging firms and where the acquirer industry concentration is greater than 1,800, and (ii) all takeovers with a positive CWE to the merging firms and where the target market share is greater than 20%. We restrict our analysis to only those takeovers with a positive CWE to the merging firms since foreclosure and collusion hypotheses predict value creation for the merging firms. As before, we use the (-10, +10) event window to measure the CWE of the merging firms. We measure the acquirer industry concentration as the sales-based Herfindahl index, computed as the sum of squares of market shares of all firms on Compustat with the same four-digit primary SIC code as the acquirer during the year of announcement. We measure market share of the target based on the sales of all firms on Compustat with the same four-digit primary SIC code as the target during the year of announcement.

In unreported results, we find that the average CAR to the acquirer rivals, target rivals, main customers, and dependent customers is positive in both these sub-samples. Thereby, we provide additional evidence that is inconsistent with foreclosure and collusion.

4. Cross-Sectional Predictions and Results

In Section 3, we solely rely on our univariate predictions on the signs of abnormal returns to the merging firms, rivals, and customer firms. The evidence there is largely consistent with the efficiency hypothesis. In the cross-sectional analyses we include all vertical deals and do not rely on the positive-negative CWE split that was used in the univariate analysis. Further, since the efficiency, foreclosure, and collusion hypotheses are not mutually exclusive to each other, we include economic variables related to each of the three hypotheses and investigate how these variables influence the wealth effects of the merging firms, rivals, and customers. We also include control variables for other motives that the extant literature has shown to be driving the deals with a negative CWE. Therefore, the cross-sectional analyses provide additional corroborating evidence to disentangle the three rationales for vertical takeovers. In this section, we first investigate the determinants of the CWE to the merging firms. We then examine the determinants of the wealth effect of acquirer/target rivals and customer firms.

4.1. Determinants of the combined wealth effect of the merging firms

We propose the cross-sectional model given by Eq. (1) to examine the determinants of the CWE to the merging firms. In the model, *CWE* is the value weighted abnormal return to the merging firms, *RDICHG* is the proxy for the extent of the future holdup, $MKTSH_{ACQ}$ is the acquirer's market share in its primary four-digit SIC industry, $MKTSH_{TAR}$ is the target's market share in its primary four-digit SIC industry, $CONC_{ACQ}$ is the concentration of the acquirer industry, *ACQCF* is the acquirer cash flow, *ACQCF (q<1)* is the interaction between the acquirer cash flow and a dummy variable that equals one if acquirer's Tobin's q is less than one and zero otherwise, *TAR (q>1*) is a dummy that equals one if the target Tobin's q exceeds one and zero otherwise, $FORCOMP_{ACQ}$ and $FORCOMP_{TAR}$ are the intensity of foreign competition in acquirer and target industry respectively, and *CONTROLS* include relative size and dummies for stock offers and hostile offers.

$$\begin{aligned} CWE = \beta + \beta_1 * RDICHG + \beta_2 * MKTSH_{ACQ} + \beta_3 * MKTSH_{TAR} + \beta_4 * CONC_{ACQ} + \beta_5 * ACQCF \\ + \beta_6 * ACQCF(q<1) + \beta_7 * TAR(q>1) + \beta_8 * FORCOMP_{ACQ} + \beta_9 * FORCOMP_{TAR} + CONTROLS \end{aligned} \quad (1)$$

Under the efficiency hypothesis, firms vertically integrate when they expect potential for future holdup. Since the vertically integrated structure gives more flexibility than the non-integrated structure to make relationship-specific investments (RSI), we expect an increase in the intensity of RSI post-merger. Further, we expect this change to be higher, the higher the extent of future holdup. Prior research has used the level of R&D intensity to measure RSI. For example, Levy (1985) uses R&D intensity as proxy for transaction-specific capital and finds a positive relationship between R&D intensity and vertical integration. Allen and Phillips (2000) suggest that industries with high R&D intensity are more likely to create relationship-specific assets. Kale and Shahrur (2007) use R&D intensity as a proxy for RSI and find that firms use less debt in their capital structure to induce RSI by customers and suppliers. We measure R&D intensity of the acquirer and target as the ratio of R&D expenditure (Compustat data item 46) to total assets (Compustat data item 6).[20]

The pre-merger level of RSI is calculated as the asset weighted R&D intensity of the acquirer and target firm and the post-merger level of RSI as the R&D intensity of the integrated firm. Further, since R&D intensity is a function of the industry in which firms operate, we adjust the raw R&D intensity by the industry median values. The pre and post industry median R&D intensities are calculated as the asset weighted R&D intensity of the median firm in the acquirer and target industry for the year in consideration. Industry-adjusted change in R&D intensity (RDICHG), which is our proxy for the extent of holdup, is calculated as the difference between the industry-adjusted post-merger level of RSI and the industry-adjusted pre-merger level of RSI. We posit that when the potential for holdup is higher, the higher would be the industry-adjusted change in R&D intensity, and also the higher would be gains from vertical integration ($\beta_1 > 0$).

As measures of potential foreclosure, we include the acquirer and target market shares during the year of takeover announcement. Under foreclosure, the higher the market share of the acquirer (target), the higher is the market power to the integrated firm to foreclose the non-integrated target (acquirer) rivals, and hence, the higher should be the gains to the merging firms ($\beta_2 > 0$, $\beta_3 > 0$). Acquirer (target) market share is measured based on the sales of all firms on Compustat with the same four-digit primary SIC code as the acquirer (target) during the year of announcement. As a measure for potential collusion, we include the concentration of the acquirer

[20] As in Coles, Daniel, and Naveen (2006), Fee, Hadlock, and Thomas (2006) and Kale and Shahrur (2007), we replace missing observations of R&D expenditure by zero. The mean value of RDICHG for the overall sample is 0.05%. For the sub-sample of takeovers with a positive CWE to merging firms, the mean RDICHG is 0.63%, and for the sub-sample of takeovers with negative CWE, the mean RDICHG is -0.58%.

industry. Under collusion, the higher the concentration of the acquirer industry, the higher is the likelihood of collusion between the integrated firm and the non-integrated acquirer rivals after the vertical takeover and, hence, the higher should be the gains to the merging firms ($\beta_4 > 0$). Acquirer industry concentration is measured as the sales-based Herfindahl index and computed as the sum of squares of market shares of all firms on Compustat with the acquirer's four-digit primary SIC code during the announcement year.[21]

In our univariate analysis, we find that a significant proportion of vertical takeovers are associated with a negative CWE to the merging firms. To investigate if agency problems in acquirers lead to the negative CWE, we include as control variables, acquirer cash flow (ACQCF) and an interaction between the acquirer cash flow and a dummy variable that equals one if acquirer's Tobin's q is less than one and zero otherwise (*ACQCF (q<1)*). This approach is consistent with Lang, Stulz, and Walkling (1991). Under the agency hypothesis, cash rich acquirers with low Tobin's q are more likely to engage in value-destroying acquisitions. Accordingly, the higher the cash flows with a low q acquirer, the greater is the extent of value destruction ($\beta_6 < 0$). Further, as in Lang, Stulz, and Walkling (1991), we include a dummy variable that equals one if the target Tobin's q is greater than one and zero otherwise (*TAR (q>1)*). Targets with low Tobin's q have poor quality of current management, and hence the higher would be the potential gains from a change in control ($\beta_7 < 0$). Consistent with their approach, we measure Tobin's q as the book value of assets plus the market value of equity less the book value of equity divided by the book value of assets, and cash flow as operating income

[21] Since the antitrust authorities use critical values of industry concentration, we use a dummy variable that is equal to one for takeovers where acquirer industry concentration is greater than 1,800 and zero otherwise instead of raw values of concentration. The results under this approach are qualitatively similar to those reported in the paper.

before depreciation less interest expense, taxes, preferred dividends and common dividends for the calendar year prior to the takeover normalized by the book value of assets.[22]

In all our regressions, we include intensity of foreign competition in the acquirer ($FORCOMP_{ACQ}$) and target ($FORCOMP_{TAR}$) industries as additional control variables since imports can increase the level of competition in an industry (Katics and Peterson (1994)). We measure the intensity of foreign competition in the acquirer (target) industry as ratio of the level of imports in the acquirer (target) industry to the total supply in the acquirer (target) industry. These measures are similar to the proxies used in Mitchell and Mulherin (1996) and Shahrur (2005). Consistent with the extant takeover literature, we use relative size (Servaes (1991), Mulherin and Boone (2000), and Shahrur (2005)), a dummy for stock offers (Travlos (1987)), and a dummy for hostile takeovers (Schwert (2000) and Shahrur (2005)) as additional control variables. We measure relative size as the ratio of the target market capitalization to the acquirer market capitalization fifteen days prior to announcement of the first bid by the successful acquirer.

We report the results for the CWE regression in Table IV. We use a window of (-10, +10) days around the period between the announcement of first bid by the successful acquirer to the announcement of the successful bid in the contest to calculate CWE. We calculate the industry-adjusted change in R&D intensity (*RDICHG*) for calendar year windows (-1, +2), and (-2, +2) years around the year of takeover announcement. Consistent with the extant takeover literature, we implement weighted least square (WLS) regressions where the weights are the inverse of the standard deviation of the market model residuals. Eckbo, Maksimovic, and Williams (1990) argue that bidder managers voluntarily engage in takeovers when they possess private information regarding the potential synergies of the takeover. In such cases, the cross sectional

[22] Tobin's q is measured as {DATA6 + (DATA25*DATA199) - DATA60}/DATA6, and Cash flow as {DATA13 - DATA15 - (DATA16 - Change in DATA35) - DATA19 - DATA21} divided by DATA6.

regressions based on OLS and WLS are inconsistent. To account for this endogeneity, they construct a consistent maximum likelihood estimator to relate announcement wealth effects to exogenous firm and industry characteristics. We also perform regressions using their approach.

Consistent with the efficiency hypothesis, we find that the coefficient on industry-adjusted change in R&D intensity (RDICHG) is positive and significant under the maximum likelihood (MLE) approach for both (-1, +2) and (-2, +2) calendar-year windows. We obtain somewhat weaker results under the weighted least square estimation (WLS) method. Inconsistent with the foreclosure hypothesis, the coefficients on acquirer market share and target market share are statistically insignificant under both the WLS and MLE methods. Inconsistent with the collusion hypothesis, the coefficient on acquirer industry concentration is statistically insignificant under both the WLS and MLE methods.[23]

We find that the coefficient on the cash flow for low q acquirers (*ACQCF (q<1)*) is negative and statistically significant except for the WLS estimation for (-1, +2) calendar-year window. This evidence suggests that agency problems in acquirers lead to lower takeover gains and is consistent with the findings in Lang, Stulz, Walkling (1991). Further, we find that low q targets (*Target q >1*) are associated with higher takeover gains under both WLS and MLE estimation. If low q targets have inefficient management, then this result suggests that a change in control through a corporate takeover creates value.

We find that the coefficients on the intensity of foreign competition in the acquirer and target industry are insignificant. Consistent with the extant takeover literature, we find that relative size is positively related to the takeover gains, stock financed takeovers are associated with lower takeover gains, and hostile takeovers are associated with higher takeover gains. Finally, the standard error of manager's private information (W) is positive and significant

[23] Since we include both market share and industry concentration as independent variables in our regressions, a valid concern is if there is multicollinearity in the data. To address this concern, we compute the variance inflation factor for all independent variables. It is found to be less than 2 suggesting that multicollinearity is not an important factor.

suggesting that the model of Eckbo, Maksimovic, and Williams (1990) is well specified. In summary, the results from the CWE regression are consistent with the efficiency hypothesis and inconsistent with the foreclosure or collusion hypotheses.

4.2. Determinants of the wealth effects of acquirer and target rivals

We propose the cross-sectional models given by Eq. (2) and Eq. (3) to explain the cross-sectional variation in the abnormal returns to the acquirer and target rivals respectively. In the models, *ACQRIVCAR* is the abnormal return to the non-integrated acquirer rivals, *TARRIVCAR* is the abnormal return to the non-integrated target rivals, *Initial* is a dummy set to one if there was no acquisition between the acquirer and target three-digit SIC codes during one year prior to the takeover announcement and set to zero otherwise, *STOCK* is a dummy set to one when the deal is stock financed and zero otherwise, *HOSTILE* is a dummy set to one for acquisitions reported as hostile by SDC and zero otherwise. All other variables are as described in Eq. (1).

$$ACQRIVCAR = \gamma + \gamma_1 * CWE + \gamma_2 * MKTSH_{TAR} + \gamma_3 * CONC_{ACQ} + \gamma_4 * Initial + \gamma_5 * FORCOMP_{ACQ} + \gamma_6 * FORCOMP_{TAR} + \gamma_7 * STOCK + \gamma_8 * HOSTILE \qquad (2)$$

$$TARRIVCAR = \theta + \theta_1 * CWE + \theta_2 * MKTSH_{ACQ} + \theta_3 * CONC_{ACQ} + \theta_4 * Initial + \theta_5 * FORCOMP_{ACQ} + \theta_6 * FORCOMP_{TAR} + \theta_7 * STOCK + \theta_8 * HOSTILE \qquad (3)$$

A negative coefficient on CWE (γ_1) is consistent with either the competitive advantage view of the efficiency hypothesis or the foreclosure hypothesis. Under the competitive advantage view, the gains to the non-integrated acquirer rivals and the merging firms are negatively related because the non-integrated acquirer rivals now face an efficient integrated firm. Under the foreclosure hypothesis, the negative relation arises because of the enhanced ability of the integrated firm to foreclose the non-integrated acquirer rivals. To distinguish between the two scenarios, we examine the coefficient on the market share of the target. The higher the target's market share, the higher is the ability of the integrated firm to foreclose the non-integrated acquirer rivals, thereby resulting in lower gains to the non-integrated acquirer rivals. Hence, we expect γ_2 to be negative only under foreclosure.

On the other hand, a positive coefficient on CWE (γ_1) is consistent with either the better information view of efficiency hypothesis or the collusion hypothesis. Under the better information view, the returns to the non-integrated acquirer rivals and the merging firms are positively related since there is new information to the rivals regarding efficiency improvement through vertical integration. Under the collusion hypothesis, the positive relation arises due to the higher likelihood of collusion between the integrated firm and the non-integrated acquirer rivals. To distinguish between the two explanations, we examine the coefficient on the concentration of the acquirer industry. Under the collusion hypothesis, the higher the concentration of the acquirer industry, the higher is the likelihood of collusion between the integrated firm and the non-integrated acquirer rivals, and consequently the higher the gains to the acquirer rivals. Hence, we expect γ_3 to be positive only under collusion.

The predictions for the target rival CAR regression are as follows. A positive coefficient on CWE (θ_1) is consistent with the better information view of the efficiency hypothesis. The positive relation arises since the takeover announcement provides new information to the non-integrated target rivals regarding efficiency improvement through vertical integration. A negative coefficient on CWE (θ_1) is consistent with competitive advantage, foreclosure, or collusion hypotheses. Under the competitive advantage view, the negative relation arises because the non-integrated target rivals now have to compete with an efficient integrated firm. Under the foreclosure hypothesis, the negative relation arises due to the enhanced ability of the integrated firm to foreclose non-integrated target rivals. Finally, under the collusion hypothesis, the negative relation arises due to the ensuing collusion between the integrated firm and the non-integrated acquirer rivals.

The coefficient on the acquirer market share allows us to distinguish between foreclosure and the other two competing hypotheses. The higher the acquirer's market share, the higher is the ability of the integrated firm to foreclose the non-integrated target rivals, and hence the lower the gains to the non-integrated target rivals. Hence, we expect θ_2 to be negative under foreclosure. To test the collusion hypothesis, we look at the coefficient on the acquirer industry concentration. The higher the concentration of the acquirer industry, the lower the gains to the non-integrated target rivals, due to higher input prices on account of upstream collusion (forward takeovers) or a reduced demand for their output on account of downstream collusion (backward takeovers). Hence, we expect θ_3 to be negative under collusion.

The acquisition probability hypothesis of Song and Walkling (2000) suggests that unexpected acquisition attempts create a reassessment of the likelihood of acquisition attempts for target rivals. Under this hypothesis, the magnitude of abnormal returns to the target rivals is increasing in the degree of surprise in the acquisition. To test this hypothesis, we include *Initial*, which is a dummy that equals one when there is no acquisition between the acquirer and target three-digit SIC codes during the one year prior to the takeover announcement and equals zero otherwise as a control variable. Under their hypothesis, we expect the coefficient on *Initial* to be positive in the target rival CAR regression.[24] In both the acquirer rival CAR and target rival CAR regressions, we include a dummy for stock offers, a dummy for hostile offers, and the intensity of foreign competition in the acquirer and target industries as additional control variables. If stock financed takeovers provide new information regarding industry-wide overvaluation in the acquirer's industry, then the returns to the acquirer rivals would also be related to the nature of takeover financing and we expect a negative coefficient on the stock dummy ($\gamma_7 < 0$).

[24] To be consistent, we include *Initial* as a control variable in the acquirer rival CAR regression as well. Our results do not change if we exclude *Initial* from the acquirer rival CAR regression.

The regression results for the wealth effects of the non-integrated acquirer and target rivals are reported in Table V. We use an event window of (-10, +10) days around the announcement of the first bid by the successful acquirer to measure acquirer/target rival CARs and an event window of (-10, +10) days around the period between the announcement of first bid by the successful acquirer and the announcement of the successful bid in the contest to measure the CWE of the merging firms. We winsorize the dependent variables at the 1st and the 99th percentile to account for outliers in the sample and perform weighted least square estimation.

In the acquirer rival CAR regression, we find that the coefficient on CWE is positive and significant at the 1% level. This result is consistent with the better information view or collusion motives and is inconsistent with the competitive advantage or foreclosure hypotheses. The coefficient on the acquirer industry concentration is insignificant, which is inconsistent with the collusion hypothesis. Further, inconsistent with the foreclosure hypothesis, the coefficient on target market share is statistically insignificant. The coefficient on *Initial* is insignificant suggesting that the magnitude of surprise does not affect the abnormal returns to the non-integrated acquirer rivals. We also find that the coefficient on the stock dummy is statistically insignificant. This indicates that the performance of acquirer rivals cannot be explained by the industry-wide over-valuation due to equity financing. Finally, the coefficient on the hostile dummy is statistically insignificant suggesting that hostility in takeovers has no implications for rivals in the acquirer industry.

In the target rival CAR regression, we find that the coefficient on CWE is positive and significant at the 1% level. This result is consistent with the better information view of efficiency hypothesis and inconsistent with the competitive advantage, foreclosure or collusion hypotheses. The coefficient on the acquirer market share is statistically insignificant, which is inconsistent with the foreclosure hypothesis. Further, inconsistent with the collusion hypothesis, the coefficient on acquirer industry concentration is statistically insignificant. Finally, the coefficient on *Initial* is positive and significant at the 5% level which indicates that the returns to the target rivals are positively related to the magnitude of surprise in the vertical takeover. This result is consistent with the acquisition probability hypothesis of Song and Walkling (2000). The coefficient on the hostile dummy is negative and significant, indicating that target rivals in hostile acquisitions experience lower abnormal returns. The coefficients on the intensity of foreign competition in the acquirer and target industries are insignificant in both acquirer rival and target rival regressions.

Collectively, we find that the CWE of the merging firms is positively related to the returns to the non-integrated acquirer and target rivals. Further, the acquirer/target market shares (our measures for potential foreclosure), and acquirer industry concentration (our measure for potential collusion) do not affect abnormal returns to the rivals. These results appear to be consistent with the efficiency rationale and inconsistent with the anti-competitive rationales.

4.3. Determinants of the wealth effect of customers

We propose the regression model specified in Eq. (4) to examine the determinants of the wealth effects of main and dependent customers. In the model, *CUSTCAR* is the abnormal return to the customer firms and all other variables are as described in Eq. (1).

$$CUSTCAR = \alpha + \alpha_1 * CWE + \alpha_2 * MKTSH_{ACQ} + \alpha_3 * MKTSH_{TAR} + \alpha_4 * CONC_{ACQ} + \alpha_5 * FORCOMP_{ACQ} + \alpha_6 * FORCOMP_{TAR} + \alpha_7 * STOCK + \alpha_8 * HOSTILE \quad (4)$$

Under the efficiency hypothesis, we expect that at least some of these benefits arising through reduced transaction costs to be passed on to customers through lower prices. Therefore, under efficiency, we expect the customer returns and the CWE of the merging firms to be positively related ($\alpha_1 > 0$). In contrast, under foreclosure and collusion, the increased market power of the integrated firm enables it to extract rents from customer firms. Hence, we expect the customer return and the CWE of the merging firms to be negatively related ($\alpha_1 < 0$). Under the foreclosure hypothesis, the higher the market share of the acquirer (target), the higher is the market power of the integrated firm to foreclose the non-integrated target (acquirer) rivals, which in turn leads to lower gains to the customers ($\alpha_2 < 0$, $\alpha_3 < 0$). Finally, under the collusion hypothesis, the higher the concentration of the acquirer industry, the higher is the likelihood of collusion between the integrated firm and the non-integrated acquirer rivals after the vertical takeover. The increased likelihood of collusion leads to lower gains to the customers ($\alpha_4 < 0$). As additional control variables, we include a dummy for stock offers, a dummy for hostile takeovers, and the intensity of foreign competition in the acquirer and target industries.

The results for the main and dependent customer CAR regressions are reported in Table VI. We use an event window of (-10, +10) days around the announcement of the first bid by the successful acquirer to measure the main and dependent customer returns and an event window of (-10, +10) days around the period between the announcement of first bid by the successful acquirer and the announcement of the successful bid in the contest to measure the CWE of the merging firms. We winsorize the dependent variables at the 1st and the 99th percentile to account for outliers in the sample and perform weighted least square estimation.

Consistent with the efficiency hypothesis and inconsistent with the foreclosure and collusion hypotheses, we find that the coefficient on CWE is positive and significant at least at the 5% level in both the main and dependent customer regressions. Inconsistent with the collusion hypothesis, we find that the coefficient on the acquirer industry concentration is insignificant in both the main and dependent customer regressions. Further, going against the predictions of the foreclosure hypothesis, the coefficient on acquirer market share is positive and significant in the dependent customer regression, while it is insignificant in the main customer regression. Similarly, inconsistent with the foreclosure hypothesis, the coefficient on the target market share is statistically insignificant in both the main and dependent customer regressions.

The coefficients on the intensity of foreign competition and other control variables are generally statistically insignificant in both the main customer and dependent customer regressions.[25]

To summarize, we find a positive and significant relationship between the CWE of the merging firms and the returns to the main and dependent customers. Further, the acquirer/target market share (our measures for potential foreclosure), and acquirer industry concentration (our measure for potential collusion) affect customer returns in manner inconsistent with these rationales. This evidence is again supportive of the efficiency rationale and inconsistent with foreclosure and collusion hypotheses.

5. Conclusions

Vertical integration has been a topic of interest to the economists over several decades (Joskow (2005)). However, little is known regarding the sources of value creation in vertical takeovers. We attempt to bridge this gap by conducting the first comprehensive, large sample study that investigates the efficiency, foreclosure, and collusion rationales for vertical takeovers. For this purpose, we identify a sample of 453 successful vertical takeovers over the period 1981-2004 using the benchmark input-output accounts of the U.S. economy. To examine the three rationales for vertical takeovers, we analyze the announcement period wealth effects of the merging firms, acquirer rivals, target rivals, and customer firms. Our research design includes univariate predictions on the signs of the wealth effects to the above parties, as well as cross-sectional analyses which include structural variables related to the efficiency, foreclosure, and collusion hypotheses.

Consistent with the extant literature, we find that vertical takeovers are associated with a positive average combined wealth effect (CWE) for the merging firms. In the sub-sample of

[25] To investigate if the vertical acquisition is truly a novel transaction (first vertical merger involving acquirer/target industry) or just moving to the industry norm (later vertical mergers), we use the Compustat segment tapes and find the percentage of firms in the acquirer (target) industry that have a segment in the target (acquirer) industry, i.e. already vertically integrated. The mean (median) value of this variable is 2.89% (0.65%). We include this variable in the CWE, ACQRIVCAR, TARRIVCAR, and CUSTCAR regressions and find that it is statistically insignificant. The results for the other independent variables are qualitatively similar to those reported in the paper.

takeovers where the merging firms experience a positive CWE, we find that the acquirer rivals and target rivals tend to gain, main customer firms do not lose, and dependent customer firms gain. In our cross-sectional tests, we find that the CWE of the merging firms is positively related to abnormal returns to the acquirer rivals, target rivals, main customers, and dependent customers. Concentration of the acquirer industry (our proxy to test collusion), and market share of the acquirer/target firm (our proxies for foreclosure) affect to the wealth effects of the merging firms, target/acquirer rivals, and customer firms in a manner inconsistent with the predictions of these anti-competitive rationales. Finally, the industry-adjusted change in R&D intensity of the merging firms around the year of takeover announcement (proxy for the extent of holdup) is positively related to the CWE of the merging firms.

Collectively, both our univariate and cross-sectional results indicate that firms use corporate takeovers to alter their vertical boundaries consistent with an efficiency improvement rationale rather than foreclosure or collusion rationales. Our findings build upon the work in Eckbo (1983) and Rosengren and Meehan (1994) which does not find evidence supporting anti-competitive motives in vertical takeovers challenged by FTC and DOJ prior to 1978. Further, our evidence advances the industry-specific case studies which find that vertical integration is efficiency enhancing (Mullin and Mullin (1997), Chipty (2001), and Hortaçsu and Syverson (2007)). Finally, the non-horizontal merger guidelines of FTC and DOJ, originally set forth in 1984, still remain in place leading to several vertical merger challenges in the 1990's on grounds of foreclosure or collusion (Morse (1998) and Warren-Boulton (2002)). In this regard, our analysis of the rivals and, in particular, the customer firms may be of interest to the regulators since it provides new information on the welfare effects of vertical takeovers in recent years.

Appendix A

Pairs of Acquirer and Target Input-Output Industries and Vertical Relatedness Coefficients

This appendix contains examples of acquirer and target input-output industries that have significant vertical relationships based on $V_{1,TA}$ and $V_{1,AT}$. *ACQIODESC* and *TARIODESC* are the descriptions of the six-digit input-output industries of the Bureau of Economic Analysis. *ACQIOCODE* and *TARIOCODE* are the input-output industry codes for acquirer and target industries as obtained from *Use Table* of Bureau of Economic Analysis. The 1982, 1987, 1992 and 1997 *Use tables* are used to identify vertical relations in takeovers during the periods 1981 to 1985, 1986 to 1990, 1991 to 1997, and 1998 to 2004 respectively. $V_{1,AT}$ ($V_{2,AT}$) is the dollar flow from the acquirer to the target industry per dollar of acquirer (target) industry total output. $V_{1,TA}$ ($V_{2,TA}$) is the dollar flow from the target industry to the acquirer industry per dollar of acquirer (target) industry output. Acquirer vertical relatedness coefficient (*ACQVRC*) is calculated as Max ($V_{1,AT,}$ $V_{1,TA}$). Target vertical relatedness coefficient (*TARVRC*) is calculated as Max ($V_{2,AT,}$ $V_{2,TA}$). For every acquirer-target industry pair in the appendix, the values of $V_{1,AT}$, $V_{1,TA,}$ $V_{2,AT,}$ and $V_{2,TA}$ are calculated as the average values across different *Use Tables* that correspond to the time period during which vertical takeovers appear in the sample.

ACQIOCODE	ACQIODESC	TARIOCODE	TARIODESC	$V_{1,AT}$	$V_{1,TA}$	$V_{2,AT}$	$V_{2,TA}$
310101	Petroleum refining	080000	Crude petroleum and natural gas	<0.01	0.67	<0.01	0.74
680201	Natural gas transportation	310101	Petroleum refining	0.64	0.02	0.07	<0.01
142300	Flavoring extracts and flavoring syrups	142200	Bottled and canned soft drinks	0.49	<0.01	0.18	<0.01
160100	Broad woven fabric mills	180400	Apparel made from purchased materials	0.37	<0.01	0.18	<0.01
190200	House furnishings	160100	Broad woven fabric mills	<0.01	0.37	<0.01	0.08
331315	Aluminum sheet, plate, and foil mfg.	331312	Primary aluminum production	<0.01	0.36	<0.01	0.35
280100	Plastics materials and resins	270100	Industrial inorganic and organic chemicals	<0.01	0.35	<0.01	0.13
280200	Synthetic rubber	270100	Industrial inorganic and organic chemicals	<0.01	0.31	<0.01	0.01
680200	Gas production and distribution (utilities)	080000	Crude petroleum and natural gas	0.01	0.30	<0.01	0.20
670000	Radio and TV broadcasting	760101	Motion picture services and theaters	<0.01	0.25	<0.01	0.28
3221A0	Paper and paperboard mills	322210	Paperboard container manufacturing	0.25	0.01	0.44	0.02
760101	Motion picture services and theaters	670000	Radio and TV broadcasting	0.20	<0.01	0.23	<0.01
311611	Animal, except poultry, slaughtering	311612	Meat processed from carcasses	0.20	<0.01	0.37	<0.01
140101	Meat packing plants	140102	Sausages and other prepared meat products	0.20	<0.01	0.52	<0.01
560300	Telephone and telegraph apparatus	570300	Other electronic components	<0.01	0.20	<0.01	0.13
325211	Plastics material and resin manufacturing	325190	Other basic organic chemical manufacturing	<0.01	0.19	<0.01	0.15
142300	Flavoring extracts and flavoring syrups	740000	Eating and drinking places	0.17	<0.01	<0.01	<0.01
600100	Aircraft	600200	Aircraft and missile engines and engine parts	<0.01	0.14	<0.01	0.35
334119	Other computer peripheral equipment mfg.	334111	Electronic computer mfg.	0.11	0.01	0.07	<0.01
326192	Resilient floor covering manufacturing	325211	Plastics material and resin manufacturing	<0.01	0.11	<0.01	<0.01
570300	Other electronic components	320400	Miscellaneous plastics products	<0.01	0.11	<0.01	0.05
334413	Semiconductors and related device mfg.	334111	Electronic computer manufacturing	0.11	<0.01	0.14	<0.01

References

Allen, Jeffrey W., and Gordon M. Phillips, 2000, Corporate Equity Ownership, Strategic Alliances, and Product Market Relationships, *Journal of Finance* 55, 2791-2815.

Arrow, Kenneth J., 1975, Vertical Integration and Communication, *The Bell Journal of Economics* 6, 173-183.

Bradley, M., Anand Desai, and E. Han Kim, 1983, The rationale behind interfirm tender offers: Information or synergy?, *Journal of Financial Economics* 11, 183.

Bradley, Michael, Anand Desai, and E. Han Kim, 1988, Synergistic gains from corporate acquisitions and their division between the stockholders of target and acquiring firms, *Journal of Financial Economics* 21, 3-40.

Chen, Yongmin, 2001, On vertical mergers and their competitive effects, *RAND Journal of Economics* 32, 667-685.

Chipty, Tasneem, 2001, Vertical Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry, *American Economic Review* 91, 428-453.

Church, J., 2004, The Impact of Vertical and Conglomerate Mergers on Competition, (Directorate General for Competition, European Commission).

Coase, R. H., 1937, The Nature of the Firm, *Economica* 4, 386-405.

Coles, Jeffrey L., Naveen D. Daniel, and Lalitha Naveen, 2006, Managerial incentives and risk-taking, *Journal of Financial Economics* 79, 431-468.

Eckbo, B. Espen, 1983, Horizontal mergers, collusion, and stockholder wealth, *Journal of Financial Economics* 11, 241-273.

Eckbo, B. Espen, 1985, Mergers and the Market Concentration Doctrine: Evidence from the Capital Market, *Journal of Business* 58, 325-349.

Eckbo, B. Espen, 1990, Competition and Wealth Effects of Horizontal Mergers, in F. Mathewson, M. Trebilcock, and M. Walker, eds.: *The Law and Economics of Competition Policy* (The Fraser Institute, Vancouver).

Eckbo, B. Espen, 1992, Mergers and the Value of Antitrust Deterrence, *Journal of Finance* 47, 1005-1029.

Eckbo, B. Espen, Vojislav Maksimovic, and Joseph Williams, 1990, Consistent Estimation of Cross-Sectional Models in Event Studies, *The Review of Financial Studies* 3, 343-365.

Fan, Joseph P. H., and Vidhan K. Goyal, 2006, On the Patterns and Wealth Effects of Vertical Mergers, *Journal of Business* 79, 877-902.

Fan, Joseph P. H., and Larry H. P. Lang, 2000, The Measurement of Relatedness: An Application to Corporate Diversification, *Journal of Business* 73, 629-660.

Fee, C. Edward, Charles J. Hadlock, and Shawn Thomas, 2006, Corporate Equity Ownership and the Governance of Product Market Relationships, *Journal of Finance* 61, 1217-1251.

Fee, C. Edward, and Shawn Thomas, 2004, Sources of gains in horizontal mergers: evidence from customer, supplier, and rival firms, *Journal of Financial Economics* 74, 423-460.

Grossman, Sanford J., and Oliver D. Hart, 1986, The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, *The Journal of Political Economy* 94, 691-719.

Hart, Oliver, and John Moore, 1990, Property Rights and the Nature of the Firm, *The Journal of Political Economy* 98, 1119-1158.

Hart, Oliver, and Jean Tirole, 1990, Vertical Integration and Market Foreclosure, *Brookings Papers on Economic Activity. Microeconomics* 1990, 205-276.

Hastings, Justine S., and Richard J. Gilbert, 2005, Market Power, Vertical Integration and the Wholesale Price of Gasoline, *Journal of Industrial Economics* 53, 469-492.

Hortaçsu, Ali, and Chad Syverson, 2007, Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices, *The Journal of Political Economy* 115, 250-301.

Jensen, Michael C., 1986, Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers, *American Economic Review* 76, 323-329.

Joskow, Paul, 2005, Vertical Integration, in Claude Menard, and Mary M. Shirley, eds.: *Handbook of New Institutional Economics* (Springer, Netherlands).

Kahle, Kathleen M., and Ralph A. Walkling, 1996, The impact of industry classifications on financial research, *Journal of Financial and Quantitative Analysis* 31, 309-335.

Kale, Jayant R., Omesh Kini, and Harley E. Ryan Jr, 2003, Financial Advisors and Shareholder Wealth Gains in Corporate Takeovers, *Journal of Financial and Quantitative Analysis* 38, 475-501.

Kale, Jayant R., and Husayn Shahrur, 2007, Corporate capital structure and the characteristics of suppliers and customers, *Journal of Financial Economics* 83, 321-365.

Katics, Michelle M., and Bruce C. Petersen, 1994, The Effect of Rising Import Competition on Market Power: A Panel Data Study of US Manufacturing, *Journal of Industrial Economics* 42, 277-286.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian, 1978, Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, *Journal of Law and Economics* 21, 297-326.

Lafontaine, F., and Margaret Slade, 2007, Vertical Integration and Firm Boundaries: The Evidence, *Journal of Economic Literature* 45, 629.

Lang, Larry H. P., Rene M. Stulz, and Ralph A. Walkling, 1991, A test of the free cash flow hypothesis: The case of bidder returns, *Journal of Financial Economics* 29, 315-335.

Levy, D. T., 1985, The Transactions Cost Approach to Vertical Integration: An Empirical Examination, *The Review of Economics and Statistics* 67, 438-445.

Martin, Stephen, Hans-Theo Normann, and Christopher M. Snyder, 2001, Vertical Foreclosure in Experimental Markets, *The RAND Journal of Economics* 32, 466-496.

Mikkelson, Wayne H., and M. Megan Partch, 1988, Withdrawn Security Offerings, *Journal of Financial and Quantitative Analysis* 23, 119-133.

Mitchell, Mark L., and J. Harold Mulherin, 1996, The impact of industry shocks on takeover and restructuring activity, *Journal of Financial Economics* 41, 193-229.

Morck, Randall, Andrei Shleifer, and Robert W. Vishny, 1990, Do Managerial Objectives Drive Bad Acquisitions?, *Journal of Finance* 45, 31-48.

Morse, M. Howard, 1998, Vertical mergers: Recent learning, *The Business Lawyer* 53, 1217-1248.

Mulherin, J. Harold, and Audra L. Boone, 2000, Comparing acquisitions and divestitures, *Journal of Corporate Finance* 6, 117-139.

Mullin, Joseph C., and Wallace P. Mullin, 1997, United States Steel's Acquisition of the Great Northern Ore Properties: Vertical Foreclosure or Efficient Contractual Governance?, *Journal of Law, Economics, and Organization* 13, 74-100.

Nocke, Volker , and Lucy White, 2007, Do Vertical Mergers Facilitate Upstream Collusion?, *American Economic Review* 97, 1321-1339.

Normann, Hans Theo, 2007, Vertical Mergers, Foreclosure and Raising Rivals' Costs - Experimental Evidence, Available at SSRN: http://ssrn.com/abstract=950205

Ordover, Janusz A., Garth Saloner, and Steven C. Salop, 1990, Equilibrium vertical foreclosure, *American Economic Review* 80, 127-142.

Perry, Martin K., 1989, Vertical integration: Determinants and effects, in Richard Schmalensee, and Robert Willig, eds.: *Handbook of Industrial Organization* (Elsevier, North Holland, Amsterdam).

Rey, Patrick, and Tirole Jean, 2006, A primer on foreclosure, in Mark Armstrong, and Robert Porter, eds.: *Handbook of Industrial Organization* (Elsevier, North Holland, Amsterdam).

Rosengren, Eric S, and James W Meehan, Jr, 1994, Empirical Evidence on Vertical Foreclosure, *Economic Inquiry* 32, 303-317.

Salinger, Michael A., 1988, Vertical Mergers and Market Foreclosure, *Quarterly Journal of Economics* 103, 345-356.

Schlossberg, Robert S., 2004. *Mergers and Acquisitions: Understanding the antitrust issues* (American Bar Association. Section of Antitrust Law, Chicago).

Schwert, G. William, 2000, Hostility in Takeovers: In the Eyes of the Beholder?, *Journal of Finance* 55, 2599-2640.

Servaes, Henri, 1991, Tobin's Q and Gains from Takeovers, *Journal of Finance* 46, 409-419.

Shahrur, Husayn, 2005, Industry structure and horizontal takeovers: Analysis of wealth effects on rivals, suppliers, and corporate customers, *Journal of Financial Economics* 76, 61-98.

Song, Moon H., and Ralph A. Walkling, 2000, Abnormal returns to rivals of acquisition targets: A test of the 'acquisition probability hypothesis', *Journal of Financial Economics* 55, 143-171.

Spiller, P. T., 1985, On Vertical Mergers, *The Journal of Law, Economics, and Organization* 1, 285-312.

Travlos, Nickolaos G., 1987, Corporate Takeover Bids, Methods of Payment, and Bidding Firm's Stock Returns, *Journal of Finance* 42, 943-963.

Warren-Boulton, F. R., 2002, The Contribution of the Merger Guidelines to the Analysis of Non-Horizontal Mergers, U.S. antitrust Division of Justice. Available at: http://www.usdoj.gov/atr/hmerger/11709.pdf.

Whinston, Michael, 2003, On the Transaction Cost Determinants of Vertical Integration, *Journal of Law, Economics, and Organization* 19, 1-23.

Williamson, Oliver E., 1971, The Vertical Integration of Production: Market Failure Considerations, *American Economic Review* 61, 112-123.

Williamson, Oliver E., 1979, Transaction-Cost Economics: The Governance of Contractual Relations, *Journal of Law and Economics* 22, 233-261.

Table I
Summary of Univariate Predictions for the Efficiency, Foreclosure and Collusion Hypotheses

This table summarizes the predictions under the efficiency, foreclosure, and collusion hypotheses regarding the signs of announcement period abnormal returns to the merging firms, acquirer rivals, target rivals, and customer firms. Acquirer rivals are firms with the same four-digit primary SIC code as the acquirer, but no segment in the target's four-digit primary SIC code. Target rivals are firms with the same four-digit primary SIC code as the target, but no segment in the acquirer's four-digit primary SIC code. Irrespective of the type of vertical takeover (forward or backward), we identify customers as firms that buy the product of the downstream industry in the vertical takeover.

	Merging firms	Non-integrated Acquirer rivals	Non-Integrated Target Rivals	Customers
Efficiency hypothesis:				
i) Better Information	Positive Reduction in future holdup	Positive Implement efficiency enhancing vertical takeovers	Positive Implement efficiency enhancing vertical takeovers	Zero to Positive Series of vertical acquisitions, lower costs passed as lower prices
ii) Competitive Advantage	Positive Reduction in future holdup	Negative Still face holdup, competitive disadvantage	Negative Still face holdup, competitive disadvantage	Zero to Positive More intense competition upstream
Foreclosure	Positive Integrated firm has an unfair advantage over rivals	Negative *Backward Takeover*: Squeezed margins due to higher input prices from integrated firm *Forward Takeover*: Reduced revenues since integrated firm does not buy their output	Negative *Backward Takeover*: Integrated firm does not buy the output of independent suppliers *Forward Takeover*: Squeezed margins due to higher input prices from integrated firm	Negative Increased market power of the integrated firm
Collusion between integrated firm and acquirer rivals	Positive Higher likelihood of collusion enhances ability to extract rents from customers	Positive Higher likelihood of collusion enhances ability to extract rents from customers	Negative *Backward Takeover*: Downstream collusion leads to a reduced demand for their output *Forward Takeover*: Upstream collusion leads to higher input prices	Negative Face higher prices due to collusion upstream

Table II
Descriptive Statistics of Vertical Takeovers during 1981-2004

The sample consists of 453 successful vertical takeovers during 1981 to 2004. The acquirer and target firms are public and the acquisition is recorded on the SDC database. Takeovers where either the acquirer or target has an SIC code between 6000-6999 are not considered. Tender offers and Mergers are identified based on the classification of the SDC database. The attitude of the deal is characterized as hostile, neutral or friendly based on the attitude of the first bid in the contest as reported by SDC. Method of Payment is characterized by SDC as all stock deals, all cash deals, and deals using both cash and stock as means of financing. Market capitalizations of the acquirer and target are calculated fifteen trading days prior to the announcement of the first bid date by the successful acquirer in the contest. Acquirer Industry Herfindahl Index is the sales based Herfindahl Index of the four-digit SIC of the acquirer during the takeover year. Acquirer (Target) Market Share is the market share of the acquirer (target) in its primary industry during the year of the takeover. $V_{1,AT}$ ($V_{2,AT}$) is the dollar flow from the acquirer to the target industry per dollar of acquirer (target) industry total output. $V_{1,TA}$ ($V_{2,TA}$) is the dollar flow from the target industry to the acquirer industry per dollar of acquirer (target) industry output. Acquirer vertical relatedness coefficient (*ACQVRC*) is calculated as Max ($V_{1,AT}$, $V_{1,TA}$). Target vertical relatedness coefficient (*TARVRC*) is calculated as Max ($V_{2,AT}$, $V_{2,TA}$). Takeovers in this sample have either *ACQVRC* or *TARVRC* greater than 1%.

Deal characteristics for the overall vertical takeover sample

	Sample size	Characteristic	Number	% of sample
		Merger	305	67.33%
Mode of Acquisition	453	Tender Offer	148	32.67%
		Only Stock	124	27.37%
Method of Payment	453	Only Cash	155	34.32%
		Stock and Cash	174	38.41%
		Friendly	388	85.65%
Attitude	453	Hostile	23	5.08%
		Neutral	42	9.27%

Firm/Industry characteristics and vertical relatedness for the overall sample

Firm/Industry Characteristics	Mean	Median	Max	Min
Acquirer Market Capitalization ($ mil)	15,658.89	2,014.64	276,097.00	8.26
Target Market Capitalization ($ mil)	669.58	129.49	24,655.33	1.25
Acquirer Industry Herfindahl Index	2,127	1,484	8,683	186
Acquirer Market Share (%)	16.68	6.46	71.78	0.10
Target Market Share (%)	5.82	1.62	35.33	0.02
Vertical Relations	**Mean**	**Median**	**Max**	**Min**
$V_{1,AT}$	0.07	0.02	0.71	0.00
$V_{1,TA}$	0.08	0.03	0.66	0.00
$V_{2,AT}$	0.07	0.03	0.51	0.00
$V_{2,TA}$	0.08	0.03	0.74	0.00
ACQVRC	0.09	0.05	0.71	0.01
TARVRC	0.09	0.05	0.74	0.01

Table III
Cumulative Abnormal Returns to Acquirer Rivals, Target Rivals and Customers

This table provides the cumulative abnormal returns (CAR) to the acquirer rival, target rival, main customer, and dependent customer portfolios in the vertical takeover sample based on a 1% cutoff. Acquirer CAR and Target CAR is measured around the window (-10, +10) days around the period running from the first bid by the successful acquirer to the announcement of the successful bid in the contest. Combined wealth effect (CWE) of a takeover is the value weighted CAR to the acquirer and target, where the weights are computed using the market capitalization of the acquirer fifteen trading days prior to the announcement of the first bid by the successful acquirer. Acquirer rival and target rival portfolios are based on all Compustat firms during the takeover year. We exclude firms with segments in target (acquirer) primary SIC while constructing acquirer (target) rival portfolios. The main customer industry is identified as the industry that accounts for the highest proportion of the total output of the downstream industry in the vertical takeover as long as it is greater than 1%. Dependent customer industry is identified as the industry that receives the highest proportion of its inputs from the downstream industry in vertical takeover to produce its total output as long as it is greater than 1%. Customer portfolios are based on single segment firms in Compustat. The acquirer rival portfolio, target rival portfolio, and customer portfolio returns are calculated as equally weighted returns for the (-1, +1), (-2, +2), (-5, +5), and (-10, +10) trading day windows around the first bid by the successful acquirer. Z statistics are used to test if the mean cumulative abnormal returns are statistically different from zero and are provided in the parentheses. % positive represents the proportion of portfolios that have positive returns. A generalized sign test is performed to test their statistical significance. *Number* is the number of portfolios of rivals or customers and *Mean (Median)* is the mean (median) number of firms in each rival or customer portfolio. Panel A provides the CARs for the overall sample. Panel B provides the CARs for the sub-sample of takeovers with a positive CWE over the (-10, +10) window, and Panel C for the negative CWE sub-sample over the same window. Panel D provides the z statistic for the difference between the positive and negative combined CAR sub-samples. ***, ** and * indicate significance at 1%, 5%, and 10% respectively.

Panel A: Abnormal returns for overall sample of vertical takeovers								
	Acquirer Rivals		Target Rivals		Main Customer		Dependent Customer	
Number	N=438		N=445		N=382		N=374	
Mean (Median)	52 (25)		59 (28)		61 (21)		25 (8)	
Event Windows:	Mean	% Positive	Mean	% Positive	Mean	% Positive	Mean	% Positive
(-1,+1)	0.00	49.09	0.22	54.71	0.19	50.00	0.00	45.72**
	(0.31)	(-0.94)	(1.41)	(1.20)	(1.17)	(-0.72)	(0.41)	(-2.06)
(-2,+2)	0.07	49.77	0.18	52.24	0.11	49.21	0.25	52.67
	(0.88)	(-0.65)	(0.81)	(0.16)	(0.76)	(-1.03)	(1.20)	(0.63)
(-5,+5)	-0.37	45.43**	0.18	50.22	-0.22	46.60**	0.11	53.74
	(-1.47)	(-2.46)	(0.35)	(-0.69)	(-0.79)	(-2.05)	(0.89)	(1.04)
(-10,+10)	-0.10	48.17	0.19	48.65	-0.24	50.26	0.69	50.80
	(-0.43)	(-1.32)	(0.48)	(-1.36)	(-0.94)	(-0.62)	(0.92)	(-0.09)

Panel B: Abnormal returns for sub-sample with positive combined wealth effect (CWE) to merging firms								
	Acquirer Rivals		Target Rivals		Main Customer		Dependent Customer	
Number	N=220		N=223		N=191		N=188	
Event Windows:	Mean	% Positive	Mean	% Positive	Mean	% Positive	Mean	% Positive
(-1,+1)	0.25**	53.64	0.38**	56.95*	0.11	49.74	0.54**	51.60
	(2.46)	(0.81)	(2.43)	(1.66)	(0.73)	(-0.51)	(2.10)	(0.17)
(-2,+2)	0.54***	55.45	0.42**	56.05*	0.20	47.12	0.73**	55.85
	(3.59)	(1.35)	(2.10)	(1.69)	(0.53)	(-1.23)	(2.56)	(1.34)
(-5,+5)	0.54**	54.09	0.54*	54.26	0.21	47.12	1.11***	59.04**
	(2.55)	(0.94)	(1.74)	(0.86)	(0.29)	(-1.23)	(2.91)	(2.22)
(-10,+10)	1.20***	56.82*	0.86**	53.81	0.93*	54.97	2.98***	57.98**
	(3.25)	(1.75)	(2.11)	(0.72)	(1.69)	(0.94)	(3.67)	(1.97)

Panel C: Abnormal returns for sub-sample with negative combined wealth effect (CWE) to merging firms								
	Acquirer Rivals		Target Rivals		Main Customer		Dependent Customer	
Number	N=218		N=222		N=191		N=186	
Event Windows:	Mean	% Positive	Mean	% Positive	Mean	% Positive	Mean	% Positive
(-1,+1)	-0.26**	44.50**	0.06	52.25	0.06	49.74	-0.53	40.32***
	(-2.02)	(-2.14)	(-0.41)	(-0.04)	(0.91)	(-0.66)	(-1.52)	(-2.95)
(-2,+2)	-0.39**	44.04**	-0.06	48.65	0.02	51.83	-0.23	49.46
	(-2.35)	(-2.28)	(-0.86)	(-1.11)	(0.53)	(-0.08)	(-0.85)	(-0.46)
(-5,+5)	-1.29***	36.70***	-0.17	46.40*	-0.65	46.07*	-0.89*	48.39
	(-4.65)	(-4.44)	(-1.11)	(-1.78)	(-1.42)	(-1.67)	(-1.65)	(-0.75)
(-10,+10)	-1.42***	39.45***	-0.48	43.69***	-1.40**	45.55*	-1.63**	43.55**
	(-3.88)	(-3.63)	(-1.26)	(-2.59)	(-2.27)	(-1.82)	(-2.38)	(-2.07)
Panel D: z statistic for the difference between positive and negative combined wealth effect sub-samples								
(-1,+1)	1.93*	1.92*	0.96	0.85	-0.52	0.10	2.19**	1.88*
(-2,+2)	2.67***	2.40**	1.07	1.51	0.51	-0.82	1.85*	1.55
(-5,+5)	3.04***	3.70***	1.08	1.65*	1.64*	0.20	2.41**	2.28**
(-10,+10)	3.11***	3.69***	1.47	2.09**	2.78***	1.85*	3.68***	2.18**

Table IV
Determinants of the Combined Wealth Effect to the Merging Firms

The dependent variable is the combined wealth effect (*CWE*) to the merging firms for the window (-10, +10) days around the period between the first bid by the successful acquirer to the announcement of the successful bid in the contest. *RDICHG* is the industry-adjusted change in R&D intensity is measured over calendar year windows (-1, +2) and (-2, +2). $MKTSH_{ACQ}$ and $MKTSH_{TAR}$ are the acquirer and target market shares in its primary industry during the year of the takeover. $CONC_{ACQ}$ is the sales based Herfindahl Index of the four-digit SIC industry of the acquirer during the takeover year. *ACQCF* is the acquirer cash flow and measured as operating income before depreciation minus interest expense, taxes, preferred dividends, and dividends for the year prior to the takeover. *ACQCF (q<1)* is an interaction between acquirer cash flow and a dummy variable that equals one when acquirer Tobin's q is less than one and zero otherwise. *Target q>1* is a dummy variable that equals one when target Tobin's q exceeds one and zero otherwise. $FORCOMP_{ACQ}$ and $FORCOMP_{TAR}$ are the foreign competition in acquirer (target) industry and calculated as the ratio of total imports divided by total supply in the industry. *Relative Size* is the ratio of the market value of the target to the market value of the bidder measured fifteen days prior to the first bid by successful acquirer. *Stock* is a dummy which equals one when the deal is stock financed and is zero otherwise. *Hostile* is a dummy that equals one when the deal is reported as hostile by SDC and is zero otherwise. MLE procedure is based on the methodology in Eckbo et al. (1990), and W represents the standard error of the manager's private information. t-statistics are provided in the parentheses. ***, ** and * indicate significance at 1%, 5%, and 10% respectively.

Dependent Variable: Combined wealth effect (*CWE*)	WLS	MLE	WLS	MLE
Intercept	0.03***	1.06***	0.02**	1.05***
	(3.03)	(18.38)	(2.11)	(17.83)
Industry adjusted change in R&D intensity, *RDICHG (years -1, +2)*	0.14	0.14***		
	(1.45)	(2.66)		
Industry adjusted change in R&D intensity, *RDICHG (years -2, +2)*			0.16*	0.16***
			(1.89)	(3.17)
Acquirer Market Share ($MKTSH_{ACQ}$)	-0.02	-0.02	-0.01	0.00
	(-1.16)	(-0.70)	(-0.52)	(-0.19)
Target Market Share ($MKTSH_{TAR}$)	0.00	-0.03	0.00	-0.02
	(-0.16)	(-1.01)	(-0.05)	(-0.65)
Acquirer Industry Herfindahl Index ($CONC_{ACQ}$)	0.03	-0.02	0.02	-0.04
	(1.60)	(-0.84)	(1.00)	(-1.35)
Acquirer Cash Flow (*ACQCF*)	-0.03	-0.08	0.02	-0.05
	(-0.49)	(-1.60)	(0.42)	(-0.94)
ACQCF (q<1)	-0.30	-0.61**	-0.44**	-0.77***
	(-1.45)	(-2.48)	(-2.12)	(-2.88)
Target q >1	-0.02***	-0.19***	-0.02***	-0.19***
	(-2.68)	(-13.41)	(-2.63)	(-13.07)
Acquirer Industry Foreign Competition ($FORCOMP_{ACQ}$)	0.03	0.01	0.02	0.00
	(0.85)	(0.29)	(0.60)	(0.03)
Target Industry Foreign Competition ($FORCOMP_{TAR}$)	0.00	-0.04	0.01	-0.03
	(0.09)	(-0.91)	(0.22)	(-0.58)
Stock Dummy (*Stock*)	-0.02**	-0.03***	-0.02**	-0.03***
	(-2.03)	(-3.11)	(-2.01)	(-2.95)
Hostile Dummy (*Hostile*)	0.06***	0.05**	0.05***	0.05*
	(3.63)	(2.21)	(2.86)	(1.84)
Relative Size	0.02***	0.02***	0.06***	0.05***
	(3.69)	(7.61)	(6.46)	(4.56)
Standard error of manager's private information (W)	-	0.22***	-	0.22***
		(18.07)		(17.77)
N	453	453	436	436
Adjusted R-Square	0.11	n.a.	0.18	n.a.

Table V
WLS Regressions for abnormal returns to Acquirer and Target Rivals

The dependent variables are the abnormal return to acquirer rivals (*ACQRIVCAR*) and target rivals (*TARRIVCAR*) in the (-10, +10) day window around the announcement of the first bid by the successful acquirer. Combined wealth effect (CWE) of a takeover is calculated as the value weighted abnormal return to the acquirer and target measured for the window (-10, +10) days around the period between the announcement of the first bid by the successful acquirer to the announcement of the successful bid in the contest. $CONC_{ACQ}$ is the sales based Herfindahl Index of the four-digit SIC industry of acquirer during the takeover year. $MKTSH_{ACQ}$ and $MKTSH_{TAR}$ are the acquirer and target market shares in its primary industry during the year of the takeover. *Initial* is a dummy that equals to one if the there is no vertical takeover between the acquirer and target three-digit SIC industries in the year prior to announcement and zero otherwise. $FORCOMP_{ACQ}$ and $FORCOMP_{TAR}$ are the foreign competition in acquirer (target) industry and calculated as the ratio of total imports divided by total supply in the industry. *Stock* is a dummy which equals one when the deal is stock financed and is zero otherwise. *Hostile* is a dummy that equals one when the deal is reported as hostile by SDC and is zero otherwise. t-statistics are provided in the parentheses. ***, ** and * indicate significance at 1%, 5%, and 10% respectively.

	Acquirer Rival CAR (*ACQRIVCAR*)	Target Rival CAR (*TARRIVCAR*)
Intercept	-0.005	0.001
	(-1.02)	(0.20)
Combined wealth effect (*CWE*)	0.12***	0.074***
	(5.52)	(3.13)
Acquirer Market Share($MKTSH_{ACQ}$)	-	0.025
		(1.50)
Target Market Share ($MKTSH_{TAR}$)	0.012	-
	(0.53)	
Acquirer Industry Herfindahl Index ($CONC_{ACQ}$)	0.024	-0.019
	(1.21)	(-1.17)
Initial Vertical Takeover (*Initial*)	0.002	0.014**
	(0.31)	(2.34)
Acquirer Industry Foreign Competition ($FORCOMP_{ACQ}$)	-0.020	-0.004
	(-0.72)	(-0.17)
Target Industry Foreign Competition ($FORCOMP_{TAR}$)	-0.005	-0.031
	(-0.20)	(-1.23)
Stock dummy (*Stock*)	0.001	-0.005
	(0.15)	(-0.85)
Hostile dummy (*Hostile*)	-0.023	-0.028**
	(-1.56)	(-2.03)
N	438	445
Adjusted R-Square	0.05	0.04

Table VI
WLS Regressions for abnormal returns to Main and Dependent Customers

The dependent variables are the abnormal return to main customers and the abnormal return to dependent customers in the (-10, +10) window around the first bid by the successful acquirer. The main customer industry is identified as the industry that accounts for the highest proportion of the total output of the downstream industry in the vertical takeover provided it is greater than 1%. The Dependent customer industry is identified as the industry that receives the highest proportion of its inputs from the downstream industry in vertical takeover to produce its total output, provided it is greater than 1%. Combined wealth effect (CWE) of a takeover is calculated as the value weighted abnormal return to the acquirer and target measured for the window of (-10, +10) days around the period between the announcement of the first bid by the successful acquirer to the announcement of the successful bid in the contest. $CONC_{ACQ}$ is the sales based Herfindahl Index of the four-digit SIC industry of acquirer during the takeover year. $MKTSH_{ACQ}$ and $MKTSH_{TAR}$ are the acquirer and target market shares in its primary industry during the year of the takeover. $FORCOMP_{ACQ}$ and $FORCOMP_{TAR}$ are the foreign competition in acquirer (target) industry and calculated as the ratio of total imports divided by total supply in the industry. *Stock* is a dummy which equals one when the deal is stock financed and is zero otherwise. *Hostile* is a dummy that equals one when the deal is reported as hostile by SDC and is zero otherwise. t-statistics are provided in the parentheses. ***, ** and * indicate significance at 1%, 5%, and 10% respectively.

	Main Customer CAR	Dependent Customer CAR
Intercept	-0.009*	0.003
	(-1.87)	(0.36)
Combined wealth effect (*CWE*)	0.058**	0.145***
	(2.23)	(4.77)
Acquirer Market Share($MKTSH_{ACQ}$)	0.021	0.042**
	(1.29)	(2.10)
Target Market Share ($MKTSH_{TAR}$)	0.007	-0.046
	(0.38)	(-1.60)
Acquirer Industry Herfindahl Index ($CONC_{ACQ}$)	0.013	-0.013
	(0.65)	(-0.55)
Acquirer Industry Foreign Competition ($FORCOMP_{ACQ}$)	-0.009	-0.069*
	(-0.32)	(-1.79)
Target Industry Foreign Competition ($FORCOMP_{TAR}$)	-0.009	0.006
	(-0.35)	(0.17)
Stock dummy	-0.001	0.008
	(-0.21)	(0.87)
Hostile dummy	0.001	-0.011
	(0.04)	(-0.52)
N	382	374
Adjusted R-Square	0.01	0.07

Figure 1
Schematic Diagrams for Backward and Forward Vertical Takeovers

Figure 1(a) represents a backward takeover and Figure 1(b) represents a forward takeover. A backward takeover is one where the acquirer is downstream (customer) and the target is upstream (supplier) in the supply chain, and a forward takeover is one where the acquirer is upstream (supplier) and the target is downstream (customer) in the supply chain. To identify corporate customers for both forward and backward takeovers, we use industries that buy product of the downstream industry in the vertical takeover. The direction of arrows indicates the flow of commodities/services from a supplier to a customer.

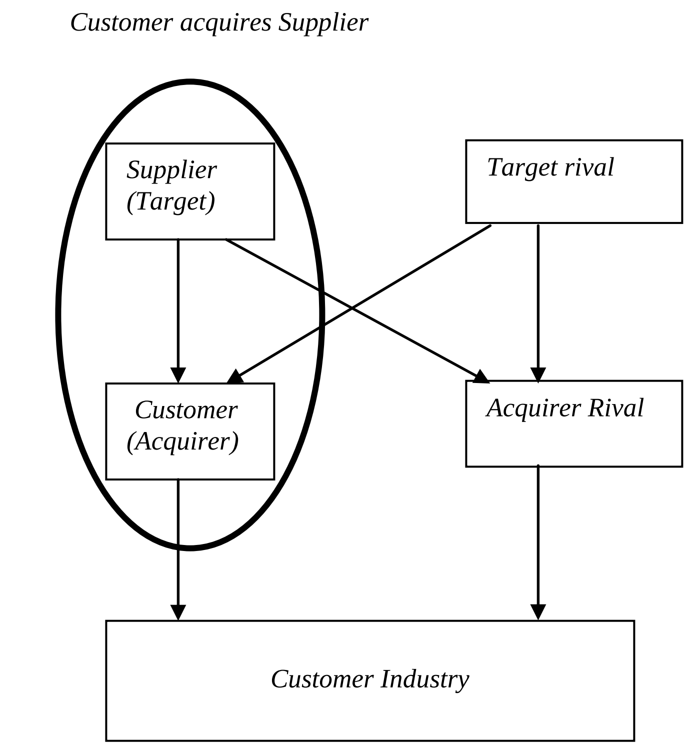

Figure 1(a): Backward Takeover

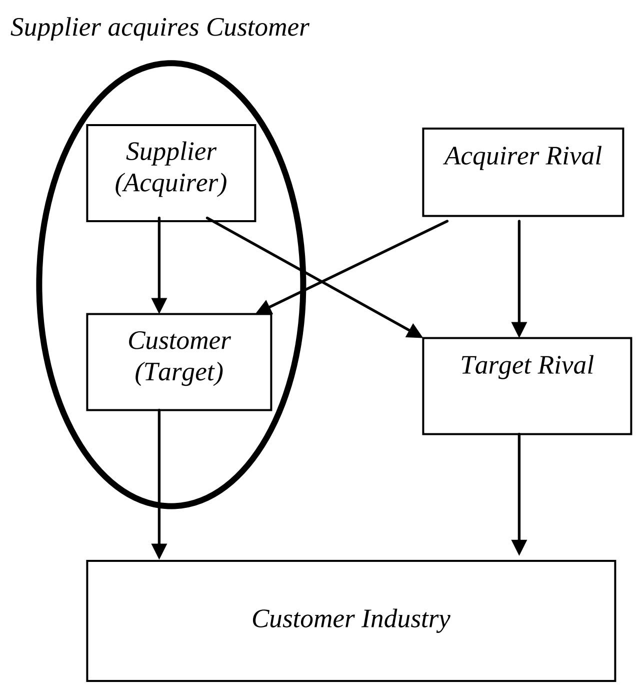

Figure 1(b): Forward Takeover

Essay 2: Determinants of Firm Vertical Boundaries and Implications for Internal Capital Markets

1. Introduction

A large body of research argues that vertical boundaries of the firm are determined by the transaction costs under different organizational forms (e.g., Coase (1937), Klein, Crawford, and Alchian (1978), Williamson (1971, 1979), Holmstrom and Roberts (1998), Bolton and Scharfstein (1998)). This literature suggests that the vertically integrated form arises in environments where contracting costs between suppliers and customers are high. In this paper, we investigate two related research questions. First, we investigate the determinants of the vertical boundaries of firms as measured by the degree of vertical relatedness between business segments of the firm. Existing research examines factors that determine the occurrence of *partial* equity stakes by customers in suppliers (e.g., Fee, Hadlock, and Thomas (2006)) and the cross-country variation in vertical integration (e.g., Acemoglu, Johnson, and Mitton (2009)). We provide the first examination of industry characteristics that lead to vertical integration in a large sample of firms operating in the United States.

Second, we investigate how vertical relatedness between business segments affects the working of internal capital markets. In this regard, Stein's (1997) 'winner picking' hypothesis suggests that firms operating in *related* lines of businesses can do a better job in the allocation of corporate resources across divisions. We posit that the degree of vertical relatedness between business segments captures one dimension of relatedness between firm projects. We then investigate how our measures of vertical relatedness impact the efficiency of internal capital allocations. We contribute to the internal capital markets literature by investigating how product market relations between segments affect the efficiency of internal capital allocations (e.g., see Stein (2003) and Maksimovic and Phillips (2006)).

The extant literature on vertical integration argues that the vertical boundaries of the firm are determined by the nature and sources of transaction costs (e.g., Coase (1937), Klein, Crawford, and Alchian (1978), Williamson (1971, 1979) among others). In particular, when contracts are incomplete, the contracting parties may take advantage of the ambiguities in contracts and behave opportunistically in their own interests. Such opportunistic behavior (termed as holdup) leads to underinvestment in relationship-specific investments (RSI). Vertical integration, by providing common ownership, mitigates such contractual problems and encourages relationship-specific investments. Based on the above, our first hypothesis is that we should observe higher vertical relatedness between segments in environments likely to be characterized by contractual incompleteness and relationship-specific investments.

Our second hypothesis pertains to the relation between inter-segment vertical relatedness and efficiency of internal capital markets (ICM). In particular, in Stein's (1997) model, when the corporate headquarters oversees projects in related lines of businesses, it is able to accurately rank projects and thereby allocate capital more efficiently. Ozbas' (2005) model extends this idea by showing that unrelated integration worsens the quality of information required by the headquarters to allocate corporate resources. Khanna and Tice (2001) provide empirical evidence that only those discount retailers who diversify into related businesses are able to allocate capital across segments efficiently in response to a negative shock.[26] We propose that the degree of vertical relatedness between business segments captures one dimension of relatedness between firm projects. We then hypothesize that internal capital markets work more efficiently in the presence of significant vertical relatedness.

[26] They use the entry of Wal-Mart into the retailer's market as the measure for the negative shock.

Our sample comprises of 32,554 multi-segment firm-years during the period 1984-2005 for which we obtain data on the Compustat industry-annual and segment databases. To identify vertically integrated firms, we calculate the degree of vertical relatedness between the different industries in which our sample firms have business segments. For this purpose, we use the benchmark input-output accounts of the U.S. economy, which provide the dollar value of commodity flows between different industries in the economy. We use this data to compute vertical relatedness coefficients between pairs of supplier-customer industries (e.g., Fan and Lang (2000), Shahrur (2005), and Fan and Goyal (2006) among others)). The vertical relatedness coefficient measures the extent of commodity transfer between these industries.

We then weight the aggregate industry coefficients by the segment sales weights and arrive at two measures of firm-level vertical relatedness, (i) the segment sales weighted vertical relatedness coefficient between all industries in which the firm operates, and (ii) the segment sales weighted vertical relatedness coefficient between the primary industry of the firm and all its secondary industries. The extant literature uses vertical relatedness coefficients of either 1% or 5% to capture economically significant vertical relatedness between business segments within a firm (e.g., Fan and Goyal (2006) and Shenoy (2008)). Based on this literature, we categorize a multi-segment firm as vertically integrated if the firm-level vertical relatedness measure exceeds 5%.

To test our first hypothesis, we use two industry-level measures for environments likely to be characterized by contractual incompleteness and relationship-specific investments. Allen and Phillips (2000) argue that property rights are not well defined in R&D intensive industries and likely to involve incomplete contracts. Kale and Shahrur (2007) suggest that R&D intensive industries are likely to involve relationship-specific investments. We, therefore, use the research and development (R&D) intensity of the primary industry of the firm as our first measure. The existing research also argues that strategic alliances and joint ventures are hybrid organizational forms used as alternatives to vertical integration for solving contractual problems (e.g., Fee, Hadlock, and Thomas (2006) and Kale and Shahrur (2007)). Therefore, high strategic alliance/joint venture intensity between the primary industry and vertically related supplier/customer industries is likely to indicate environments with holdup problems. Accordingly, the second measure we use is the intensity of strategic alliances and joint ventures involving firms in the primary industry and all vertically related supplier/customer industries.

We then estimate probit regressions and find a higher degree of vertical relatedness between segments when the primary industry of the firm is R&D intensive and when the strategic alliances and joint ventures involving firms in the primary industry and vertically related industries are more common. Both these results are supportive of our hypothesis that vertical integration should be observed in environments likely to have high contracting costs. Overall, the determinants of firm vertical boundaries seem to be consistent with theory.

To test our second hypothesis, we use the following three metrics developed in the extant literature that quantify the efficiency of internal capital market (ICM) allocations: (i) Relative Value Added by Allocation (RVA) of Rajan, Servaes, and Zingales (2000), (ii) the sensitivity of segment investment to q aggregated at the firm level (IQSENS) developed by Peyer and Shivdasani (2001), and (iii) Relative Investment Ratio (RINV) of Rajan, Servaes, and Zingales (2000). Intuitively, these measures capture the association between segment investment and segment investment opportunities aggregated across all business segments of the firm. All three measures will have a positive value in firms that systematically allocate more investment toward segments with better investment opportunities.

We first compare the ICM efficiency measures for firms that display significant vertical relations to those that do not. Consistent with our expectation, firms that display vertical relatedness of 5% or more are associated with positive and statistically significant values of RVA, IQSENS, and RINV. Further, the difference in means between the vertical and non-vertical sample is positive and significant at conventional levels. These results indicate that firms with significant inter-segment vertical relations allocate capital more efficiently within their ICMs.

To further corroborate this evidence, we conduct cross-sectional analyses of the relation between vertical relatedness and efficiency of internal capital allocations. In this analysis, we control for other factors that may affect the efficiency of ICMs such as the diversity in investment opportunities, firm Herfindahl Index based on segment sales, and firm size (e.g., Rajan, Servaes, and Zingales (2000)). These cross-sectional tests provide further support for our hypothesis. Consistent with our second hypothesis, we find a positive relationship between the degree of vertical relatedness and the efficiency of ICM allocations. We also find that the interaction between diversity in investment opportunities and vertical relatedness has a negative effect on the efficiency of internal capital allocations. This result indicates that as the diversity in investment opportunities increases, it tends to diminish the beneficial effects of vertical relatedness on ICMs. The positive relation between efficiency of ICM allocations and vertical relatedness is robust to methodological controls for endogeneity.

In summary, we provide evidence which indicates that vertical integration in firms operating in the U.S. arises in environments likely to involve high contracting costs. We also find that in presence of significant vertical relatedness between business segments, the segment investment flows towards segments with better investment opportunities consistent with a well-functioning internal capital market in vertically integrated firms.

We make the following contributions to the extant literature. First, to the best of our knowledge, this is the first study to investigate determinants of inter-segment vertical relatedness for multi-segment firms operating in the United States. We complement Acemoglu, Johnson, and Mitton's (2009) cross-country analysis in which they find a higher incidence of vertical integration in countries with poor contract enforcement mechanisms and more financial development. We also build upon the finding in Fee, Hadlock, and Thomas (2006) that *partial* equity stakes by customers in suppliers are more likely when supplier's R&D intensity is high and if the relationship is governed through a formal contractual agreement such as joint venture or strategic alliance. In particular, we show that inter-segment vertical relatedness arises in industries likely to have incomplete contracts and relationship-specific investments.[27]

Second, we contribute to the ongoing debate in the literature regarding the efficiency of ICM allocations. One stream of papers argues that internal capital markets are detrimental since the corporate headquarters engages in bureaucratic decision making (e.g., Lamont (1997), Scharfstein (1998), Shin and Stulz (1998), Rajan, Servaes, and Zingales (2000), and Scharfstein and Stein (2000)). On the other hand, another stream suggests that internal capital market allocations are beneficial because the corporate headquarters acts as an informed provider of capital and directs resources towards high yield uses (e.g., Alchian (1969) and Williamson (1975), Gertner, Scharfstein, Stein (1994), Khanna and Tice (2001), Maksimovic and Phillips (2002), and Matsusaka and Nanda (2002)). We add to this literature by showing that vertically integrated firms exhibit a well-functioning internal capital market.[28]

[27] Our large sample evidence also complements prior case or industry-specific studies that examine the determinants of vertical integration (e.g., Boerner and Macher (2001), Joskow (2005), and Lafontaine and Slade (2007) provide excellent survey articles).

[28] Yet another set of researchers argue that the evidence on inefficient cross-subsidization is an artifact of sample selection or measurement error in Tobin's q (e.g., Chevalier (2004), Whited (2001), Colak and Whited (2007)).

Finally, our paper is related to the literature which investigates how the organizational boundaries impact the decisions undertaken by the firms' managers. In particular, Mullainathan and Scharfstein (2001) find that the capacity of vertically integrated chemical producers is less responsive to market conditions than the capacity of non-integrated producers. Guedj (2006) compares integrated projects to projects governed via contracts within pharmaceutical firms and finds that only upon ownership of the project does the firm enjoy benefits of internal capital markets.

The remainder of the paper proceeds as follows. In Section 2, we describe our data sources, sample selection, empirical methodology for computing firm-level vertical relatedness, and characteristics of our sample. In Section 3, we present a discussion of the determinants of firm vertical boundaries and the results based on probit estimations. In Section 4, we present a discussion of the possible relation between vertical relatedness and ICM efficiency measures based on the extant theoretical literature followed by our univariate and multivariate analysis of this relation. Finally, we conclude the paper in Section 5.

2. Data Sources, Sample Selection, Methodology for Vertical Relatedness and Descriptive Statistics

2.1. Data Sources and Sample Selection

We obtain segment data from the Compustat segment tapes and firm level financial information from Compustat Industrial Annual database for all active and inactive firms during the period 1984-2005. For each segment, we collect data on net sales, capital expenditure, total assets, and SIC codes. We exclude segments that do not contain complete information on these variables. We also eliminate firm-years with missing firm assets or sales, where the sum of segment sales is not within 5% of the total firm sales, where the sum of segment sales is less than $20 million, and where any segment has a one-digit SIC code of six (financial industry). The above sample selection criteria are largely consistent with the corporate diversification literature (e.g., Campa and Kedia (2002) and Villalonga (2004)). The sample based on above criteria leads us to a sample of 32,554 multi-segment and 64,045 single segment firm-years.

2.2. Firm Level Measures of Vertical Relatedness

To compute measures for vertical relatedness, we rely on the benchmark input-output accounts of the U.S. economy. This data is published by the Bureau of Economic Analysis every five years for the aggregate industries of the U.S. economy. Specifically, the *Use Table* from the benchmark accounts provides a matrix of commodity flows between different pairs of input-output (IO) industries. For example, for a given IO industry 'i', we can obtain the dollar amount of commodity flow from IO industry 'j' required to produce the total output of industry 'i'. A number of papers in the finance literature have used this data to measure vertical relations between industries (e.g., Fan and Lang (2000), Fan and Goyal (2006), Shahrur (2005), Acemoglu et al. (2009), and Shenoy (2008)).

We build upon the extant literature and compute the following two measures for firm level vertical relatedness: (i) A measure that captures the extent of inter-segment vertical relatedness between all business segments of a multi-segment firm, and (ii) A measure that captures the extent to which the primary segment of the firm is vertically related to all secondary segments of the firm. We also compute separate measures for the extent of backward and forward vertical relatedness.

We compute our first set of measures (*VrcBackCoeff1*, *VrcForwCoeff1*) for backward and forward vertical relatedness based on Acemoglu et al. (2009) as follows. First, we use the segment data to identify all four-digit SIC industries in which a firm operates. We also obtain the segment sales, assets, and capital expenditures. Then, we find for each dollar of output of industry ‘i’ in which the firm operates, the dollar amount of inputs required from all other industries ‘j’ in which the firm has business segments, where j does not equal ‘i’. We denote each of these coefficients as θ_{ij}. The summation of these coefficients, $\theta_i = \sum_{j=1, j\neq i}^{n} \theta_{ij}$ represents per dollar of output of industry ‘i’, the dollar amount of inputs from all other industries ‘j’ in which the firm operates. We then compute the firm level backward vertical relatedness coefficient (*VrcBackCoeff1*) by weighting each θ_i by the sales weight of the segment, i.e., $VrcBackCoeff1 = \sum_{i=1}^{n} \theta_i * w_i$ where w_i is the sales of segment ‘i’ divided by the sales of all segments of the firm. The firm level vertical relatedness coefficient (*VrcBackCoeff1*) measures the opportunity for backward vertical integration between all segments of the firm.

We compute a similar measure based on forward vertical relatedness between segments. We find for each dollar of output of industry ‘i’ in which the firm operates, the dollar amount of output sold to all other industries ‘j’ in which the firm has business segments, where j does not equal to ‘i’. We denote each of these coefficients as α_{ij}. The summation of these coefficients $\alpha_i = \sum_{j=1, j\neq i}^{n} \alpha_{ij}$ represents per dollar of output of industry ‘i’, the dollar amount sold to all other industries in which the firm operates. We then compute the firm level forward vertical relatedness coefficient (*VrcForwCoeff1*) by weighting each α_i by the sales weight of the segment, i.e. $VrcForwCoeff1 = \sum_{i=1}^{n} \alpha_i * w_i$ where w_i is the sales of segment ‘i’ divided by the sales of all segments of the firm. The firm level vertical relatedness coefficient (*VrcForwCoeff1*) measures the opportunity for forward vertical integration between all segments of the firm.

The second measure of vertical relatedness is based on Fan and Lang (2000). Here, the focus is to measure how the primary segment of the firm is vertically related to its secondary segments. For each firm-year observation, we identify the primary segment as the segment with the largest sales and denote its corresponding industry as 'i', and all remaining segments as secondary, and their corresponding industries as 'j' for j=1 to n-1.

We then find the dollar amount of inputs from the secondary industry 'j' required to produce a dollar of the primary industry 'i' total output (γ_{ji}). Subsequently, we find the dollar flow from the primary industry 'i' required to produce a dollar of secondary industry 'j' total output (γ_{ij}). We then find $V_{ij,INPUT} = \frac{1}{2} \times (\gamma_{ji} + \gamma_{ij})$, which gives measure for the opportunity for backward integration between primary industry 'i' and secondary industry 'j'. Finally, the firm-level measure of backward vertical relatedness is computed as the sales weighted vertical relatedness between the primary industry 'i' and all secondary industries 'j' and calculated as $VrcBackCoeff2 = \sum_j V_{ij,INPUT} * w_j$ where w_j is the sales weight of the secondary segment 'j' to the sum of sales of all secondary segments of the firm. $VrcBackCoeff2$ measures the opportunity for backward vertical integration between the primary segment and all secondary segments of the firm.

We also compute a similar measure to capture the extent of forward integration between the primary industry 'i' and each secondary industry 'j'. Specifically, we find for every dollar of output of the primary industry 'i' the amount transferred to each secondary industry 'j' (η_{ij}) and for every dollar of output of the secondary industry 'j' the dollar amount transferred to the primary industry 'i' (η_{ji}). We then find the extent of output transfers between primary industry 'i' and each secondary industry 'j' as $V_{ij,OUTPUT} = \frac{1}{2} \times (\eta_{ji} + \eta_{ij})$. Finally, the firm-level measure of forward vertical relatedness is the sales weighted vertical relatedness between the primary industry 'i' and all secondary industries 'j' and calculated as $VrcForwCoeff2 = \sum_j V_{ij,OUTPUT} * w_j$ where w_j is the sales weight of the secondary segment 'j' to the sum of all secondary segment sales. $VrcForwCoeff2$ measures the opportunity for forward vertical integration between the primary segment and all secondary segments of the firm.[29]

The benchmark input-output data uses a different system of industry definitions than those from the SIC industry definitions. We, therefore, use the SIC-IO concordance table of Fan and Lang (2000) to map the four-digit segment SIC codes to their respective six-digit input-output (IO) codes. We employ the *Use* tables of 1982, 1987, 1992, and 1997 for firm-year observations during 1984 to 1985, 1986 to 1990, 1991 to 1997, and 1998 to 2005 respectively. The use of different input-output tables over our sample period is motivated by the likelihood that the input-output relations between industries may change over time. Furthermore, the 1997 benchmark input-output accounts incorporate the NAICS system instead of the SIC system of industry classification. To use the 1997 benchmark input-output tables, we first map the four-digit SIC codes of the segments to their respective six-digit NAICS codes using the Bridge tables provided by the Bureau of Census. We then find their respective IO industries using the NAICS-IO concordance table provided in the 1997 benchmark input-output accounts.

2.3. Descriptive Statistics on the Sample of Multi-Segment and Single-Segment Firms

In Panel A of Table I, we present the summary statistics of the multi-segment and single segment firms in our sample. All variables are winsorized at the 1 and 99 percentile levels to reduce the effect of outliers on the results. We find that multi-segment firms are larger than single segment firms in terms of assets and sales, have a higher profitability than single segment firms (EBIT), have a lower R&D intensity than single segment firms, are more likely to be listed on a major exchange, are more likely to be incorporated outside the U.S., are more likely to be part of the S&P index, are more likely to pay dividends, and belong to

[29] We also compute the vertical relatedness coefficient using segment asset based weights instead of segment sales based weights and obtain qualitatively similar results.

industries where a larger percentage of firms are diversified and where diversified firms account for a larger share of the market share. In unreported results, we find that the difference in means between the multi-segment and single-segment samples for all above attributes is statistically significant at the 1% level. In summary, we find that the characteristics of multi-segment firms are substantially different from those of single segment firms.

In Panel B of Table I, we provide descriptive statistics on our measures of vertical relatedness for multi-segment firms. In particular, the opportunity for backward (forward) vertical integration between all business segments of multi-segment firms in our sample, *VrcBackCoeff1* (*VrcForwCoeff1*), is on average, 2.81% (2.15%). Further, the opportunity for backward (forward) vertical integration between the primary industry of the firm and all secondary industries in which the firm operates, *VrcBackCoeff2* (*VrcForwCoeff2*), is on average, 1.26% (1.36%). Furthermore, primary segments on average account for 66% of multi-segment firm sales (*CORESIZE*). Secondary segments account for the remaining 34% of multi-segment firm sales. This finding indicates that secondary segments represent a significant percentage of the total sales (assets) of multi-segment firms.

The literature has used a vertical relatedness cutoff of either 1% or 5% to capture economically significant vertical relations (e.g., Fan and Goyal (2006) and Shenoy (2008)). In unreported results, we find that 4,455 (3,544) firm-years have significant backward (forward) inter-segment vertical relatedness between all segments based on *VrcBackCoeff1* (*VrcForwCoeff1*) of 5% or greater. Similarly, we also find that 2,220 (2,295) firm-years have significant backward (forward) vertical relatedness between the primary segment and all secondary segments based on *VrcBackCoeff2* (*VrcForwCoeff2*) of 5% or greater. In summary, we find that a significant proportion of multi-segment firms display economically meaningful backward and forward vertical relatedness between their business segments.

3. Determinants of Firm Vertical Boundaries

In this section, we make predictions regarding the different economic forces that can impact the vertical boundaries of firms. We then outline our empirical methodology and present and discuss our results based on probit estimations.

3.1. Variables to Capture Determinants of Vertical Boundaries of the Firm

The existing literature on vertical integration argues that in presence of contractual incompleteness trading partners are reluctant to make relationship-specific investments fearing future contractual bargaining problems (e.g., Coase (1937), Klein, Crawford, and Alchian (1978), Williamson (1971, 1979)). This leads to underinvestment in relationship-specific investments. Vertical integration, by providing common ownership, mitigates this underinvestment problem and provides incentives to make relationship-specific investments. Based on the above, we hypothesize that the vertically integrated form should be observed in environments likely to involve relationship-specific investments and where contracts are likely to be incomplete.

In contrast to the efficiency argument outlined above, an alternate stream of literature suggests that vertical integration is anti-competitive in nature. This literature proposes two possible routes through which vertical integration can enhance market power, namely, *foreclosure*, where vertical integration gives the integrated firm an unfair advantage over its non-integrated rivals, and *collusion*, where the vertical integration enhances co-ordination with the non-integrated rivals (e.g., Shenoy (2008)). In the determinants section, we also investigate these anti-competitive strategies of vertical integration. We propose the following variables for the determinants of vertical integration.

(i) R&D intensity of the primary segment's four-digit SIC industry measured as R&D expenditure divided by net sales (*INDRDI*). Allen and Phillips (2000) argue that property rights are not well defined R&D intensive industries and, therefore, are likely to have contracting problems. Fee, Hadlock, and Thomas (2006) find that equity stakes in supplier-customer relationships are more common in R&D intensive environments. Kale and Shahrur (2007) use industry R&D intensity to measure relationship-specific investments. Based on the above, we use R&D intensity as the first proxy for incomplete contracts and for the prevalence of relationship-specific investments. We predict a positive relation between inter-segment vertical relatedness and R&D intensity of the primary industry, i.e., a positive sign on *INDRDI*.

(ii) Strategic alliance/joint venture intensity measured as the number of joint ventures and strategic alliances between firms in the primary industry and firms in all secondary industries that are vertically related at the 1% level divided by the number of firms in the primary industry of the firm (*SAJVINT*).[30] This acts as our second proxy for contractual incompleteness and prevalence of relationship-specific investments. Kale and Shahrur (2007) argue that industries in which strategic alliances and joint ventures with firms in supplier and customer industries are prevalent are likely to involve contractual frictions. Fee, Hadlock, and Thomas (2006) find that equity stakes by customers in their suppliers are more common if the relationship was governed by formal alliance agreements. They argue that equity stakes and explicit alliance agreements are complements and can both be used to resolve holdup problems. Based on this, we conjecture a positive relation between the degree of vertical

[30] As robustness, we measure *SAJVINT* based on a 5% cutoff for identifying vertically related industries. We find similar results under this approach.

relatedness between segments and the strategic alliance and joint venture intensity, i.e., a positive sign on *SAJVINT*.[31]

(iii) Advertising intensity of the primary segment four-digit SIC industry measured as the advertising expenditure divided by net sales (*INDADV*). Prior literature suggests that investments in brand name represent relationship-specific investing (e.g., Gatignon and Anderson (1988)). It is likely that advertising spending represents investments towards brand capital. Therefore, in industries with high advertising intensity there is likely to be more relationship-specific investing as measured by investment in brand name. Accordingly, we posit that the higher the industry advertising intensity, the greater is the likelihood to observe vertical integration, i.e. a positive sign on *INDADV*.[32]

(iv) Selling, general, and administrative expenditure intensity of the primary segment four-digit SIC industry measured as the selling, general, and administrative expenditure divided by net sales (*INDSELL*). If a firm's segments are vertically related it is likely that the firm would spend less on transmitting information about its product to prospective buyers/suppliers since part of the output produced by some of its segments is potentially being used internally by other vertically related segments. If vertical integrating into related industries helps the firm to economize on costs of transmitting information, it is likely that vertically integrated firms would be observed in industries with less selling, general, and administrative expenditure intensity. Consistent with this argument, the extant literature documents a negative relationship between vertical relatedness and selling, general, and administrative expenditure (e.g., Caves and Bradburd (1988)). Based on the above, we posit a negative relation between

[31] The alliance/joint venture data is obtained from SDC Platinum database.

[32] In line with our hypothesis, prior research documents a positive relation between firm advertising intensity and vertical integration (e.g., Levy (1985), Boerner and Macher (2001), Lafontaine and Shaw (2005), and Nickerson and Silverman (2003)).

vertical relatedness and industry selling, general, and administrative expenditure intensity, i.e., a negative sign on *INDSELL*.

(v) Sales based Herfindahl index of the primary industry (*INDHERF*). This choice is based on anti-competitive rationales for vertical integration such as collusion (e.g., Chen (2001) and Nocke and White (2007)). In these models, when an industry is already concentrated, a vertical takeover with a firm in the supplier/customer industry increases the likelihood of collusion between the integrated firm and non-integrated rivals by facilitating a mechanism that aids the flow of information between the integrated firm and non-integrated rivals. Accordingly, if the motivation behind vertical integration was collusion, we posit a positive relation between vertical relatedness and primary industry concentration, i.e., a positive sign on *INDHERF*.

(vi) Market shares of the firm in its primary and secondary industries (*PRIMSEGMKTSH* and *SECSEGMKTSH*). The extant literature proposes foreclosure as yet another anti-competitive rationale for vertical integration (e.g., Salinger (1988), Ordover, Saloner, and Salop (1990), Hart and Tirole (1990) among others). Under this hypothesis, vertical integration provides an opportunity for integrated firms to raise the costs of their non-integrated rivals by denying or limiting access to inputs or distribution outlets to their rivals. It is likely that the higher the market share of the integrated firm in its primary/secondary industries, the greater is its market power to foreclose its non-integrated rivals. Accordingly, if the motivation behind vertical integration was foreclosure, we expect a positive relation between vertical relatedness and the market shares of the firm in its primary/secondary industries, i.e., a positive sign on *PRIMSEGMKTSH* and *SECSEGMKTSH*.[33]

[33] A multi-segment firm can have multiple secondary segments. We compute the market share of each of a firm's secondary segment industries, and then value weight these market shares with segment sales weights to arrive at *SECSEGMKTSH*.

(vii) Interaction term between proxies for contracting difficulties and industry shocks. Klein (1996) and Klein and Murphy (1997) argue that the likelihood of contractual hazards is magnified in presence of relationship-specific investments when market conditions change sufficiently to place the relationship outside the self-enforcing range of contracts. Consistent with this argument, Fan (2000) finds that an increase in price uncertainty in the petrochemical industry makes vertical integration more desirable to govern relationship-specific transactions. Accordingly, we posit that the interaction between our proxies that capture relationship-specific assets and an industry shock variable would also be a determinant of vertical integration. As a proxy for the industry shock, we calculate the one-year sales growth of the primary industry of the firm (*SALGROWTH*). We then interact *SALGROWTH* with *INDRDI* and *SAJVINT*, our two main variables that capture the likelihood of contracting problems, and posit that both the interaction terms would have a positive sign.

3.2. Estimation Methodology

We now outline the empirical methodology employed to investigate the determinants of vertical relatedness between firm segments. We create dummy variables *VrcBackDum1*, *VrcForwDum1*, *VrcBackDum2*, and *VrcForwDum2* to measure significant vertical relatedness. Specifically, the dummy variable, *VrcBackDum1* (*VrcForwDum1*) equals one if *VrcBackCoeff1* (*VrcForwCoeff1*) is 5% or greater, and is zero otherwise. Similarly, *VrcBackDum2* (*VrcForwDum2*) equals one if *VrcBackCoeff2* (*VrcForwCoeff2*) is 5% or greater, and is zero otherwise. *VrcBackDum1* and *VrcForwDum1* capture the extent of backward and forward relatedness between all business segments of multi-segment firms. On the other hand, *VrcBackDum2* and *VrcForwDum2* capture the extent of backward and forward relatedness between the primary segment and all secondary segments of the firm.[34] We then estimate probit regressions to investigate how these vertical relatedness dummies are related to the determinants of vertical integration as proposed above.

3.3. Results for the Determinants of Vertical Relatedness across all Segments

In Table II, we provide results based on probit estimation for the determinants of vertical relatedness between all segments of multi-segment firms. As highlighted earlier, the binary dependent variable *VrcBackDum1* (*VrcForwDum1*) measures backward (forward) vertical relatedness between all segments of a multi-segment firm. In Models 1 and 2, we include as explanatory variables industry R&D intensity (*INDRDI*), strategic alliance and joint venture intensity (*SAJVINT*), industry advertising expenditure intensity (*INDADV*), industry selling, general, and administrative expenditure intensity (*INDSELL*), industry Herfindahl Index (INDHERF), and market shares of the firm in its primary and secondary industry (*PRIMSEGMKTSH* and *SECSEGMKTSH*). We also include firm size (*FIRMSIZE*) as an additional control variable. All specifications have calendar year dummies and the reported p-values are based on heteroskedasticity robust standard errors and are clustered by firm.

As hypothesized, we find a positive relation between the R&D intensity of the firm's primary industry (*INDRDI*) and vertical relatedness between all segments (*VrcBackDum1* and *VrcForwDum1*) in all our four specifications. This indicates that vertical relatedness between business segments is more likely when the firm's primary industry is R&D intensive. Further, we find that the coefficient on *SAJVINT* is positive and significant at the 1% level in all four specifications. This indicates that inter-segment vertical relatedness is observed in a firm when strategic alliances and joint ventures between the primary industry and all vertically

[34] As a robustness check, we use continuous measures of vertical relatedness (*VrcBackCoeff1*, *VrcForwCoeff1*, *VrcBackCoeff2*, and *VrcForwCoeff2*) instead of dummy variables. The results under this approach are qualitatively similar to those reported in the paper.

related industries are more prevalent. Overall, both these results show that inter-segment vertical relatedness is observed in environments likely to have costly contracting.

We find that *INDADV* is positively related to the vertical relatedness in all four specifications; however, the results are statistically insignificant at conventional levels. The positive sign on *INDADV* is in the hypothesized direction but the results lack statistical power. The coefficient on *INDSELL* is negative and significant at the 1% level in all four specifications. A vertically integrated firm, by using part of its outputs internally, is likely to spend less on transmitting information about its product to prospective buyers/suppliers. If this is true, we should observe vertically integrated firms in industries with less selling, general, and administrative expenditure intensity. The negative sign on *INDSELL* is consistent with the above argument.

The coefficient on *INDHERF* is insignificant in all specifications, which indicates that the vertical integration is unlikely to be motivated by an attempt to promote collusion with non-integrated rivals. The coefficient on *PRIMSEGMKTSH* is found to be negative and significant in all four specifications. The negative sign is directly opposite to the prediction under the foreclosure hypothesis. Further, inconsistent with the foreclosure hypothesis, the coefficient on *SECSEGMKTSH* is found to be statistically insignificant. Overall, our proxies to capture anti-competitive intent of vertical integration behave in a manner inconsistent with these hypotheses. The extant literature on mergers and acquisitions and other industry and case studies generally find that vertical integration is unlikely to be motivated by anti-competitive strategies such as foreclosure and collusion (e.g., Eckbo (1983), Hortaçsu and Syverson (2007), and Shenoy (2008) among others). Our evidence complements this literature by showing more generally that vertical integration decisions undertaken by managers do not seem to be motivated by anti-competitive strategies.

In Models 3 and 4, we include all explanatory variables included in Models 1 and 2 along with the two interaction terms *SAJVINT*SALGROWTH* and *INDRDI*SALGROWTH*. We have argued that the potential for holdup is magnified in presence of relationship-specific investments when market conditions change sufficiently. We find support for this hypothesis in some specifications. In particular, in Model 3, we find that the coefficient on *INDRDI*SALGROWTH* is positive and significant. Further, in Model 4, we find that the coefficient on *SAJVINT*SALGROWTH* is positive and significant. The signs on all other explanatory variables are in the same direction as those obtained in Models 1 and 2. The results from Models 3 and 4 provide partial support for the view presented by Klein (1996) and Klein and Murphy (1997) that in presence of relationship-specific investments, significant changes in the market conditions as proxied by the primary industry sales growth increases the likelihood of vertical integration.

3.4. Results for the Determinants of Vertical Relatedness between Primary Segment and all Secondary Segments of the Firm

In Table III, we provide results based on probit estimation for the determinants of firm vertical relatedness as measured by the vertical relatedness between the primary segment and all secondary segments of the firm. The dependent variable is a binary variable *VertBackDum2* (*VertForwDum2*) that equals 1 when the backward (forward) vertical relatedness coefficient *VrcBackCoeff2* (*VrcForwCoeff2*) exceeds 5% and 0 otherwise.

In line with the findings in Table II, we find a positive association between the R&D intensity of the firm's primary industry (*INDRDI*) and vertical relatedness between the primary segment and all secondary segments of the firm in all four specifications. Furthermore, we find a positive relationship between *SAJVINT* and vertical relatedness between the primary segment and all secondary segments of the firm.

We find that *INDADV* is positively related only to *VrcForwDum2* in Models 2 and 4. If industry advertising expenditures capture the extent of asset specificity, this result supports the view that vertical integration is observed in environments likely to involve relationship-specific investments. The relationship between *INDADV* and *VrcBackDum2* is however found to be insignificant. Therefore, overall we obtain mixed results based on *INDADV*. The coefficient on *INDSELL* is negative and significant at the 1% level in all four specifications, which is consistent with our argument that vertical integration helps firms to economize on costs of transmitting information.

Finally, the coefficient on *INDHERF* is insignificant in all specifications, the coefficient on *PRIMSEGMKTSH* is found to be negative and significant, and the coefficient on *SECSEGMKTSH* is found to be statistically insignificant. In Model 3, we find that the coefficient on *INDRDI*SALGROWTH* and *SAJVINT*SALGROWTH* are positive and significant. However, in Model4, we find that both the interactive terms are positive but insignificant. The signs on all other explanatory variables are in the same direction as those obtained in Models 1 and 2.

In summary, we investigate the determinants of vertical relatedness between business segments of a firm as measured by (i) Vertical relatedness between all segments of the firm and (ii) Vertical relatedness between the primary segment and all secondary segments of the firm. Using both measures, we find consistent support for the view that the degree of vertical relatedness between business segments of firms is higher in environments likely to be plagued by contractual incompleteness and where relationship-specific investments are prevalent. Furthermore, inter-segment vertical relatedness does not seem to be motivated by anti-competitive rationales such as foreclosure or collusion.

4. Vertical Relatedness and its Impact on Internal Capital Markets

In this section, we first discuss the different measures that capture internal capital market efficiency as proposed in the extant literature. We then outline our empirical methodology to investigate the relation between vertical relatedness and ICM efficiency. Subsequently, we perform both univariate analysis and multivariate analyses (based on OLS, Heckman, and 2SLS estimations) to investigate how vertical relatedness between business segments affects the internal capital market allocations.

4.1. Measures for Efficiency of Internal Capital Market Allocations

We use the following measures developed in the extant literature to capture the efficiency of internal capital market allocations, Relative Value Added by Allocation (*RVA*) of Rajan, Servaes, and Zingales (2000), the Investment-Q sensitivity aggregated over all business segments of a firm (*IQSENS*) developed by Peyer and Shivdasani (2001), and Relative Investment Ratio (*RINV*) developed by Rajan, Servaes, and Zingales (2000). These measures capture the association between segment investment and segment investment opportunities aggregated across all business segments of multi-segment firms.

Our first measure Relative Value Added by Allocation (*RVA*) is computed as follows.

$$RVA = \sum_{j=1}^{n} w_j (q_j - \bar{q}) \left\{ \frac{I_j}{A_j} - \left(\frac{I}{A} \right)_j^{ss} - \sum_{i=1}^{n} w_i \left[\frac{I_i}{A_i} - \left(\frac{I}{A} \right)_i^{ss} \right] \right\} \quad (1)$$

In equation (1), w_j is the fraction of total firm assets that belong to segment 'j', I_j is the capital expenditure of segment 'j' obtained from Compustat segment tapes, A_j is the book value of segment 'j' assets, q_j is the imputed q for segment 'j' and measured as the median Tobin's q for single-segment firms matched on the narrowest SIC industry (four-digit, three-digit, or two-digit SIC) that includes at least five single-segment firms, $\bar{q}$ is the asset-weighted imputed q across all segments of the firm, and $\left(\frac{I}{A}\right)_i^{ss}$ is the asset-weighted ratio of capital-expenditure to book value of assets for single-segment firms in industry 'i', matched on the narrowest SIC industry (four-digit, three-digit, or two-digit SIC) that includes at least five single-segment firms.

As a proxy for the transfer related to a segment 'j', Rajan, Servaes, and Zingales (2000) use the industry-adjusted $\left(\frac{I}{A}\right)_j^{ss}$ and firm-adjusted $\sum_{i=1}^{n} w_i \left[\frac{I_i}{A_i} - \left(\frac{I}{A}\right)_i^{ss}\right]$ investment ratio for that segment. If transfer for a segment 'j' is positive then the segment is a net receiver, and, if negative, the segment is a net provider of funds.

Since segments are not publicly traded entities the literature has typically used imputed q as a proxy for segment investment opportunities. Consistent with this literature, we calculate imputed q for a segment as the median Tobin's q of single-segment firms in the four-digit, three-digit, or two-digit SIC industry of the segment that includes at least five single-segment firms. If the internal capital allocations are efficient, segments with high investment opportunities (imputed q greater than $\overline{q}$) would be receivers of funds, whereas segments with low investment opportunities (imputed q less than $\overline{q}$) would be providers of funds. This would lead *RVA* to be positive. Finally, the magnitude of *RVA* gives the overall value added (subtracted) by the internal allocation policy of diversified firms.

The second measure *IQSENS* is a variant of the *RVA* measure and is computed below in equation (2). In Equation (2), w_j is the fraction of total firm assets that belong to segment j, q_j is the imputed q for segment j and calculated as the median Tobin's q for single-segment firms matched on the narrowest SIC industry (four-digit, three-digit, or two-digit SIC) that includes at least five single-segment firms, $\overline{q}$ is the asset-weighted imputed q across all segments of the firm, I_j is the capital expenditure of segment 'j', A_j is the book value of segment j assets, and $\sum_{i=1}^{n} w_i * \frac{I_i}{A_i}$ is the firm capital expenditure calculated as the asset-weighted capital expenditure to asset ratio across all segments of the firm.

$$IQSENS = \sum_{j=1}^{n} w_j (q_j - \bar{q}) \left\{ \frac{I_j}{A_j} - \sum_{i=1}^{n} w_i * \frac{I_i}{A_i} \right\} \quad (2)$$

$\left\{ \frac{I_j}{A_j} - \sum_{i=1}^{n} w_i * \frac{I_i}{A_i} \right\}$ is a measure of the extent of transfer of capital for a segment. It provides the j^th segment's capital expenditure to asset ratio minus the asset-weighted capital expenditure to asset ratio for all segments in the firm. Segments with positive values of this variable can be interpreted as net "receivers" of funds, whereas segments with negative values represent net "providers" of funds. Similarly, $(q_j - \bar{q})$ measures the difference between the imputed q for the j^th segment and the asset-weighted imputed q of all segments in the firm. Overall, *IQSENS* will be positive if high q segments (segments with imputed q above $\bar{q}$) are net receivers of funds and low q segments (segments with imputed q below $\bar{q}$) are net providers of funds. Therefore, positive values for *IQSENS* indicate efficient internal capital market allocations since investment flows towards segments with better investment opportunities.

The final efficiency measure *RINV* was developed by Rajan, Servaes, and Zingales (2000) and is given below in equation (3). Here, for j=1 to k segments, the imputed q is greater than the asset-weighted imputed q measured across 'n' segments of the firm, and for j=k-n+1 to n segments that imputed q is less than the asset-weighted imputed q across 'n' segments of the firm. If the firm invests more in segments where imputed q is greater than asset-weighted imputed q of firm than in segments where imputed q is less than asset-weighted imputed q of firm it would lead to positive values of *RINV* which indicates efficient internal capital market allocations.

$$RINV = \sum_{j=1}^{k} w_j (q_j - \bar{q}) \left\{ \frac{I_j}{A_j} - \left(\frac{I}{A}\right)_j^{ss} - \sum_{i=1}^{n} w_i \left[\frac{I_i}{A_i} - \left(\frac{I}{A}\right)_i^{ss} \right] \right\}$$

$$- \sum_{j=n-k+1}^{n} w_j (q_j - \bar{q}) \left\{ \frac{I_j}{A_j} - \left(\frac{I}{A}\right)_j^{ss} - \sum_{i=1}^{n} w_i \left[\frac{I_i}{A_i} - \left(\frac{I}{A}\right)_i^{ss} \right] \right\} \qquad (3)$$

4.2. Relation between Vertical Relatedness and Internal Capital Market Allocations

We have argued that the degree of vertical relatedness between business segments of firms measures the extent of relatedness in firm projects. Based on Stein (1997), we hypothesize that the higher the degree of vertical relatedness, the greater is the efficiency of internal capital market allocations. To test this hypothesis, we regress measures that capture the efficiency of the internal capital market given in equations (1), (2), and (3) on the degree of vertical relatedness and other control variables known to affect internal capital market allocations. We propose the following regression models given by equations (4)-(6).

$$RVA_{it} = \alpha + \alpha_1 * VrcBackDum1_{it} + \alpha_2 * DIVERSITY_{it} + \alpha_3 * VrcBackDum1_{it} * DIVERSITY_{it} + \alpha_4 * HERFSAL_{it} + \alpha_5 * FIRMSIZE_{it} \qquad (4)$$

$$IQSENS_{it} = \beta + \beta_1 * VrcBackDum1_{it} + \beta_2 * DIVERSITY_{it} + \beta_3 * VrcBackDum1_{it} * DIVERSITY_{it} + \beta_4 * HERFSAL_{it} + \beta_5 * FIRMSIZE_{it} \qquad (5)$$

$$RINV_{it} = \gamma + \gamma_1 * VrcBackDum1_{it} + \gamma_2 * DIVERSITY_{it} + \gamma_3 * VrcBackDum1_{it} * DIVERSITY_{it} + \gamma_4 * HERFSAL_{it} + \gamma_5 * FIRMSIZE_{it} \qquad (6)$$

The dependent variable is one of the measures of efficiency as outlined in section 4.1. *VrcBackDum1* is a dummy that equals one when the sales-weighted backward vertical relatedness coefficient *VrcBackCoeff1* exceeds 5% and zero otherwise. We also estimate specifications using *VrcForwDum1*, *VrcBackDum2*, and *VrcForwDum2* as alternative measures for vertical relatedness. The benefit of using indicator variables is that it enables us to compare the investment behavior of vertically integrated firms vs. those that are not.[35] The control variables are based on Rajan et al. (2000) and outlined as follows: *DIVERSITY* is the diversity in investment opportunities, *VrcBackDum1*DIVERSITY* is the interaction between vertical relatedness and diversity, *FIRMSIZE* is firm size measured as the logarithm of the firm's net sales, and *HERFSAL* is the sales-based Herfindahl Index of the firm.

DIVERSITY is calculated as the standard deviation of the firm's asset-weighted segment imputed q's divided by the equally weighted average imputed q (see equation (7)). In this equation, q_j is the imputed q for segment 'j' and is calculated as the median Tobin's q for single-segment firms matched on the four digit, three digit, or two digit SIC codes, w_j is the asset-weight of segment 'j', and $\overline{wq}$ is the asset-weighted imputed q across all segments of the firm. In Table I, we show that the average value of *DIVERSITY* is 0.30 which is similar to the values in Rajan et al. (2000).

$$DIVERSITY = \frac{\sqrt{\sum_{j=1}^{n}\left[\frac{\left(w_j q_j - \overline{wq}\right)^2}{n-1}\right]}}{\sum_{j=1}^{n}\frac{q_j}{n}} \qquad (7)$$

Under Stein's winner-picking hypothesis, we expect a positive effect of vertical relatedness on the ICM efficiency. Accordingly, we would observe a positive sign on α_1, β_1, and γ_1. Rajan et al. (2000) argue that diversity in investment opportunities (*DIVERSITY*) increases the managerial rent seeking behavior and distorts investment towards segments with relatively lower investment opportunities. Consistent with their argument, we expect a

[35] We perform the following robustness checks. First, we replicate the ICM efficiency regressions using continuous vertical relatedness variables (see Footnote 11 for details). Second, instead of using separate specifications for backward and forward relatedness we consolidate them into the following dummies; *HIGHHIGH* which is one for firms with high backward and forward relatedness, and *HIGHLOW* is one for firms with high (low) backward and low (high) forward relatedness. We find that *HIGHHIGH* is positive and significant in all specifications. *HIGHLOW* is positive but is statistically significant in some specifications.

negative relation between diversity and internal capital market efficiency measure (α_2<0, β_2<0, and γ_2<0). Further, for a vertically integrated firm, as the diversity in investment opportunities increases there is greater rent-seeking behavior by divisional managers which negatively impacts the allocating efficiency. Therefore, we expect a negative sign on the interaction term between the diversity in investment opportunities and vertical relatedness (α_3<0, β_3<0, and γ_3<0). Finally, the extant literature has used segment sales-based Herfindahl index as a proxy for firm focus and argued that firm focus improves allocative efficiency of internal capital markets (e.g., Rajan et al. (2000)). Further, Stein (1997) predicts that internal capital market allocations are efficient when the headquarters oversees a small set of projects. Based on the above, we expect a positive relation between *HERFSAL*, and the efficiency of internal capital markets (α_4>0, β_4>0, and γ_4>0).

4.3. Univariate Results

In this section, we present and discuss our univariate results on the internal capital market efficiency measures. Specifically, we investigate how internal capital market efficiency measures (*RVA*, *IQSENS*, and *RINV*) vary in sub-samples of firms that exhibit significant vertical relatedness and those that do not.

In Panel A of Table IV, we provide results for our overall sample of 32,552 multi-segment firm-years. For the overall sample, we find that the average values of *RVA* and *RINV* are negative, whereas that for *IQSENS* is positive. However, the average values for all three measures for the overall sample are found to be statistically insignificant. This indicates that for the overall sample of firms no value is added by internal capital allocations. We then segregate our sample of multi-segment firm-years into those that display significant vertical relations and those that do not. We expect to observe higher internal capital market efficiency in the sub-sample of firms that display significant vertical relatedness.

In Panel B, we provide results for sub-samples based on cutoffs of the backward vertical relatedness coefficient *VrcBackCoeff1* and *VrcBackCoeff2*. For the sub-sample of firms that have *VrcBackCoeff1* greater than or equal 5%, we find that the average values of *RVA*, *IQSENS*, and *RINV* are 0.00012, 0.00035, and 0.00058, respectively. These are statistically significant at conventional levels. On the other hand, in the sub-sample of firms with *VrcBackCoeff1* less than 5%, the corresponding values are -0.00008, 0.00022, and -0.00025, respectively and are also found to be statistically significant. The difference in mean for the above and below cutoff samples is statistically significant at least at the 10% level. We also provide results based on sub-samples based on *VrcBackCoeff2* values of above and below 5%. Here also, we find that the difference in means between the two sub-samples is statistically significant at least at the 5% level.

In Panel C, we provide results for sub-samples based on cutoffs of the forward vertical relatedness coefficient, *VrcForwCoeff1* and *VrcForwCoeff2*. In the sub-sample of firms where *VrcForwCoeff2* is greater than or equal 5%, we find that the average values of *RVA*, *IQSENS*, and *RINV* are 0.00027, 0.00048, and 0.00081, respectively. These are statistically significant at least at the 10% level. For the sub-sample of firms below the 5% vertical relatedness cutoff, the average values are -0.00009, 0.00021, and -0.00025, respectively and are also found to be statistically significant. We also observe that the difference in means for the above and below cutoff samples is statistically significant at least at the 1% level. Qualitatively similar results are found when the sub-samples are based on a forward vertical relatedness coefficient *VrcForwCoeff2* cutoff of 5%.

Overall, in this section, we document the following findings. In the sub-sample of firms that display significant vertical relations, we find that the average values for *RVA*, *IQSENS*, and *RINV* are positive and significant. Furthermore, the difference in means between the sub-samples of firms with high and low vertical relatedness is significant. This preliminary evidence shows that (i) vertically related firms systematically allocate investment towards segments with better investment opportunities reflecting in positive values of efficiency measures, and (ii) vertically related firms exhibit a higher efficiency of internal capital allocations than non-vertically related firms.

4.4. OLS Estimation

In Table V, we present the results from OLS estimation of Equations (4), (5), and (6) to investigate the relation between inter-segment vertical relatedness and internal capital market allocations. In Panel A, we report results based on vertical relatedness dummies *VrcBackDum1* and *VrcForwDum1*, which measure vertical relations across all segments of the firm. In Panel B, we report results with vertical relatedness dummies *VrcBackDum2* and *VrcForwDum2*, which measure vertical relations between the primary segment and all secondary segments of the firm. All OLS and subsequent estimations in Sections 4.5 to 4.7 contain calendar-year dummies and the reported p-values are based on heteroskedasticity robust standard errors and clustered by firm.

In Panel A, we observe that the coefficient on the vertical relatedness measures (*VrcBackDum1* and *VrcForwDum1*) is positive and statistically significant at conventional levels in all specifications. A similar positive relation is found between vertical relatedness measures (*VrcBackDum2* and *VrcForwDum2*) and internal capital market efficiency measures in Panel B. These results are consistent with our expectation that vertical relatedness between business segments of the firm improves the allocative efficiency of internal capital markets.

The interaction term between vertical relatedness and diversity (*VrcBackDum1*DIVERSITY*, *VrcForwDum1*DIVERSITY*, *VrcBackDum2*DIVERSITY*, *VrcForwDum2*DIVERSITY*) is negative and significant in most specifications. This indicates that as the diversity in investment opportunities increases, the beneficial effect of vertical relatedness on the efficiency of internal capital market allocations is reduced. Further, the coefficient on the sales-based Herfindahl Index of the firm (*HERFSAL*) is positive and statistically significant at the 1% level in Panel A and B. The positive sign suggests that as the multi-segment firm becomes more focused, it displays higher efficiency in internal capital market allocations. Finally, we document a negative but statistically insignificant relation between diversity in investment opportunities (*DIVERSITY*) and the internal capital market efficiency measures.

4.5. Heckman Model Estimation

In this section, we control for the endogeneity of the firms' decision to diversify by adopting the Heckman's two stage model. In the first stage of the Heckman methodology, called the selection equation, we pool the multi-segment and single segment observations and estimate a probit regression to model the decision to diversify. We then obtain the Inverse Mills Ratio from the first stage and include it in the second stage to correct for the self-selection bias. This methodology has been used widely in the corporate diversification literature.

Consistent with the diversification literature, we include both firm-level and industry-level variables to model the propensity to diversify (e.g., Campa and Kedia (2002) and Villalonga (2004)). Specifically, we use firm size measured as the logarithm of firm net sales (*FIRMSIZE*), firm profitability measured as the earnings before interest and taxes divided by net sales (*EBIT*), firm investment in capital expenditure measured as the capital expenditures divided by net sales (*CAPX*), firm investment in research and development measured as the research and development expenditure divided by net sales (*RDI*), an indicator variable that equals one for firms listed on a major exchange (*MAJOREX*), an indicator variable that equals one if the firm is incorporated outside the U.S. (*FOREIGN*), an indicator variable that equals one for firms that belong to the S&P index (*SPDUMMY*), an indicator variable for firms that pay dividends (*DIVIDUM*), the logarithm of the number of years listed on CRSP (*LNAGE*), the fraction of firms in the industry that are diversified (*PCTDIV*), and the fraction of industry sales accounted by diversified firms (*PCTSALEDIV*), the GDP growth in the prior year (*GDPG*), the number of months of recession in the prior year (*CONT*), the number of mergers and acquisitions in the prior year as provided by SDC Platinum database (*NMERG*), and the deal value of all the mergers and acquisitions as provided by SDC Platinum database (*DMERG*). The estimated selection equation is reported below.

$$\begin{aligned}&\text{Prob(Multi-segment} = 1) = -3.6 + 0.14 * FIRMSIZE - 0.44 * EBIT - 0.76 * CAPX - 0.57 * RDI + 0.07 * MAJOREX \\ &+ 0.22 * FOREIGN + 0.12 * SPDUMMY + 0.03 * DIVIDUM + 0.23 * LNAGE + 3.1 * PCTDIV + 0.08 * PCTSALEDIV \\ &+ 0.01 * GDPG - 0.004 * CONT + 0.001 * NMERG - 0.00001 * DMERG \qquad (7)\end{aligned}$$

In the selection equation, we find that both firm and industry characteristics play an important role in the decision of a firm to diversify into multiple segments. For example, firms with larger size (*FIRMSIZE*), lower profitability (*EBIT*), lower investment in capital expenditure (*CAPX*), and lower investment in research and development (*RDI*) are more likely to be multi-segment. Firms with higher age (*LNAGE*), firms that pay dividends (*DIVIDUM*), firms listed on major exchanges (*MAJOREX*), and firms that are part of the S&P index (*SPDUMMY*) are more likely to be multi-segment. At the industry level, firms in industries with larger percentage of diversified firms (*PCTDIV*), and in industries where diversified firms account for larger percentage of sales (*PCTSALEDIV*) are more likely to be multi-segment. Finally, the larger the number of mergers (*NMERG*), and the larger the GDP growth in the prior year (*GDPG*), the more likely it is for the firms to be diversified. Our results for the selection equation are generally consistent with the findings in Campa and Kedia (2002) and Villalonga (2004).

The results from the second stage of the Heckman methodology are reported in Table VI. In Panel A, we report results based on vertical relatedness dummies *VrcBackDum1* and *VrcForwDum1* which measure vertical relations across all segments of the firm. In Panel B, we report results with vertical relatedness dummies *VrcBackDum2* and *VrcForwDum2* which measure vertical relations between the primary segment and secondary segments of the firm.

We find that the coefficient on our measures for vertical relatedness (*VrcBackDum1*, *VrcForwDum1*, *VrcBackDum2*, and *VrcForwDum2*) is positive and statistically significant at conventional levels in all specifications. The interaction term between vertical relatedness and diversity in investment in investment opportunities (*VrcBackDum1**DIVERSITY*, *VrcForwDum1**DIVERSITY*, *VrcBackDum2**DIVERSITY*, *VrcForwDum2**DIVERSITY*) is negative and significant in most specifications. Diversity in investment opportunities (*DIVERSITY*) is found to be negatively related to the efficiency of internal capital markets. However, the relation is statistically insignificant in most specifications. The coefficient on the sales based Herfindahl Index of the firm (*HERFSAL*) is positive and statistically significant at the 1% level in all specifications indicating that focus improves allocative efficiency. Finally, the Inverse Mills ratio (*INVMILLS*) is significant in two of six specifications reported in Panel A and in four of six specifications in Panel B. This indicates that the self-selection bias is a relevant econometric issue in some of these regressions and needs to be controlled for by modeling the propensity to diversify in the first stage.

In summary, in this section, we find that the firm/industry characteristics can explain the decision of firms to diversify. Even after controlling for the selection bias that arises due to this situation, we find that an increase in the degree of vertical relatedness between segments improves the efficiency of the internal capital market allocations. Diversity in investment opportunities generally reduces this beneficial effect of vertical relatedness on internal capital markets.

4.6. 2SLS Estimation

In this section, we tackle the potential endogeneity between vertical relatedness and efficiency of internal capital market allocations by using 2SLS estimation. The endogeneity can arise if, for example, some omitted variable like manager skill leads to higher vertical relatedness between segments as well as a higher efficiency in internal capital market allocations. To address this endogeneity, we first identify instruments that are related to the degree of vertical relatedness between business segments of the firm but that are potentially uncorrelated with the efficiency of internal capital market allocations.

In Section 3.1, we identified industry level variables that are motivated by economic theory to explain the extent of vertical relatedness between segments. Since these variables are measured at the industry level they are unlikely to impact the firm-level efficiency of internal capital market allocations. We also showed that these variables are significant determinants vertical relatedness between segments. Based on the above, we use the industry level variables *INDRDI*, *SAJVINT*, *INDADV*, *INDSELL*, and *INDHERF* as prospective instruments for the degree of vertical relatedness.

The results for the second stage of the 2SLS estimation and all tests pertaining to endogeneity and instrumental variable validity are reported in Table VII. All estimation models involve an interaction between the endogenous variable, our measure of inter-segment vertical relatedness (*VrcBackDum1*, *VrcForwDum1*, *VrcBackDum2*, and *VrcForwDum2*), and diversity in investment opportunities (*DIVERSITY*). As instruments for the interaction term, we use the interaction between our instruments for vertical relatedness and the diversity investment opportunities (e.g., Wooldridge (2002)). In the first stage, we include all control variables from the second stage along with instruments including those for the interaction term. Due to space constraints, we do not report the first stage estimation results.

In Panel A, we report results based on vertical relatedness dummies *VrcBackDum1* and *VrcForwDum1* which measure vertical relations across all segments of the firm. In Panel B, we report results with vertical relatedness dummies *VrcBackDum2* and *VrcForwDum2* which measure vertical relatedness between the primary segment and all secondary segments of the firm.

In all specifications, the C statistic rejects the null hypothesis that the endogenous variables are jointly exogenous to the efficiency of internal capital market allocations. This adds validity to the usage of 2SLS estimation. Further, the Hansen J is statistically insignificant for all specifications. We, therefore, cannot reject the null hypothesis that the chosen instruments are valid. Finally, the Anderson-Rubin statistic is significant in all specifications indicating that the coefficients on the endogenous regressors are jointly significant in the second stage.

In both Panels A and B, we find that our measures for vertical relatedness (*VrcBackDum1*, *VrcForwDum1*, *VrcBackDum2*, and *VrcForwDum2*) are positively related to the efficiency of internal capital market allocations at conventional levels of significance in all specifications. Diversity in investment opportunities (*DIVERSITY*) and the interaction term between vertical relatedness and diversity in investment opportunities (*VrcBackDum1*DIVERSITY*, *VrcForwDum1*DIVERSITY*, *VrcBackDum2*DIVERSITY*, *VrcForwDum2*DIVERSITY*) are found to be statistically insignificant in most specifications. Finally, we document a positive relationship between the sales-based Herfindahl Index of the firm and the efficiency of internal capital market allocations in all specifications.

Overall, using an instrumental variables approach, we show that vertical relatedness between segments of multi-segment firms improves efficiency of internal capital market allocations.[36]

4.7. Single Segment Firms that Choose to Diversify

As an additional test, we investigate the investment behavior for a sample of single-segment firms that choose to diversify. In particular, we pay attention to single-segment firms that choose to diversify into a vertically related industry. We denote the segment under the single-segment structure as "existing" segment. The newly added segment could share product market relations with the existing segment (such as vertical or horizontal) or could be unrelated to the existing segment. We then compare the sensitivity of investment to investment opportunities for the "existing" segment when it operated under the multi-segment structure versus that under the single-segment structure.

We have argued earlier that vertical integration solves the underinvestment problem and provides flexibility to undertake investments. If so, the existing segment should be able to better respond to investment opportunities under the integrated structure. Accordingly, we hypothesize that in the vertically related expansions there will be an increase in the sensitivity of investment to investment opportunities. To test this hypothesis, we identify all firms that report an increase in the number of segments during 1984 to 2005. We treat the year a firm increased the number of segments as t=0, the two years under the multi-segment structure as t=+1 and t=+2, and the two years under the single-segment structure as t=-1 and t=-2. We create a dummy *AFTER* which equals 1 for t=+1 and t=+2 and equals 0 for t=-1 and t=-2. We

[36] We perform the following robustness tests. First, we run the OLS, Heckman, and 2SLS estimations of (4), (5), and (6) without the interaction term between the vertical relatedness dummy and *DIVERSITY*. We find that the vertical dummy is significantly positive in all 2SLS models and for most of the OLS/Heckman models. Second, we use continuous variables of vertical relatedness (*VrcBackCoeff1*, *VrcForwCoeff1*, *VrcBackCoeff2*, and *VrcForwCoeff2*) instead of dummy variables. We find that the positive relation between vertical relatedness and ICM efficiency still persists in all the OLS estimations, and for most of the Heckman/2SLS specifications.

then pool the 'before' and 'after' observations for the segment under the single-segment structure.

The extant literature has used the investment-q sensitivity as a measure for the efficiency of ICMs (e.g., Scharfstein (1998) and Gertner, Powers, and Scharfstein (2002)). Based on this literature, we propose the regression specification given by Equation (8) to compare the investment-q sensitivity under the single-segment vs. vertically integrated structures. In the model, *CAPX* is the ratio of segment capital expenditure to sales of the existing segment, *MEDTOBQ* is the proxy for investment opportunities of the segment and measured as the median Tobin's q for single-segment firms matched on the narrowest SIC industry (four digit, three digit, or two digit SIC) with at least five single-segment firms, *AFTER* is a dummy variable which equals one for observations that belong to t=+1 and t=+2, and zero for observations of t=-1 and t=-2, *VERT* is a dummy variable that equals one if the newly added segment shares a vertical relatedness of 5% level or greater with the existing segment under single-segment structure, and equals zero if not, *HOR* is a dummy variable that equals one if the four-digit SIC code of the existing segment equals the four-digit SIC code of the newly added segment and zero otherwise. Consistent with Gertner, Powers, and Scharfstein (2002), we include the segment operating profit scaled by segment sales (*OPSS*) as a control variable in the regression.

$$CAPX = \delta + \delta_1 * MEDTOBQ + \delta_2 * OPSS + \delta_3 * MEDTOBQ * AFTER + \delta_4 * MEDTOBQ * AFTER * VERT + \delta_5 * MEDTOBQ * AFTER * HOR \qquad (8)$$

In the above specification, the coefficient on δ_3 provides the change in the sensitivity of segment investment to investment opportunities from before to after for the addition of an unrelated new segment. If expanding into a vertically related industry provides better investment incentives in relation to the unrelated expansions, then we expect δ_4 to be positive.

We find 286 cases of single-segment firm-years that diversify into two segments the following year during the period 1984 to 2005. We find that in 85 of these expansions the newly added segment is vertically related to the existing segment based on vertical relatedness coefficient of 5% or more. We provide the results based for the OLS estimation of equation (8) in Table VIII. We find that there is a decrease in the sensitivity of investment to investment opportunities for the existing segment which does not share product market relations with the newly added segment (δ_3 is negative). We find that the coefficient on δ_4 is positive and statistically significant. This indicates that in the vertically related expansions, the segment investment is more responsive to investment opportunities than in the unrelated expansions. Moreover, the sum of δ_3 and δ_4 is positive, indicating that in the vertically related expansions there is an increase in the investment-q sensitivity. These findings are consistent with our hypothesis. To investigate whether the 1998 change in the segment reporting standards (SFAS No. 131) accounts for our findings, we create a dummy *PRE1998* which equals one for observations prior to 1998 and zero otherwise. We then interact this variable with *AFTER*MEDTOBQ*VERT*. In model 2, we find that this interaction term is statistically insignificant indicating that the improvement in sensitivity of investment to investment opportunities for vertical expansions is not driven by the change in reporting standards.[37]

5. Conclusions

In this paper, we use the benchmark input-output accounts of the U.S. economy and measure vertical relatedness between business segments for firms operating in the United States. The paper attempts to shed light on two issues, (i) The determinants of vertical

[37] As a robustness test, we use the sum of segment capital and R&D expenditures divided by segment sales as our dependent variable. We obtain qualitatively similar results under this approach.

relatedness between segments of multi-segment firms on Compustat database, and (ii) How inter-segment vertical relatedness affects efficiency of internal capital markets. We measure vertical relatedness in a variety of ways. First, we exploit the benchmark input-output data to compute backward and forward vertical relatedness for the firm. Second, we use different measures to capture (i) the extent of vertical relatedness between all segments of the firm, and (ii) the extent to which the secondary segments are vertically related to the primary segment of the firm. Our sample comprises of 32,554 multi-segment firm-years covered by Compustat database during the period 1984-2005.

Researchers have argued that vertical integration arises in response to costly contracting (e.g., Klein, Crawford, and Alchian (1978), Williamson (1971, 1979)). We should therefore observe a high degree of vertical relatedness between segments in industries likely to involve relationship-specific investments and incomplete contracts. Consistent with our hypothesis, we find a higher degree of inter-segment vertical relatedness when the R&D intensity of the primary industry is higher, and when strategic alliances and joint ventures between firms in the primary industry and all vertically related supplier/customer industries are more prevalent. We also find that inter-segment vertical relatedness is not motivated by the anti-competitive rationales for vertical integration such as foreclosure or collusion. In this regard, our evidence is consistent with the mergers literature which finds that vertical mergers are efficiency enhancing and are not motivated to enhance market power (e.g., Eckbo (1983) and Shenoy (2008)).

We then investigate how vertical relatedness between business segments affects the working of internal capital markets. Although a large body of empirical research addresses whether internal capital markets are efficient in allocating funds, very few studies investigate how the presence of product market relations between segments affects the working of internal capital markets. In this regard, Stein (1997)'s 'winner-picking' hypothesis suggests that firms operating in related lines of businesses are able to do a better job in the internal allocation of corporate resources across divisions. We test this hypothesis by studying the capital allocation made by the universe of all vertically integrated firms and single-segment firms that choose to vertically integrate. Consistent with Stein (1997), we find that in firms that exhibit significant inter-segment vertical relatedness, the investment flows towards segments with better investment opportunities.

We make the following contributions to the extant literature. First, we provide the first examination of determinants of the vertical boundaries for Compustat firms. Our analysis builds upon Fee, Hadlock, and Thomas (2006)'s study on the determinants of partial equity stakes and Acemoglu et al. (2009)'s analysis on the cross-country variation in vertical integration. Second, we add to the bright side view of internal capital markets by showing that diversifying into vertically related industries facilitates the functioning of internal capital markets. Our evidence is consistent with the findings in Khanna and Tice (2001) that related diversifiers exhibit efficient internal capital allocations.

References

Acemoglu, Daron, Simon Johnson, and Todd Mitton, 2009, Determinants of Vertical Integration: Financial Development and Contracting Costs, *Journal of Finance* Forthcoming.

Alchian, Armen, 1969, Corporate Management and Property Rights, in Harold Manne, ed.: *Economic Policy and the Regulation of Corporate Securities* (American Enterprise Institute, Washington D.C.).

Allen, Jeffrey W., and Gordon M. Phillips, 2000, Corporate Equity Ownership, Strategic Alliances, and Product Market Relationships, *Journal of Finance* 55, 2791-2815.

Boerner, Christopher S. and Macher, Jeffrey, T., 2001, Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences (Working Paper, Georgetown University).

Bolton, Patrick, and David S. Scharfstein, 1998, Corporate Finance, the Theory of the Firm, and Organizations, *Journal of Economic Perspectives* 12, 95-114.

Campa, Jose Manuel, and Simi Kedia, 2002, Explaining the Diversification Discount, *Journal of Finance* 57, 1731-1762.

Caves, R. E., and Ralph M. Bradburd, 1988, The Empirical Determinants of Vertical Integration, *Journal of Economic Behavior and Organization* 9, 265-279.

Chen, Yongmin, 2001, On vertical mergers and their competitive effects, *RAND Journal of Economics* 32, 667-685.

Chevalier, Judith, 2004, What Do We Know About Cross-subsidization? Evidence from Merging Firms, *Advances in Economic Analysis and Policy* 4.

Coase, Ronald. H., 1937, The Nature of the Firm, *Economica* 4, 386-405.

Colak, Gonul., and Toni Whited, 2007, Spin-offs, Divestitures, and Conglomerate Investment, *The Review of Financial Studies* 20, 557-595.

Eckbo, Espen B., 1983, Horizontal mergers, collusion, and stockholder wealth, *Journal of Financial Economics* 11, 241-273.

Fan, Joseph, 2000, Price Uncertainty and Vertical Integration: An Empirical Examination of Petrochemical Firms, *Journal of Corporate Finance* 6, 345-376.

Fan, Joseph P. H., and Vidhan K. Goyal, 2006, On the Patterns and Wealth Effects of Vertical Mergers, *Journal of Business* 79, 877-902.

Fan, Joseph P. H., and Larry H. P. Lang, 2000, The Measurement of Relatedness: An Application to Corporate Diversification, *Journal of Business* 73, 629-660.

Fee, C. Edward, Charles J. Hadlock, and Shawn Thomas, 2006, Corporate Equity Ownership and the Governance of Product Market Relationships, *Journal of Finance* 61, 1217-1251.

Gatignon, Hubert, and Erin Anderson, 1988, The Multinational Corporation's Degree of Control over Foreign Subsidiaries: An Empirical Test of a Transaction Cost Explanation, *Journal of Law, Economics, and Organization* 4, 305-336.

Gertner, Robert, David S. Scharfstein, and Jeremy C. Stein, 1994, Internal vs. External Capital Markets, *Quarterly Journal of Economics* 109, 1211-1230.

Guedj, Ilan, 2006, Ownership vs. Contract: How Vertical Integration Affects Investment Decisions in Pharmaceutical R&D, (Working Paper, University of Texas at Austin).

Hart, Oliver, and Jean Tirole, 1990, Vertical Integration and Market Foreclosure, *Brookings Papers on Economic Activity Microeconomics* 1990, 205-276.

Holmstrom, Bengt, and John Roberts, 1998, The Boundaries of the Firm Revisited, *Journal of Economic Perspectives* 12, 73-94.

Hortaçsu, Ali, and Chad Syverson, 2007, Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices, *Journal of Political Economy* 115, 250-301.

Joskow, Paul, 2005, Vertical Integration, in Claude Menard, and Mary M. Shirley, eds.: *Handbook of New Institutional Economics* (Springer, Netherlands).

Kale, Jayant R., and Husayn Shahrur, 2007, Corporate capital structure and the characteristics of suppliers and customers, *Journal of Financial Economics* 83, 321-365.

Khanna, Naveen, and Sheri Tice, 2001, The Bright Side of Internal Capital Markets, *Journal of Finance* 56, 1489-1528.

Klein, Benjamin, 1996, Why Holdups Occur: The Self-Enforcing Range of Contractual Relationships, *Economic Inquiry* 34, 444-463.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian, 1978, Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, *Journal of Law and Economics* 21, 297-326.

Klein, Benjamin, and Kevin Murphy, 1997, Vertical Integration as a Self-Enforcing Contractual Arrangement, *American Economic Review* 87, 415-420.

Lafontaine, Francine, and Kathryn L. Shaw, 2005, Targeting managerial control: evidence from franchising, *The Rand Journal of Economics* 36, 131-150.

Lafontaine, Francine and Margaret Slade, 2007, Vertical Integration and Firm Boundaries: The Evidence, *Journal of Economic Literature* 45, 629-685.

Lamont, Owen, 1997, Cash Flow and Investment: Evidence from Internal Capital Markets, *Journal of Finance* 52, 83-110.

Levy, David T., 1985, The Transactions Cost Approach to Vertical Integration: An Empirical Examination, *The Review of Economics and Statistics* 67, 438-445.

Maksimovic, Vojislav, and Gordon Phillips, 2002, Do Conglomerate Firms Allocate Resources Inefficiently Across Industries? Theory and Evidence, *Journal of Finance* 57, 721-767.

Maksimovic, Vojislav, and Gordon Phillips, 2006, Conglomorate Firms and Internal Capital Markets, in Espen B. Eckbo, ed.: *Handbook of Corporate Finance: Empirical Corporate Finance* (Elsevier, North Holland).

Matsusaka, John G., and Vikram Nanda, 2002, Internal Capital Markets and Corporate Refocusing, *Journal of Financial Intermediation* 11, 176-211.

Mullainathan, Sendhil, and David Scharfstein, 2001, Do Firm Boundaries Matter?, *American Economic Review* 91, 195-199.

Nickerson, Jack A., and Brian S. Silverman, 2003, Why Aren't All Truck Drivers Owner-Operators? Asset Ownership and the Employment Relation in Interstate for-Hire Trucking, *Journal of Economics & Management Strategy* 12, 91-118.

Nocke, Volker , and Lucy White, 2007, Do Vertical Mergers Facilitate Upstream Collusion?, *American Economic Review* 97, 1321-1339.

Ordover, Janusz A., Garth Saloner, and Steven C. Salop, 1990, Equilibrium vertical foreclosure, *American Economic Review* 80, 127-142.

Ozbas, Oguzhan, 2005, Integration, organizational processes, and allocation of resources, *Journal of Financial Economics* 75, 201-242.

Peyer, Urs C., and Anil Shivdasani, 2001, Leverage and internal capital markets: evidence from leveraged recapitalizations, *Journal of Financial Economics* 59, 477-515.

Rajan, Raghuram, Henri Servaes, and Luigi Zingales, 2000, The Cost of Diversity: The Diversification Discount and Inefficient Investment, *Journal of Finance* 55, 35-80.

Salinger, Michael A., 1988, Vertical Mergers and Market Foreclosure, *Quarterly Journal of Economics* 103, 345-356.

Scharfstein, David. S., 1998, The Dark Side of Internal Capital Markets II: Evidence from Diversified Conglmorates, (Working Paper, NBER).

Scharfstein, David S., and Jeremy C. Stein, 2000, The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment, *Journal of Finance* 55, 2537-2564.

Shahrur, Husayn, 2005, Industry structure and horizontal takeovers: Analysis of wealth effects on rivals, suppliers, and corporate customers, *Journal of Financial Economics* 76, 61-98.

Shenoy, Jaideep, 2008, An Examination of the Efficiency, Foreclosure, and Collusion Rationales for Vertical Takeovers, (Working Paper, Georgia State University).

Shin, H. H., and Rene Stulz, 1998, Are Internal Capital Markets Efficient?, *The Quarterly Journal of Economics* 113, 531-553.

Stein, Jeremy C., 1997, Internal Capital Markets and the Competition for Corporate Resources, *Journal of Finance* 52, 111-133.

Stein, Jeremy, 2003, Agency, Information, and Corporate Investment, in George Costantinides, Milton Harris, and Rene Stulz, eds.: *Handbook of Economics and Finance* (Elsevier Science, Amstredam: North Holland).

Villalonga, Belen, 2004, Does Diversification Cause the "Diversification Discount"?, *Financial Management* 33, 5-27.

Whited, Toni M., 2001, Is It Inefficient Investment that Causes the Diversification Discount?, *The Journal of Finance* 56, 1667-1691.

Williamson, Oliver E., 1971, The Vertical Integration of Production: Market Failure Considerations, *American Economic Review* 61, 112-123.

Williamson, Oliver E., 1975. *Markets and Hierarchies: Analysis and Antitrust Implications* (Collier Macmillan Publishers, Inc., New York).

Williamson, Oliver E., 1979, Transaction-Cost Economics: The Governance of Contractual Relations, *Journal of Law and Economics* 22, 233-261.

Wooldridge, Jeffrey M., 2002. *Econometric Analysis of Cross Section and Panel Data* (The MIT Press, Cambridge, Massachusetts).

Table I
Summary Statistics for the Sample of Multi-segment and Single Segment firms

This table provides the descriptive statistics of all multi-segment and single segments firms for the sample period 1984-2005. *NUMSEG* is the number of business segments as reported on Compustat, *ASSETS* is the book value of firm assets in million dollars (Compustat Data6), *SALES* is the net sales in million dollars (Compustat Data12), *EBIT* is the Earnings before interest and taxes (Compustat Data13 minus Data14) divided by net sales, *CAPX* is the Capital Expenditures (Compustat Data128) divided by net sales, *RDI* is the research and development expenditure (Compustat Data 46) divided by net sales, *MAJOREX* is an indicator variable that equals 1 for firms listed on a major exchange, *FOREIGN* is an indicator variable that equals 1 if the firm is incorporated outside the U.S., *SPDUMMY* is an indicator variable that equals 1 for firms that belong to the S&P index, *DIVIDUM* is an indicator variable for firms that pay dividends, *LNAGE* is the logarithm of the firm age measured as the number of years listed on CRSP, *PCTDIV* is the fraction of firms that are diversified in the industry, and *PCTSALEDIV* is the fraction of industry sales accounted by diversified firms. VrcBackCoeff1 (VrcForwCoeff1) is the segment sales weighted backward (forward) vertical relatedness coefficient between all segments of the firm and is based on the methodology developed by Acemoglu et al. (2009). VrcBackCoeff2 (VrcForwCoeff2) is the segment sales weighted backward (forward) vertical relatedness between the primary segment of the firm and all its secondary segments and is computed based on the methodology in Fan and Lang (2000). *INDRDI* is the R&D expenditure (Compustat Data46) scaled by net sales (Compustat Data12) for the primary industry of the firm. *INDADV* is the advertising expenditure (Compustat Data45) scaled by net sales (Compustat Data12) for the primary industry of the firm. *INDSELL* is the selling, general, and administrative expenditure (Compustat Data189) scaled by net sales (Compustat Data12) for the primary industry of the firm. *INDHERF* is the sales based Herfindahl Index of the primary industry of the firm. *SAJVINT* is the number of strategic alliances/joint ventures between firms in the primary industry of the firm and all vertically related industries at the 1% level as obtained from the SDC Platinum database divided by the number of firms in the primary industry. *PRIMSEGMKTSH* is the market share of the primary segment in its industry, and *SECSEGMKTSH* is the segment sales weighted market share of all secondary segments in their respective industries. *CORESIZE* is the proportion of total firm sales accounted by the primary segment of the firm, *DIVERSITY* is the diversity in investment opportunities as measured in Rajan, Servaes, and Zingales (2000), and *HERFSAL* is the Herfindahl Index of the firm based on its segment sales.

Panel A: Characteristics of multi-segment and single-segment firms in sample

	Multi-Segment Firms					Single-Segment Firms				
	N	Mean	Median	Lower Quartile	Upper Quartile	N	Mean	Median	Lower Quartile	Upper Quartile
NUMSEG	32,554	2.936	3.000	2.000	3.000	64,045	1.000	1.000	1.000	1.000
ASSETS ($m.)	32,554	2417.2	447.3	109.0	1971.0	64,019	944.94	140.12	48.90	482.86
SALES ($ m.)	32,554	2054.3	446.0	115.4	1764.6	64,045	795.62	146.62	53.64	486.79
EBIT	32,502	0.061	0.071	0.026	0.121	63,808	0.054	0.069	0.018	0.134
CAPX	32,554	0.081	0.043	0.023	0.085	64,045	0.096	0.043	0.019	0.097
RDI	32,554	0.022	0.000	0.000	0.022	64,018	0.034	0.000	0.000	0.036
MAJOREX	32,554	0.767	1.000	1.000	1.000	64,045	0.700	1.000	0.000	1.000
FOREIGN	32,554	0.131	0.000	0.000	0.000	64,045	0.089	0.000	0.000	0.000
SPDUMMY	32,554	0.105	0.000	0.000	0.000	64,045	0.047	0.000	0.000	0.000
PCTDIV	32,554	0.693	0.710	0.579	0.825	64,045	0.444	0.464	0.250	0.636

PCTSALEDIV	32,554	0.720	0.767	0.598	0.893	64,045	0.467	0.485	0.181	0.727
DIVIDUM	32,554	0.489	0.000	0.000	1.000	64,045	0.306	0.000	0.000	1.000
LNAGE	32,554	2.52	2.64	1.79	3.30	64,045	1.950	1.946	1.099	2.708

Panel B: Vertical relatedness and industry/firm characteristics for multi-segment firms

	N	Mean	Median	Lower Quartile	Upper Quartile
VrcBackCoeff1	32,552	2.81%	0.23%	0.00%	1.92%
VrcForwCoeff1	32,552	2.15%	0.14%	0.00%	1.33%
VrcBackCoeff2	32,397	1.26%	0.11%	0.00%	0.95%
VrcForwCoeff2	32,397	1.36%	0.07%	0.00%	0.71%
INDRDI	32,384	0.024	0.002	0.000	0.022
INDADV	32,384	0.011	0.003	0.000	0.015
INDSELL	32,384	0.182	0.170	0.091	0.248
INDHERF	32,384	0.193	0.161	0.090	0.260
SAJVINT	32,554	0.241	0.058	0.00	0.308
PRIMSEGMKTSH	32,410	0.066	0.016	0.0033	0.071
SECSEGMKTSH	32,506	0.0094	0.0011	0.0001	0.007
CORESIZE	32,554	0.660	0.657	0.520	0.812
DIVERSITY	32,550	0.302	0.269	0.159	0.425
HERFSAL	32,554	0.560	0.534	0.412	0.690

Table II

Determinants of Vertical Relatedness between all Business Segments of Multi-Segment Firms

This table provides results for probit regressions of the determinants of vertical relatedness between business segments of multi-segment firms. The dependent variable *VrcBackDum1* (*VrcForwDum1*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff1* (*VrcForwCoeff1*), based on Acemoglu et al. (2009) exceeds 5% and 0 otherwise. The sample period is 1984-2005. *INDRDI* is the R&D expenditure (Compustat Data 46) scaled by net sales (Compustat Data 12) for the primary industry of the firm. *SAJVINT* is the intensity of strategic alliances/joint ventures between the primary industry of the firm and all vertically related at the 1% level as obtained from the SDC Platinum database. *INDADV* is the advertising expenditure (Compustat Data45) scaled by net sales (Compustat Data 12) for the primary industry of the firm. *INDSELL* is the selling, general, and administrative expenditure (Compustat Data 189) scaled by net sales (Compustat Data 12) for the primary industry of the firm. *INDHERF* is the sales based Herfindahl Index of the primary industry of the firm. *PRIMSEGMKTSH* is the market share of the primary segment in its industry, and *SECSEGMKTSH* is the segment sales weighted market share of all secondary segments in their respective industries. *FIRMSIZE* is the logarithm of firm net sales. *SALGROWTH* is the one-year sales growth of the primary industry of the firm. All variables are winsorized at the 1 and 99 percentile level. All specifications contain calendar year dummies. p-values reported in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. The symbols ***, **, and * denote p<0.01, p<0.05, and p<0.1 respectively.

	VrcBackDum1	VrcForwDum1	VrcBackDum1	VrcForwDum1
INDRDI	2.813***	1.7697**	2.4839***	1.6105**
	(<0.01)	(0.02)	(<0.01)	(0.03)
SAJVINT	0.234***	0.2416***	0.2340***	0.2381***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
INDADV	2.3963	1.5015	2.366	1.4413
	(0.11)	(0.33)	(0.11)	(0.35)
INDSELL	-2.0855***	-1.7057***	-2.0669***	-1.6877***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
INDHERF	0.1482	0.0709	0.1471	0.0553
	(0.29)	(0.66)	(0.30)	(0.73)
PRIMSEGMKTSH	-1.2483***	-0.9323***	-1.2532***	-0.9391***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
SECSEGMKTSH	-0.0279	0.7983	-0.0597	0.7741
	(0.98)	(0.28)	(0.95)	(0.30)
*SAJVINT*SALGROWTH*			0.0079	0.0227**
			(0.31)	(0.03)
*INDRDI*SALGROWTH*			1.6444***	0.7399
			(<0.01)	(0.28)
FIRMSIZE	0.1836***	0.1560***	0.1841***	0.1561***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Constant	-1.7504***	-2.0813***	-1.7441***	-2.0708***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Calendar year dummies	Yes	Yes	Yes	Yes
Observations	32,333	32,333	32,326	32,326
Chi-Squared	401.3	339.6	411.6	351.4
P Value	<0.01	<0.01	<0.01	<0.01
Pseudo RSquared	0.084	0.0719	0.0845	0.0724

Table III

Determinants of Vertical Relatedness between the Primary Segment and all Secondary Segments of Multi-Segment Firms

This table provides results for probit regressions of the determinants of vertical relatedness between the primary segment and all secondary segments of multi-segment firms. The dependent variable *VrcBackDum2* (*VrcForwDum2*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff2* (*VrcForwCoeff2*), based on Fan and Lang (2000) exceeds 5% and 0 otherwise. The sample period is 1984-2005. *INDRDI* is the R&D expenditure (Compustat Data46) scaled by net sales (Compustat Data12) for the primary industry of the firm. *SAJVINT* is the intensity of strategic alliances/joint ventures between the primary industry of the firm and all vertically related at the 1% level as obtained from the SDC Platinum database. *INDADV* is the advertising expenditure (Compustat Data45) scaled by net sales (Compustat Data12) for the primary industry of the firm. *INDSELL* is the selling, general, and administrative expenditure (Compustat Data189) scaled by net sales (Compustat Data12) for the primary industry of the firm. *INDHERF* is the sales based Herfindahl Index of the primary industry of the firm. *PRIMSEGMKTSH* is the market share of the primary segment in its industry, and *SECSEGMKTSH* is the segment sales weighted market share of all secondary segments in their respective industries. *FIRMSIZE* is the logarithm of firm net sales. *SALGROWTH* is the one-year sales growth of the primary industry of the firm. All variables are winsorized at the 1 and 99 percentile level. All specifications contain calendar year dummies. p-values reported in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. The symbols ***, **, and * denote p<0.01, p<0.05, and p<0.1 respectively.

	VrcBackDum2	VrcForwDum2	VrcBackDum2	VrcForwDum2
INDRDI	1.6982*	1.5506*	1.633**	1.7522**
	(0.06)	(0.08)	(0.03)	(0.02)
SAJVINT	0.2625***	0.213***	0.2608***	0.2098***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
INDADV	0.7953	3.258*	1.3205	3.778**
	(0.67)	(0.07)	(0.73)	(0.03)
INDSELL	-2.031***	-2.4664***	-2.1832***	-2.6351***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
INDHERF	-0.078	-0.1703	-0.0846	-0.1806
	(0.68)	(0.35)	(0.45)	(0.31)
PRIMSEGMKTSH	-2.609***	-2.437***	-2.5799***	-2.4043***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
SECSEGMKTSH	-1.7605	-0.7577	-1.7558	-0.7429
	(0.15)	(0.51)	(0.15)	(0.52)
*SAJVINT*SALGROWTH*			0.0189*	0.0174
			(0.07)	(0.11)
*INDRDI*SALGROWTH*			2.3018***	1.148
			(<0.01)	(0.13)
FIRMSIZE	0.188***	0.1575***	0.1872***	0.1562***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Constant	-1.9924***	-2.0112***	-1.9634***	-1.983***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Calendar year dummies	Yes	Yes	Yes	Yes
Observations	32,178	32,178	32,171	32,171
Chi-Squared	307.1	279	341	295
Pseudo RSquared	0.104	0.094	0.105	0.0947

Table IV

Univariate Results for the Measures of Internal Capital Market Efficiency by Vertical Relatedness

This table provides gives the univariate results on the internal capital market efficiency measures. The sample period is 1984-2005 and the sample includes all multi-segment firms on Compustat. *RVA* is the Relative Value Added by Allocation developed by Rajan, Servaes, and Zingales (2000), *IQSENS* is the Investment to Q sensitivity developed by Peyer and Shivdasani (2001), and *RINV* is the Relative Investment Ratio developed by Rajan, Servaes, and Zingales (2000). VrcBackCoeff1 (VrcForwCoeff1) is the sales weighted backward (forward) vertical relatedness between all segments of the firm and is based on the methodology proposed in Acemoglu et al. (2009). VrcBackCoeff2 (VrcForwCoeff2) is the sales weighted backward (forward) vertical relatedness between the primary segment and all secondary segments of the firm and is based on the methodology proposed in Fan and Lang (2000). All variables are winsorized at the 1 and 99 percentile level. Panel A provides the univariate results of efficiency measures for the overall sample of multi-segment firms. Panel B provides the sub-sample analysis based on the backward vertical coefficients (VrcBackCoeff1, VrcBackCoeff2) and Panel C provides sub-sample analysis based on the forward vertical coefficient (VrcForwCoeff1, VrcForwCoeff2). In each panel, cutoffs of 5% and 1% are used for VRCATINP and VRCATOUT. Efficiency measures are reported for the firms above the cutoff and below the cutoff. DiffMean is the t-statistic for the difference in means between the below and above cutoff samples. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Efficiency Measures	N	Mean	Lower Quartile	Upper Quartile
RVA	32,552	-0.00005	-0.00089	0.00057
IQSENS	32,552	0.00024	-0.00029	0.00048
RINV	32,472	-0.00013	-0.0065	0.00485

Panel B-Backward Vertical Relatedness

	VrcBackCoeff1<0.05		VrcBackCoeff1>=0.05		
	N	Mean	N	Mean	DiffMean
RVA	28,097	-0.00008**	4,455	0.00012*	-2.20**
IQSENS	28,097	0.00022***	4,455	0.00035***	-1.83**
RINV	28,023	-0.00025*	4,449	0.00058*	-2.16**

	VrcBackCoeff2<0.05		VrcBackCoeff2>=0.05		
	N	Mean	N	Mean	DiffMean
RVA	30,180	-0.00008**	2,220	0.00034***	-3.33***
IQSENS	30,180	0.00022***	2,220	0.00048***	-2.47**
RINV	30,104	-0.00022*	2,216	0.001*	-2.36**

Panel C-Forward Vertical Relatedness

	VrcForwCoeff1<0.05		VrcForwCoeff1>=0.05		
	N	Mean	N	Mean	DiffMean
RVA	29,008	-0.00009***	3,544	0.00027**	-3.54***
IQSENS	29,008	0.00021***	3,544	0.00048***	-3.21***
RINV	28,934	-0.00025*	3,538	0.00081*	-2.51**

	VrcForwCoeff2<0.05		VrcForwCoeff2>=0.05		
	N	Mean	N	Mean	DiffMean
RVA	30,105	-0.0001***	2,295	0.00051**	-4.92***
IQSENS	30,105	0.00021***	2,295	0.00056***	-3.37***
RINV	30,028	-0.00029**	2,292	0.0018***	-4.06***

Table V

OLS Regressions of Internal Capital Market Efficiency Measures on Vertical Relatedness

The sample includes all multi-segments on Compustat from 1984-2005. The dependent variable is the measure for internal capital market efficiency (*RVA*, *IQSENS*, or *RINV*). *FIRMSIZE* is the logarithm of firm net sales. *DIVERSITY* is the diversity in investment opportunities is measured as the standard deviation of the asset weighted segment q's. *HERFSAL* is the sales based Herfindahl index across the business segments of the firm. *VrcBackDum1* (*VrcForwDum1*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff1* (*VrcForwCoeff1*), based on Acemoglu et al. (2009) exceeds 5% and 0 otherwise. *VrcBackDum2* (*VrcForwDum2*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff2* (*VrcForwCoeff2*), based on Fan and Lang (2000) exceeds 5% and 0 otherwise. All variables are winsorized at the 1 and 99 percentile level. Panel A (Panel B) provides regressions based on asset (sales) weighted vertical relatedness coefficients. All specifications contain calendar year dummies. p-values reported in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. The symbols ***, **, and * denote p<0.01, p<0.05, and p<0.1 respectively.

Panel A	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum1	0.0006**	0.0004*	0.0027***			
	(0.02)	(0.07)	(0.01)			
*VrcBackDum1*DIVERSITY*	-0.0013**	-0.0008	-0.0062**			
	(0.03)	(0.14)	(0.02)			
VrcForwDum1				0.0008***	0.0005**	0.0022*
				(<0.01)	(0.02)	(0.06)
*VrcForwDum1*DIVERSITY*				-0.0016**	-0.0008	-0.0038
				(0.04)	(0.21)	(0.28)
FIRMSIZE	0.000	0.000	0.0001	0.000	0.000	0.0001
	(0.12)	(0.77)	(0.57)	(0.15)	(0.86)	(0.52)
DIVERSITY	-0.0006	-0.0006*	-0.0014	-0.0006	-0.0006*	-0.0017
	(0.14)	(0.08)	(0.34)	(0.13)	(0.07)	(0.26)
HERFSAL	0.0015***	0.0009***	0.0047***	0.0015***	0.0009***	0.0046***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Constant	-0.0016***	-0.0003	-0.0039***	-0.0016***	-0.0003	-0.0038***
	(<0.01)	(0.57)	(<0.01)	(<0.01)	(0.59)	(<0.01)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,548	32,548	32,468	32,548	32,548	32,468
RSquared	0.00367	0.00193	0.00223	0.00396	0.00218	0.00212
F Val	3.52	1.785	1.906	3.626	1.97	1.866

Panel B	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum2	0.0010***	0.0006**	0.0041**			
	(<0.01)	(0.03)	(0.01)			
VrcBackDum2 DIVERSITY*	-0.0022***	-0.0012*	-0.0097**			
	(<0.01)	(0.07)	(0.01)			
VrcForwDum2				0.0012***	0.0007**	0.0049***
				(<0.01)	(0.02)	(<0.01)
VrcForwDum2 DIVERSITY*				-0.0024***	-0.0013*	-0.0101**
				(<0.01)	(0.07)	(0.02)

FIRMSIZE	0.0000*	0.000	0.0001	0.000	0.000	0.0001
	(0.08)	(0.64)	(0.40)	(0.11)	(0.71)	(0.49)
DIVERSITY	-0.0005	-0.0005	-0.0012	-0.0005	-0.0005	-0.0011
	(0.19)	(0.11)	(0.41)	(0.22)	(0.12)	(0.45)
HERFSAL	0.0014***	0.0008**	0.0043***	0.0013***	0.0008**	0.0041***
	(<0.01)	(0.01)	(<0.01)	(<0.01)	(0.01)	(0.01)
Constant	-0.0016***	-0.0003	-0.0039***	-0.0016***	-0.0003	-0.0037***
	(<0.01)	-0.57	(<0.01)	(<0.01)	(0.60)	(<0.01)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,396	32,396	32,316	32,396	32,396	32,316
RSquared	0.0039	0.00196	0.00226	0.00425	0.00213	0.00255
F Val	3.665	1.821	1.888	3.707	1.941	1.969

Table VI

Heckman Regressions of Internal Capital Market Efficiency Measures on Vertical Relatedness

The sample includes all multi-segments on Compustat from 1984-2005. The dependent variable is the measure for internal capital market efficiency (*RVA*, *IQSENS*, or *RINV*). *FIRMSIZE* is the logarithm of firm net sales. *DIVERSITY* is the diversity in investment opportunities is measured as the standard deviation of the asset weighted segment q's. *HERFSAL* is the sales based Herfindahl index across the business segments of the firm. *VrcBackDum1* (*VrcForwDum1*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff1* (*VrcForwCoeff1*), based on Acemoglu et al. (2009) exceeds 5% and 0 otherwise. *VrcBackDum2* (*VrcForwDum2*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff2* (*VrcForwCoeff2*), based on Fan and Lang (2000) exceeds 5% and 0 otherwise. *INVMILLS* is the Inverse Mills Ratio from the selection equation. All variables are winsorized at the 1 and 99 percentile level. Panel A (Panel B) provides regressions based on asset (sales) weighted vertical relatedness coefficients. All specifications contain calendar year dummies and reported p-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. The symbols ***, **, and * denote p<0.01, p<0.05, and p<0.1 respectively.

Panel A	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum1	0.0006**	0.0004*	0.0028***			
	(0.02)	(0.07)	(0.01)			
*VrcBackDum1*DIVERSITY*	-0.0013**	-0.0008	-0.0065**			
	(0.03)	(0.14)	(0.01)			
VrcForwDum1				0.0008***	0.0005**	0.0023*
				(0.01)	(0.02)	(0.06)
VrcForwDum1 DIVERSITY*				-0.0016**	-0.0008	-0.0041
				(0.04)	(0.22)	(0.24)
FIRMSIZE	0.0001**	0.000	0.0001	0.0001**	0.000	0.0001
	(0.02)	(0.85)	(0.28)	(0.03)	(0.97)	(0.26)
DIVERSITY	-0.0006	-0.0006*	-0.0016	-0.0006	-0.0006*	-0.0018
	(0.11)	(0.08)	(0.29)	(0.1)	(0.07)	(0.22)
HERFSAL	0.0014***	0.0009***	0.0046***	0.0014***	0.0009***	0.0045***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Constant	-0.0012***	0.0001	-0.0030**	-0.0011***	0.0002	-0.0029**
	(<0.01)	(0.57)	(0.02)	(<0.01)	(0.53)	(0.03)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Total Observations	96,033	96,033	96,033	96,033	96,033	96,033
Censored Observations	63,627	63,627	63,707	63,627	63,627	63,707
INVMILLS	0.0002**	-0.00001	0.0006	0.0002**	0.00003	0.0006
Chi-Square	95.31	48.32	50.46	97.42	53.62	48.76
R-squared	.	.	.	.	.	.

Panel B	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum2	0.0010***	0.0006**	0.0041**			
	(<0.01)	(0.03)	(0.01)			
*VrcBackDum2*DIVERSITY*	-0.0023***	-0.0012*	-0.0101**			
	(<0.01)	(0.06)	(0.01)			
VrcForwDum2				0.0012***	0.0007**	0.0050***
				(<0.01)	(0.02)	(<0.01)
*VrcForwDum2*DIVERSITY*				-0.0024***	-0.0013*	-0.0106**
				(0.01)	(0.07)	(0.02)
FIRMSIZE	0.0001**	0.000	0.0002	0.0001**	0.000	0.0001
	(0.01)	(0.7)	(0.16)	(0.02)	(0.77)	(0.22)

DIVERSITY	-0.0006	-0.0005	-0.0014	-0.0005	-0.0005	-0.0013
	(0.15)	(0.11)	(0.34)	(0.18)	(0.12)	(0.38)
HERFSAL	0.0013***	0.0008***	0.0042***	0.0013***	0.0008**	0.0041***
	(<0.01)	(0.01)	(0.01)	(<0.01)	(0.01)	(0.01)
Constant	-0.0012***	0.0002	-0.0030**	-0.0011***	0.0002	-0.0029**
	(<0.01)	(0.56)	(0.02)	(<0.01)	(0.52)	(0.03)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,879	95,879	95,879	95,879	95,879	95,879
Censored Observations	63,627	63,627	63,707	63,627	63,627	63,707
INVMILLS	0.0003**	-0.000001	0.00069*	0.0003**	-0.000001	0.00066*
Chisqr	99.48	49.2	50.23	100.3	52.62	51.94
R-Squared	-	-	-	-	-	-

Table VII
2SLS Regressions of Internal Capital Market Efficiency Measures on Vertical Relatedness

The table reports the results for the second stage of the 2SLS estimation. The sample period is 1984-2005. The dependent variable is the measure for internal capital market efficiency (*RVA*, *IQSENS*, or *RINV*). *FIRMSIZE* is the logarithm of firm net sales. *DIVERSITY* is the diversity in investment opportunities is measured as the standard deviation of the asset weighted segment q's. *HERFSAL* is the sales based Herfindahl index across the business segments of the firm. *VrcBackDum1* (*VrcForwDum1*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff1* (*VrcForwCoeff1*), based on Acemoglu et al. (2009) exceeds 5% and 0 otherwise. *VrcBackDum2* (*VrcForwDum2*) is a dummy that equals 1 if the firm-level backward (forward) vertical relatedness, *VrcBackCoeff2* (*VrcForwCoeff2*), based on Fan and Lang (2000) exceeds 5% and 0 otherwise. All variables are winsorized at the 1 and 99 percentile level. Panel A (Panel B) provides regressions based on asset (sales) weighted vertical relatedness coefficients. The Hansen J statistic tests the overidentifying restrictions with the joint null hypothesis that all instruments are valid. The Anderson Rubin statistic tests the joint significance of the endogenous regressors in the second stage with the null hypothesis that all coefficients are zero. The C statistic tests the exogeneity of endogenous regressors under the null that the endogeneous regressors can be treated as exogenous. All specifications contain calendar year dummies and p-values reported in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. The symbols ***, **, and * denote p<0.01, p<0.05, and p<0.1 respectively.

VARIABLES	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum1	0.002***	0.0009*	0.0061**			
	(<0.01)	(0.09)	(0.03)			
*VrcBackDum1*DIVERSITY*	-0.0025	-0.0003	-0.0051			
	(0.16)	(0.82)	(0.49)			
VrcForwDum1				0.0021***	0.0010*	0.0064**
				(0.01)	(0.09)	(0.05)
VrcForwDum1 DIVERSITY*				-0.0025	-0.0005	-0.0037
				(0.24)	(0.79)	(0.67)
FIRMSIZE	0.000	0.000	-0.0001	0.000	0.000	0.000
	(0.85)	(0.61)	(0.65)	(0.69)	(0.75)	(0.81)
DIVERSITY	-0.0005	-0.0006*	-0.0018	-0.0005	-0.0006*	-0.0019
	(0.21)	(0.07)	(0.26)	(0.19)	(0.08)	(0.24)
HERFSAL	0.0016***	0.0010***	0.0054***	0.0016***	0.0010***	0.0054***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Constant	-0.0010***	0.0001	-0.0028**	-0.0010***	0.0001	-0.0025**
	(<0.01)	(0.73)	(0.03)	(<0.01)	(0.64)	(0.04)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,379	32,185	32,105	32,379	32,170	32,105
Hansen J	3.59	10.37	4.03	3.25	12.70	3.65
Hansen J (P value)	(0.17)	(0.11)	(0.26)	(0.20)	(0.12)	(0.30)
Anderson Rubin	16.67***	19.2**	15.82***	16.67***	22.5**	15.82***
Anderson Rubin (P Value)	(<0.01)	(0.01)	(<0.01)	(<0.01)	(0.01)	(<0.01)
C Stat	10.04***	7.72**	10.05***	8.61**	5.40*	8.80**
C Stat (P Value)	(<0.01)	(0.02)	(<0.01)	(0.01)	(0.07)	(0.01)
R-squared	-	-	-	-	-	-

VARIABLES	RVA	IQSENS	RINVFIRM	RVA	IQSENS	RINVFIRM
VrcBackDum2	0.0029***	0.0011*	0.0082**			
	(<0.01)	(0.09)	(0.03)			

*VrcBackDum2*DIVERSITY*	-0.0043*	-0.0005	-0.0077			
	(0.06)	(0.82)	(0.41)			
VrcForwDum2				0.0028***	0.0011*	0.0079**
				(<0.01)	(0.10)	(0.03)
*VrcForwDum2*DIVERSITY*				-0.0041	-0.0003	-0.007
				(0.07)	(0.88)	(0.46)
FIRMSIZE	0.00002	0.000	0.000	0.000	0.000	0.000
	(0.46)	(0.82)	(0.95)	(0.77)	(0.83)	(0.99)
DIVERSITY	-0.0004	-0.0006*	-0.0013	-0.0003	-0.0006	-0.0011
	(0.39)	(0.09)	(0.39)	(0.46)	(0.11)	(0.47)
HERFSAL	0.0012***	0.0008**	0.0039**	0.0012***	0.0007**	0.0037**
	(<0.01)	(0.02)	(0.01)	(<0.01)	(0.03)	(0.02)
Constant	-0.0009***	0.0002	-0.0021*	-0.0008***	0.0002	-0.0018
	(<0.01)	(0.43)	(0.09)	(0.01)	(0.34)	(0.14)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,225	32,225	32,145	32,225	32,225	32,145
Hansen J	3.96	13.55	3.86	4.11	11.05	4.07
Hansen J P Val	(0.14)	(0.11)	(0.15)	(0.13)	(0.14)	(0.13)
Anderson Rubin	18.26***	20.83**	15.19***	18.26***	20.83**	15.19***
Anderson Rubin P	(<0.01)	(0.01)	(<0.01)	(<0.01)	(0.01)	(<0.01)
C Stat	9.81***	7.02**	10.00***	7.21**	5.96*	6.98**
C Stat P Val	(<0.01)	(0.03)	(<0.01)	(0.03)	(0.05)	(0.03)
R-squared	-	-	-	-	-	-

Table VIII
Sensitivity of Segment Investment to Investment Opportunities for Single-Segment Firms that Choose to Diversify

This table contains the results for OLS regression models for the segment investment sensitivity to Tobin's q for single-segment firms that started during the sample period of 1984 to 2005 as single-segment firms but chose to diversify. The observations included are for the segment that appeared in the single-segment regime as well as the multi-segment regime. Observations for t=-2 (two years prior to the calendar year the firm became multi-segment), t=-1 (one year prior to the calendar year the firm became multi-segment), t=+1 (one year after the calendar year the firm became multi-segment), and t=+2 (two years after the calendar year the firm became multi-segment) have been included in the analysis. The dependent variable *CAPX* which is the segment capital expenditure divided by sales *MEDTOBQ* is the median Tobin's q of single segment firms matched on the four-digit, three-digit, or two-digit SIC codes. *OPSS* is the segment operating income divided by segment sales. *AFTER* is a dummy that is set to one for observations at t=+1 and t=+2 and zero otherwise. *VERT* is a dummy that is set to one if the vertical relatedness coefficient between the segment under the single-segment status and newly added segment is greater than or equal to 5% and set to zero otherwise. *HOR* is a dummy that is set to one if the four digit SIC code of the old segment equals that of the new segment and set to zero otherwise. *PRE1998* is a dummy that equals one for observations prior to 1998 and zero for observations in 1998 or later. p-values reported in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10% respectively.

Dependent Variable: *CAPX*	Model 1	Model 2
MEDTOBQ	0.0111	0.0134
	(0.45)	(0.37)
OPSS	0.344***	0.349***
	(<0.01)	(<0.01)
*AFTER*MEDTOBQ*	-0.0169***	-0.0164***
	(<0.01)	(<0.01)
*AFTER*MEDTOBQ*VERT*	0.0304**	0.049*
	(0.04)	(0.09)
*AFTER*MEDTOBQ*HOR*	0.0162	0.0125
	(0.34)	(0.49)
*AFTER*MEDTOBQ*VERT*PRE1998*		-0.035
		(0.25)
Constant	0.042**	0.038**
	(0.03)	(0.05)
Observations	1,050	1,050
F Val	6.13***	5.37***
R-squared	0.11	0.11