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Essays on Corporate Vertical Integration

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ESSAYS ON CORPORATE VERTICAL INTEGRATION

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Dedication

To my beloved mother, grandmother, uncle and aunt,
who have been there for me from day one

ESSAYS ON CORPORATE VERTICAL INTEGRATION

by

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Abstract

My dissertation examines the corporate diversification strategy of vertical integration. Vertical integration refers to the organizational structure in which divisions within the firm are integrated along the supply chain. I examine the advantages and disadvantages associated with vertical integration in two chapters.

In Chapter 2, I model how inter-divisional spillover effects mitigate internal capital market (ICM) inefficiencies. The model shows that the spillover effect helps align the objectives of division managers and the objective of the CEO and the firm, and thus facilitates efficient capital allocation at equilibrium. Empirically, I measure the size of the spillover effect by the degree of vertical integration of the firm. I present evidence that higher level of vertical integration is associated with more efficient internal capital markets.

In Chapter 3, I show that vertically integrated firms are relatively lower valued firms. Using a vertical integration coefficient (*VIC*), constructed with Industry Benchmark Input-Output accounts data, provided by the Bureau of Economic Analysis (BEA), I find that compared to laterally integrated firms, vertical integration is associated with a significant firm value discount of approximately 1.56%. Even more strikingly, compared to firms located in the lowest *VIC* quartile, firms located in the highest *VIC* quartile exhibit a significant larger discount of approximately 3.34%. I find that there are two important sources of this additional discount: lower profit margins and more cross-subsidization.

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Chapter 1: Introduction

The focus of my dissertation is corporate vertical integration. While the effects of corporate diversification have been extensively discussed in the literature, the comparison between different diversification strategies has received much less attention. The central topics of discussion in the corporate diversification literature are the efficiency of internal capital market (ICM) within conglomerates and the valuation effects of diversification. And my dissertation investigates these two research questions in the context of corporate vertical integration.

By design, the information advantages possessed by ICM partially solve the overinvestment problem and financial constraints faced by stand-alone firms in the external capital market, and thus could facilitate efficient resource allocation. However, there are a large amount of theoretical arguments and empirical evidence on the inefficiencies of ICM. Specifically, the misalignment between division managers' self-interests and firm interests leads the managers to influence corporate resource allocation to be in favor of their own divisions, through various value destroying behaviors, which results in misallocation of corporate capital at equilibrium.

However, what is neglected in existing studies is that conglomerates can mitigate the conflict of interest between division managers and the firm by adopting a particular diversification strategy. Specifically, I propose vertical integration, in which divisions within the firm are integrated along the supply chain. In Chapter 2 of my dissertation "Vertical Integration to Mitigate Internal Capital Market Inefficiencies: Theory and Evidence", I first develop a theoretical model that demonstrates the mechanism of how vertical integration aligns division managers' self-interests and firm interests, and encourages division managers to pursue actions that optimize equilibrium capital allocation within the firm. In addition, I construct a measure of vertical integration and provide empirical evidence of lower cash flow- investment sensitivity and higher innovative efficiency under vertical integration, both of which indicate higher ICM

efficiency. The important contribution of this study to the literature is that it highlights the importance of diversification strategy, a subject that has been largely neglected in the literature. It provides insights on the advantages of vertical integration based on theoretical grounds, and important practical implications of how conglomerates can utilize these attributes to enhance corporate allocation efficiency.

Chapter 3 of my dissertation continues the discussion of vertical integration by examining its valuation effects. The literature identifies numerous factors that contribute to the "diversification discount", such as inefficient ICM, cross-subsidization, and higher cost incurred in the bankruptcy procedure, etc. Since firm value is not influenced by a single factor, the more efficient ICM within vertically integrated firms may not guarantee a higher firm value. In the chapter "Why Does Vertical Integration Destroy Firm Value?", I first document a further discount associated with vertical integration, versus lateral integration, and then explore the sources of this discount. Evidence shows that vertical integration leads to significantly lower profit margin, due to internal transactions, and greater cross-subsidization.

The two chapters in my dissertation are complementary in theme. Together, they provide a comprehensive picture of the pros and cons associated with the vertical integration strategy. They also shed light on the important question of when firms should adopt a vertically integrated structure. One can interpret the evidence in the two essays as to suggest that vertical integration is value-enhancing through improving allocation efficiency, but value-destroying through lowering operating efficiency. Although not directly tested in my dissertation, practically speaking, the importance of allocation efficiency may outweigh that of operating efficiency for firms at a growth stage, where firms face various investment opportunities associated with great a level of information asymmetry. Alternatively, operating efficiency may dominate allocation efficiency when firm enters the mature stage. My dissertation, therefore, provides justifications for adopting dynamic diversification strategies to fit the different stages of the business life cycle.

Chapter 2: Vertical Integration to Mitigate Internal Capital Market Inefficiencies

2.1 INTRODUCTION

Coase's (1937) treatise on the boundary of firms is the foundation of a large amount of literature and debate among financial economists. One of the important questions originating from Coase's work, which academicians have wrestled with for a substantial amount of time, is the role the internal capital market (ICM from hereon) plays in corporate resource allocation. By design, ICM possesses information and monitoring advantages, compared to the external capital market (e.g., Alchian, 1969; Weston, 1970; Williamson, 1970, 1975, 1986) and therefore, should allow for more efficient resource allocation within the firm. This attribute of ICM has been shown to be especially desirable with the existence of information asymmetry (Hubbard and Palia, 1999; Peyer, 2002) and higher cost of external financing (Hovakimian, 2011; Khanna and Tice, 2001; Matsusaka and Nanda, 2002; and Yan, 2006). Gertner, Scharfstein, and Stein (1994) and Stein (1997, 2003) theoretically support the efficiency of ICM, and show that such efficiency is derived from the control rights and "winner picking" function that the corporate headquarters maintains and performs.

In contrast, there is also a large amount of empirical evidence of inefficient resource allocation within the ICM (e.g., Lamont, 1997; Palia, 1999; Rajan, Servaes and Zingales, 2000; Scharfstein and Stein; 1998; Seru, 2014; Shin and Stulz, 1998). Williamson (1975) and Donaldson (1984) suggest that the cause of ICM inefficiencies is "internal competition". In a credit-constrained multi-division firm, the extent to which a division gets funded depends not only on the absolute value of its own projects, but also on the value of these projects relative to

the investment opportunities of other divisions of the firm. This creates internal competition for corporate resources. While the CEO's incentives are to allocate the limited capital to the "winner", this conflicts with the private benefits of the division managers who do not have the best investment opportunity in the firm. Such misalignment of interests can lead to manipulations of the allocation process by the division managers through various value-destroying behaviors, given the information asymmetry that exists between the divisions and the headquarters. Examples of these value destroying behaviors are influence costs (Meyer, Milgrom, and Roberts, 1992), rent-seeking (Scharfstein and Stein, 2000), and power-grabbing (Rajan et al., 2000), all of which can hinder the CEO's "winner picking".

If the internal conflict of interest is the cause of resource misallocation, such inefficiencies should be mitigated if the agents' incentives are more aligned. In this study, I propose such a mechanism that unifies the objectives of the corporate internal agents. Specifically, I propose the spillover effect, which allows one division's production to benefit from other divisions' investments. I demonstrate in a model that, without the spillover effect, the optimums of the division managers are independent of the optimum of the CEO and the firm, and their attempts to influence capital allocation to be in favor of their own divisions can result in inefficiencies at equilibrium. After the spillover effect is introduced, productions of different divisions become interrelated, and the optimums of the agents converge with the optimum of the firm, which reduces the managers' need to influence the capital allocation process, and facilitates efficient equilibrium outcome. I also relate my model to existing theories that support the inefficient view of ICM, and show that the spillover effect can be generally applied to address the different causes of misallocation explained by these theories.

Since the spillover effect allows one division's production to benefit from other divisions' investments, these divisions must be operationally related. The most common operational linkage within a firm is the inter-divisional supplier-customer relation. The diversification strategy that creates this linkage is vertical integration, in which the divisions are integrated along the supply chain and inter-divisional transactions are an integral part of the firm's operations. Due to the inter-divisional supplier-customer relation and the frequent internal transactions under vertical integration, costs and revenues of the divisions are positively related. As a result, a successful investment made by one division can have a positive spillover effect on the production of another division along the supply chain. The idea that vertical integration positively relates the productions of different divisions is consistent with the findings in Cohen and Frazzini (2008), who show that supplier-customer economic links are useful in predicting future returns. Therefore, I construct a vertical integration coefficient (*VIC*), using the IO accounts of dollar flows between all industries in the U.S. economy provided by the Bureau of Economic Analysis (BEA), and use *VIC* to proxy for the size of the spillover effect.

Empirically, I test the efficiency of ICM in two ways. First, following Shin and Stulz (1998), I examine the extent to which investments of small divisions in diversified firms depend on the divisions' own cash flows and investment prospects, and whether this dependence varies with the level of vertical integration. If ICM is efficient in resource allocation, investments of small divisions should depend less on the divisions' own cash flows, when the relative prospects of these investment projects are better among all divisions of the firm. On the other hand, if ICM is inefficient, the dependence of small divisions' investments on their own cash flows should not vary with the relative prospects of their investment opportunities. The test results show that, as the level of vertical integration increases, the dependence of small divisions' investments on their

own cash flows decreases, when investment prospects of these divisions are the best among all the investment opportunities faced by the firm. Specifically, when holding *VIC* and cash flows constant, having the best investment opportunity within the firm lowers the cash flow sensitivity of the smallest segment by 0.88%. And there is an additional 0.29% decrease in cash flow sensitivity for firms located in the third *VIC* quartile of the sample, compared to firms in the first *VIC* quartile, which magnifies the effect of having the best investment project by about 33%. This evidence is consistent with the prediction of the model that the spillover effect associated with vertical integration increases ICM efficiency.

As a second test of the model, I examine the influence of diversification strategy on ICM efficiency, using R&D investment outcomes. Seru (2014) argues that R&D investments are characterized by significant information asymmetry between the researchers (or divisions) and outside evaluators (i.e., corporate headquarters). In the presence of information asymmetry, the division researchers have an incentive to overstate their investment prospects to corporate headquarters. This information manipulation may, in turn, lead corporate headquarters to either allocate scarce capital to mediocre projects, or to refrain from embarking on novel research in the first place. Seru (2014) finds lower innovative efficiency in conglomerates, indicating inefficient resource allocation by the ICM. Following the intuition presented in his paper, I examine whether innovative efficiency in multi-division firms varies with the level of vertical integration. I find that, given the level of R&D investment, the number of patents produced increases as the level of vertical integration increases. Holding R&D intensity constant, moving from the first to the third *VIC* quartile in the innovation sample leads to 0.24 more patents produced, which is equivalent to an approximately 12% increase in innovative efficiency. As higher innovative efficiency indicates higher ICM efficiency, this result, again, is in line with the main model

prediction that vertical integration creates potential spillover and increases ICM efficiency. Importantly, the results pertaining to investment cash flow sensitivity and innovative efficiency are robust when I use a subsample of firms with 3 or fewer divisions, and when I employ an alternative measure of vertical integration.

The rest of the paper is organized as follows. Section 2.2 presents the model. Section 2.3 describes the data and the samples used in the empirical tests. Sections 2.4 and 2.5 present the empirical tests of the model, and in Section 2.6 I report the results of the robustness analyses. Finally, Section 2.7 concludes.

2.2 THE MODEL

2.2.1 Structural and Financial Setting

I start by describing the structural and financial settings of the model. The model concerns a two-division firm that features three types of agents: two division managers, the CEO and outside investors. The CEO has no financial resource of her own, but is endowed control rights by outside investors, and thus has full authority in allocating corporate investment capital across the two divisions. Both division managers and the CEO derive private benefits from the assets they oversee. Specifically, division managers' private benefits equal a fraction, ρ, of the production outputs of their own divisions; and the CEO's private benefits are a fraction, δ, of the total production outputs of the firm. Both ρ and δ are positive and less than one. The division managers and the CEO are self-interested, in that their objectives are to maximize their private benefits. As the CEO maximizes her private benefits through maximizing the firm's production outputs, her interests align with the interests of the firm and outside investors. In contrast, the division managers maximize their private benefits through maximizing the production outputs of their own divisions, which, as I show later, may not be in the best interests of the firm and outside investors. While the production outputs are costless verifiable, the agents' private benefits are non-contractible. In every production cycle t, the firm is endowed with investment capital $C_{f,t}$, which is fully allocated to divisions *i* and j, and thus $C_{i,t} + C_{j,t} = C_{f,t}$.

2.2.2 Investment and Production

The firm has a production function $k\ (C_t)$, where C_t is the capital invested in period *t*, and $k(.)$ is an increasing and concave function, with $k'(.) > 0, k'(0) = \infty$, and $k^{''}(.) < 0$. Within each production cycle *t*, the production outputs equal $\theta_t k(C_t)$, where θ_t measures the productivity of the assets in place in period *t*. θ_t can also be considered as the investment state of period *t*. I assume that θ_1, θ_2, θ_3,… are independently and identically distributed and drawn from a finite interval, $[\theta_L,\ \theta_H]$, which is common knowledge to all three types of agents. Furthermore, the productivities of the two divisions, $\theta_{i,t}$ and $\theta_{j,t}$ are independent, and are only directly observable to their own division managers before any production occurs.

2.2.3 Information Process and Capital Allocation

To understand the information and capital allocation process within the firm, consider a production cycle *t*. Without losing generality, I describe the timeline of the events using division *i*. Since the CEO does not have direct observation of $\theta_{i,t}$, she forms an estimation, $\widehat{\theta_{i,t}}$, of division *i*'s productivity, based on a signal received from manager *i*. This gives manager *i* the opportunity to exert her influence on capital allocation, in order to maximize the production outputs of division *i*, and her private benefits. Specifically, at the beginning of period *t*, division manager *i* first observes $\theta_{i,t}$ and decides the level of influence to exert, $I_{i,t}$. She then reports to the CEO information regarding her division's productivity in the form of a signal, $S_{i,t} = \theta_{i,t} + I_{i,t}$, where $I_{i,t}$ ε [*0*, *I*]. $I_{i,t}$ cannot be directly observed by the CEO or outside investors before production. However, once production occurs and outputs are verified, the CEO will be able detect the level of influence that has been exerted. The concept of division managers' influence is captured in several previous models that explain the inefficiencies of the ICM. For example, in the influence cost model in Meyer et al. (1992), managers of divisions facing the threat of layoffs might attempt to prevent downsizing by exaggerating their units' prospects in order to gain access to corporate resources. In some respects, the managers' influence efforts are also similar to the rent-seeking activities modeled in Stein and Scharfstein (2000), which increase the bargaining power of the division managers during salary negotiations with the CEO.

After receiving the signal, the CEO forms her own estimation of the actual productivity of the division *i*. In particular, being aware of the manager *i*'s tendency to exert influence, the CEO estimates a conjectured level of influence $\widehat{I_{i,t}}$. This estimation is based on the detected influence of the previous period. Specifically, $\widehat{I_{i,t}} = f(I_{i,t-1})$, where $f(.)$ is a non-decreasing

function known only to the CEO. Subsequently, the CEO downgrades the signal received from manager i, by her own estimation of manager i's influence efforts, thus $\widehat{\theta_{i,t}} = S_{i,t} - \widehat{I_{i,t}} = \theta_{i,t} + I_{i,t} - \widehat{I_{i,t}}$. Similarly, $\widehat{\theta_{j,t}} = S_{j,t} - \widehat{I_{j,t}} = \theta_{j,t} + I_{j,t} - \widehat{I_{j,t}}$. The CEO's capital allocation decision is a function of her estimated relative productivities of the two divisions: in period t, the capital allocated to division i, $C_{i,t}$, is given by the function, $C_{i,t} = g(\frac{\widehat{\theta_{i,1}}}{\widehat{\theta_{j,1}}})$, where $g'(.) > 0$. The CEO's decision function is not crucial in the model, but its implication is consistent with the CEO's optimum shown later, which is that the CEO will always allocate more capital to the division with relatively higher estimated productivity. The timeline of the events is shown in Figure 2.1

2.2.3.1 The Case with No Spillover Effects

2.2.3.1.1 CEO's Optimum

In the case with no spillover effects between divisions *i* and *j*, I first examine the CEO's optimization problem. Since the CEO's private benefits align with the firm's interests, the optimum shown here is also the efficient capital allocation for the firm. Specifically, the CEO and firm's optimum is given by the following proposition.

***Proposition 1*:** *Optimal capital allocation for the CEO and the firm requires* $\frac{\widehat{\theta_{j,t}}}{\widehat{\theta_{i,t}}} = \frac{\theta_{j,t}}{\theta_{i,t}}$.

Proof: In period *t*, the CEO's objective is to maximize her private benefits, given by:

$$U_{CEO,t} = \delta\left[\theta_{i,t}k(C_{i,t}) + \theta_{j,t}k(C_{j,t})\right] \quad (1)$$

subject to the fixed capital constraint:

$$C_{i,t} + C_{j,t} = C_{f,t} \quad (2)$$

The associated Lagrangian of this constrained maximization is:

$$L_{CEO,t} = \delta\left[\theta_{i,t}k(C_{i,t}) + \theta_{j,t}k(C_{j,t})\right] - \lambda_{CEO,t}\left(C_{i,t} + C_{j,t} - C_{f,t}\right) \quad (3)$$

And the first-order conditions of this Lagrangian are:

$$\frac{\partial L_{CEO,t}}{\partial C_{i,t}} = \delta\theta_{i,t}k'(C_{i,t}) - \lambda_{CEO,t} = 0 \quad (4)$$

$$\frac{\partial L_{CEO,t}}{\partial C_{j,t}} = \delta\theta_{j,t}k'(C_{j,t}) - \lambda_{CEO,t} = 0 \quad (5)$$

$$\frac{\partial L_{CEO,t}}{\partial \lambda_{CEO,t}} = C_{f,t} - C_{i,t} - C_{j,t} = 0 \quad (6)$$

Define $C_{i,t}^*$ and $C_{j,t}^*$ as the optimal capital allocation in period *t*. At the optimum:

$$\frac{k'(C_{i,t}^*)}{k'(C_{j,t}^*)} = \frac{\theta_{j,t}}{\theta_{i,t}} \quad (7)$$

Intuitively, (7) implies that, at the optimal capital allocation, the ratio of marginal productivities of capital of the two divisions equals the reverse ratio the two divisions' productivities. Given that $k'(.) > 0$ and $k''(.) < 0$, the optimum requires that the division with relatively higher productivity gets the bigger share of corporate capital, which is consistent with the CEO's capital allocation decision function described above.

Given that the CEO does not directly observe $\theta_{i,t}$ and $\theta_{j,t}$, her capital allocation decision will be based on her estimations of the productivities, $\widehat{\theta_{i,t}}$ and $\widehat{\theta_{j,t}}$, thus we have:

$$\frac{k'(C_{i,t})}{k'(C_{j,t})} = \frac{\widehat{\theta_{j,t}}}{\widehat{\theta_{i,t}}} \quad (8)$$

Therefore, the sufficient and necessary condition for capital allocation, $C_{i,t}$ and $C_{j,t}$, to be optimal is:

$$\frac{\widehat{\theta_{j,t}}}{\widehat{\theta_{i,t}}} = \frac{\theta_{j,t}}{\theta_{i,t}} \quad (9)$$

The implication of Proposition 1 is that, in order for the CEO to allocate capital efficiently, her estimated relative productivity must equal to the actual relative productivity. Equation (9) reflects an idea similar to the concept of "winner picking" explained in Stein (1997). The corporate headquarters ranks order all investment opportunities to make capital allocation decision. And when doing such relative ranking, absolute errors in the CEO's estimations of investment prospects do not necessarily lead to inefficient capital allocation. As long as the estimation errors are correlated across all projects, the estimated relative ranking is the same as the actual relative ranking, and capital allocation is efficient. For example, suppose

the CEO overestimates the productivities of both divisions by 10%, which means $\widehat{\theta_{i,t}} = 110\%\theta_{i,t}$, and $\widehat{\theta_{j,t}} = 110\%\theta_{j,t}$. It is easy to see that equation (9) is still satisfied in that case.

2.2.3.1.2 Equilibrium

In this section, I incorporate the managers' influence activities, and show how their influence affects equilibrium capital allocation. The idea is that if the CEO can perfectly estimate relative productivity, condition (9) is always satisfied. However, the CEO's estimation is partially determined by the managers' influence. Therefore, at equilibrium, optimal capital allocation is jointly determined by both the managers and the CEO.

Proposition 2**:** *If, at equilibrium, capital allocation is optimal, there must be* $\frac{I_{j,t}^{*}-\widehat{I_{j,t}}}{I_{i,t}^{*}-\widehat{I_{i,t}}} = \frac{\theta_{j,t}}{\theta_{i,t}}$.

Proof: At equilibrium, the CEO will allocate capital according to (8). Substituting $\widehat{\theta_{i,t}} = S_{i,t} - \widehat{I_{i,t}} = \theta_{i,t} + I_{i,t} - \widehat{I_{i,t}}$ and $\widehat{\theta_{j,t}} = S_{j,t} - \widehat{I_{j,t}} = \theta_{j,t} + I_{j,t} - \widehat{I_{j,t}}$ into (8) gives:

$$\frac{k'(C_{i,t})}{k'(C_{j,t})} = \frac{\theta_{j,t} + I_{j,t} - \widehat{I_{j,t}}}{\theta_{i,t} + I_{i,t} - \widehat{I_{i,t}}} \tag{10}$$

Define $I_{i,t}^{*}$ and $I_{j,t}^{*}$ as the levels of managers' influence at optimal capital allocation. Combining with (9), for capital allocation to be optimal at equilibrium, we must have:

$$\frac{\theta_{j,t} + I_{j,t}^{*} - \widehat{I_{j,t}}}{\theta_{i,t} + I_{i,t}^{*} - \widehat{I_{i,t}}} = \frac{\theta_{j,t}}{\theta_{i,t}} \tag{11}$$

Simplifying (11) gives:

$$\frac{I_{j,t}^{*} - \widehat{I_{j,t}}}{I_{i,t}^{*} - \widehat{I_{i,t}}} = \frac{\theta_{j,t}}{\theta_{i,t}} \tag{12}$$

Up to this point, I have added the managers' influence to the model, and derived the sufficient and necessary condition for efficient capital allocation at equilibrium. In words, for equilibrium capital allocation to be optimal, the ratio of the actual influence exerted by the two

managers, in excess to the CEO's estimations of their influence, must equal to the relative productivity of the two divisions. Suppose, if manager *j* exercises more influence than the level indicated by (12), division *j* will be allocated more capital at equilibrium than the optimal amount. The excess influence exerted by both managers can be understood as the CEO's judgement errors of the managers' influence activities. In a way, condition (12) reflects the same theme as condition (9), that absolute estimation errors may not necessarily destroy efficiency. If the estimation errors of influence activities are made in proportion to productivities, equilibrium capital allocation is still optimal. Importantly, equation (12) also shows that equilibrium capital allocation is jointly determined by the behaviors of both division managers and the CEO. With none of the parameters in (12) being observable to all the internal agents, this condition can only be satisfied with joint coordination among the managers and the CEO.

2.2.3.1.3 Division Managers' Optimum

Now I examine the division managers' equilibrium behaviors, and its impact on the outcome of equilibrium capital allocation. As before, I use manager *i* to illustrate.

Proposition 3*: *Without the spillover effect, at equilibrium, manager i's influence is given by $I_{i,t} = min[\theta_H - \theta_{i,t}, I]$.

Proof: In period *t*, manager *i*'s objective is to maximize her private benefits:

$$U_{i,t} = \rho\theta_{i,t}k(C_{i,t}) \tag{13}$$

subject to the capital constraint:

$$C_{i,t} \leq C_{f,t} \tag{14}$$

The Lagrangian associated with this maximization is:

$$L_{i,t} = \rho\theta_{i,t}k(C_{i,t}) + \lambda_{i,t}(C_{f,t} - C_{i,t}) \tag{15}$$

The first order conditions of this Lagragian are:

$$\frac{\partial L_{i,t}}{\partial C_{i,t}} = \rho\theta_{i,t}k'(C_{i,t}) - \lambda_{i,t} = 0 \tag{16}$$

$$\frac{\partial L_{i,t}}{\partial \lambda_{i,t}} = C_{f,t} - C_{i,t} = 0 \tag{17}$$

$$\lambda_{i,t} \geq 0 \tag{18}$$

$$C_{i,t} \leq C_{f,t} \tag{19}$$

Define $C_{i,t}^{**}$ as the optimal capital allocation for manager *i*. At the optimum:

$$C_{i,t}^{**} = C_{f,t} \tag{20}$$

Comparing the optimal capital allocation for manager *i* in (20) with the optimal capital allocation for the CEO and the firm in (7), it should be recognized that the CEO and the firm's optimum concerns the relative productivity of the two divisions, whereas manager *i*'s optimum is independent of this factor. In other words, it is not in the interests of the managers to rank order productivities of the divisions. This difference in the agents' objectives, as I show later, can lead to inefficient capital allocation within the ICM.

To see how the optimum in (20) affects the equilibrium behaviors of manager *i*, note that it is ideal for manager *i* to get the entirety of the corporate capital for her own division. Therefore, regardless of $\theta_{j,t}$, manager *i* will, to her best ability, maximize the signal reported to the CEO regarding the productivity of division *i*, specifically,

$$S_{i,t} = \max[\theta_H, \theta_{i,t} + I] \tag{21}$$

Therefore, at equilibrium, manager *i*'s influence in period *t* is given by:

$$I_{i,t} = \min\left[\theta_H - \theta_{i,t}, I\right] \tag{22}$$

Equation (22) describes the equilibrium behavior of manager *i*. In word, manager *i* will, if within her ability, exert enough influence to signal to the CEO that her division's productivity is the highest productivity realizable. And if that is beyond her influence ability, she will exert the maximum influence she can in the signal she sends to the CEO. Interestingly, (22) also implies that the lower the actual productivity of division *i* is, the more influence manager *i* is likely to exert. This is similar to the conclusion of Meyer et al. (1992) that influence cost is caused by the divisions with the prospects of decline or layoffs. But the most important implication of (22) is that, consistent with equation (20), at equilibrium, manager *i*'s influence is independent of the

relative productivity of the two divisions. Moreover, behaviors of the other internal agents are also irrelevant to manager *i*'s equilibrium influence. Given that (22) also applies to manager *j*, the left side of (12) can be anywhere within the interval $[\frac{\theta_L}{\theta_H}, \frac{\theta_H}{\theta_L}]$, and thus the condition for optimal capital allocation in (12) can only happen by random chance. To explain the inefficient capital allocation presented at this point intuitively, it is to the best interest of the firm for the agents to coordinate and base capital allocation decisions on relative productivity, but the managers optimums in (20) and equilibrium behaviors in (22) does not provide the incentives for them to be concerned about the other agents' behaviors or the productivity ranking orders. Therefore, to mitigate the inefficiency problem, an incentive is needed to align the interests of the managers with the interests of the firm and the CEO.

2.2.3.2 The Case with Spillover Effects

In this section, I introduce a spillover effect between divisions *i* and j, and show how this effect helps align the interests of the agents, and thus facilitates optimal capital allocation at equilibrium. With the presence of the spillover effect, the production of division j generates incremental outputs for division i, in the amount of a fraction, α, of division j's production outputs, with $\alpha \varepsilon [0,1]$ and observable to all the agents. That is to say, in period *t*, the spillover gain in division *i*'s outputs, from division *j*'s production, is given by $\alpha\theta_{j,t}k(C_{j,t})$. Essentially, this spillover represents a positive externality, and to help understanding, I use the following example to illustrate. Consider a steel company, with one division controlling the mills that make the steel, and another division extracting iron from the mines. Suppose the mining division invests in an advanced iron extraction technology that significantly reduces extraction costs and increases outputs. As a result, the mining division is able to supply a greater quantity of iron to the mills at a lower price, and thus increase the production outputs of the mills without necessarily increasing its production costs. Note that, on one hand, the mills do not incur any investment expenditure for the incremental outputs; on the other hand, the mining division does not need to share the return of this investment in order to create the spillover gain for the mills. This second point also distinguishes the spillover effect from the sharing of investment surplus modeled in Rajan et al. (2000), in which the gain of one division comes at the expense of the loss of another division.

This spillover effect essentially changes the production function of the firm. Specifically, with both divisions generating outputs for themselves and for each other, the firm's production function becomes $(1+\alpha)k(C_t)$. And the outputs of division i are now given by $\theta_{i,t}k\big(C_{i,t}\big)+\alpha\theta_{j,t}k(C_{j,t})$. It is easily seen that the spillover effect does not alter the CEO and the firm's

optimization problem. Therefore, with the spillover effect, the CEO and the firm's optimum is, again, given by (7), with the sufficient and necessary condition given by (12). Propositions 1 and 2 still apply here. However, the optimums and equilibrium behaviors of the managers change significantly once the spillover effect is introduced. Specifically, I have the following proposition.

Proposition 4: *With the spillover effects, at equilibrium, manager i's influence is given by* $I\_sp_{i,t} = \frac{\theta_{i,t}(\theta_{j,t}+I_{j,t}-\widehat{I_{j,t}})}{\alpha\theta_{j,t}} - \theta_{i,t} + \widehat{I_{i,t}}$.

Proof: With the spillover effect, in period *t*, manager *i*'s objective is still to maximize her private benefits:

$$U\_sp_{i,t} = \rho[\theta_{i,t}k(C_{i,t}) + \alpha\theta_{j,t}k(C_{j,t})] \tag{23}$$

subject to the same capital constraint in (2). The Lagrangian associated with this maximization is:

$$L\_sp_{i,t} = \rho[\theta_{i,t}k(C_{i,t}) + \alpha\theta_{j,t}k(C_{j,t})] - \lambda\_sp_{i,t}(C_{i,t} + C_{j,t} - C_{f,t}) \tag{24}$$

The first order conditions of this Lagragian are:

$$\frac{\partial L\_sp_{i,t}}{\partial C_{i,t}} = \rho\theta_{i,t}k'(C_{i,t}) - \lambda\_sp_{i,t} = 0 \tag{25}$$

$$\frac{\partial L\_sp_{i,t}}{\partial C_{j,t}} = \rho\alpha\theta_{j,t}k'(C_{j,t}) - \lambda\_sp_{i,t} = 0 \tag{26}$$

$$\frac{\partial L\_sp_{i,t}}{\partial \lambda\_sp_{i,t}} = C_{f,t} - C_{i,t} - C_{j,t} = 0 \tag{27}$$

Define $C\_sp_{i,t}^{**}$ and $C\_sp_{j,t}^{**}$ as the optimal capital allocation for manager i. At the optimum:

$$\frac{k'(C\_sp_{i,t}^{**})}{k'(C\_sp_{j,t}^{**})} = \alpha \frac{\theta_{j,t}}{\theta_{i,t}} \tag{28}$$

First, comparing with the optimum in (20), manager *i*'s optimum in (28) is no long independent of the two divisions' relative productivity. Essentially, the spillover effect makes the productivity of division *j* relevant in manager *i*'s optimum. And this relevance increases with α. Comparing manager *i*'s optimum in (28) with the CEO and firm's optimum in (7), I observe that, for $\alpha \, \varepsilon \, [0,1]$, as α increases, manager *i*'s optimum approaches the CEO and the firm's optimum. In other words, the higher the spillover effect is, the less the objectives of the agents differ. And in the extreme case where the spillover effect is 100%, the optimum of manager *i* in (28) converges to the optimum of the CEO and the firm given by (7).

Now I examine how the spillover effect facilitates efficient capital allocation through changing the manager *i*'s equilibrium influence level. Once again, the CEO's capital allocation decision is given by (8). In order to maximize her private benefits, at equilibrium, manager *i* will exert influence, $I\_sp_{i,t}$, so that

$$\frac{\widehat{\theta_{j,t}}}{\widehat{\theta_{i,t}}} = \alpha \frac{\theta_{j,t}}{\theta_{i,t}} \tag{29}$$

Substituting $\widehat{\theta_{i,t}} = S_{i,t} - \widehat{I_{i,t}} = \theta_{i,t} + I_{i,t} - \widehat{I_{i,t}}$ and $\widehat{\theta_{j,t}} = S_{j,t} - \widehat{I_{j,t}} = \theta_{j,t} + I_{j,t} - \widehat{I_{j,t}}$ into (29) gives:

$$I\_sp_{i,t} = \frac{\theta_{i,t}(\theta_{j,t} + I_{j,t} - \widehat{I_{j,t}})}{\alpha\theta_{j,t}} - \theta_{i,t} + \widehat{I_{i,t}} \tag{30}$$

Equation (30) describes the equilibrium behavior of manager *i* with the presence of the spillover, and should be distinguished from the one given by (22) in that, now the productivities of both divisions and actions of all internal agents come into play in manager *i*'s decision

making. Moreover, for given levels of productivities, manager j's influence, and the CEO's estimations of the influence activities, the larger the spillover effect is, the less influence manager i will exert at equilibrium. Most importantly, as $\alpha \to 1$, $I\_sp_{i,t}$ in (30) approaches the sufficient and necessary condition required for efficient capital allocation in (12). And when $\alpha = 1$, the influence levels of the two managers converge, both managers' optimums converge with the firm's optimum, and equation (30) converges with the optimal allocation condition (12). Essentially, the implication of Proposition 4 is that the spillover effect helps align the objectives of different agents and the firm, and thus improves the efficiency of the ICM through changing the agents' equilibrium behaviors. The larger the spillover effect is, the closer the equilibrium capital allocation is to the optimal capital allocation. Eventually, when the spillover effect is 100%, there is no longer any discrepancy between the objectives of the agents. In this case, the inefficiencies of ICM are eliminated, and capital allocation within a multi-division firm converges to the case of a stand-alone entity.

2.2.4 Related Models

2.2.4.1 Efficient ICM: Stein (1997)

At this point, it is useful to relate the model to existing theories in the literature. In support of the internal capital market, Stein (1997) models how the "winner picking" function of the corporate headquarters provides a partial solution to the overinvestment problem that occurs when all investments are financed as stand-alone projects. Since "winner picking" only requires that the CEO's judgement errors on the qualities of all investment projects are correlated, it justifies the organizational design with a focused strategy, because higher degree of focus leads to more correlated projection errors. And with the projection errors being highly correlated, the CEO's ranking orders of the investment opportunities are likely to be correct, regardless of the magnitudes of the absolute projection errors.

Stein (1997) demonstrates how the projection error correlations in the focused strategy mitigate the effects of any misjudgements on investment prospects. A natural question that follows is: what mechanism in a focused strategy can create the correlations in the CEO's projection errors? Stein (1997) gives an example where all the divisions in the firm belong to the same industry. This example is certainly appropriate because divisions in the same industry are more likely to face similar investment opportunities and prospects. As a result, the CEO is also more likely to mis-evaluate all investment opportunities to the same degree, and thus effectively perform "winner picking".

Besides diversifying within industry, there can be other ways to mitigate allocation inefficiencies in a multi-division firm. Without contradicting Stein's example, my model

proposes another solution that applies to a broader scope of firms. Essentially, through the spillover effect, the production of one division is partially linked to the production the other division. As a result, the managers adjust their equilibrium influence levels in accordance to both the relative productivity, and the influence exerted by their counterparts. And as the size of the spillover increases, the managers are more likely to exert excess influence in proportion to the two divisions' productivities, leading to higher correlation in the CEO's estimation errors. Of course, in the extreme case of 100% spillover, all internal agents' behaviors become transparent at equilibrium, all division managers exert zero influence, and the CEO does not anticipate any influence activities. What's also important is that the spillover effect can exist even if the divisions do not belong to the same industry. In that case, linkages between the productions of different divisions can be created through internal transactions.

2.2.4.2 Inefficient ICM: The Rent-seeking Models

The literature also offers theories in support of ICM inefficiencies. Among the theoretical studies that explain the inefficient capital allocation by the ICM, my model is first closely related to the two rent-seeking models in Meyer et al. (1992) and Scharfstein and Stein (2000), in the sense that inefficient capital allocation starts with division managers' manipulation of the capital distribution process. Division managers' rent-seeking activities can take various forms, such as exaggerating investment prospects (Meyer et al., 1992), "resume polishing" and "scorched earth" (Scharfstein and Stein, 2000). These types of rent-seeking generate private benefits for the managers in different ways. In Meyer et al. (1992), managers exert influence effort to increase their job security, whereas in Scharfstein and Stein (2000), rent-seeking helps increase the managers' bargaining power with the CEO, and thus increases their compensations. Regardless of the type of rent-seeking that causes the inefficiencies, the spillover effect helps relate the private benefits of each division manager to the wellbeing of other divisions, and thus align the objectives of the managers with the objective of the firm as a whole.

Comparing to the influence cost model in Meyer et al. (1992), my model also factors an additional layer of conflict of interest. Meyer et al. (1992) only focus on the conflict between the division level and the corporate headquarters level, but does not model the competition between the divisions. In contrast, in my model, in absence of any spillover, all three internal agents have different objectives. Therefore, the effects of the spillover are demonstrated in a multiway dynamic environment.

In the two-tiered rent-seeking agency model, Scharfstein and Stein (2000) argue that allocation inefficiencies do not necessarily occur with the presence of rent-seeking activities, if

the rent-seeking managers get compensated with cash. My model does not conflict with this argument. Instead, the important message is that the spillover effect reduces the managers' needs of engaging in any form of rent-seeking. Consequently, the potential of any allocation inefficiencies is reduced on the first layer of the agency problem. Scharfstein and Stein (2000) also show that, to some extent, one manager's rent-seeking may depend on the rent-seeking strategy of the other manager, and the scenario in which inefficiencies are most likely to occur is when a weak division is paired with a strong division. The implication of this conclusion is that the more diverse the prospects of the divisions are, the more likely it is for the ICM to be inefficient. In some respect, the spillover effect also addresses this problem of diverse investment states. Intuitively, the spillover effect creates an interrelation between the production outcomes of different divisions. Therefore, the larger the spillover effect is, the closer the divisions' production outcomes will be, which reduces the diversity in production prospects.

2.2.4.3 Inefficient ICM: The Power-grabbling Model

Rajan et al. (2000) offers another explanation of the investment distortion within the ICM. Instead of focusing on the inefficiencies in the distribution of investment capital that occurs *ex ante*, they examine the *ex post* sharing of investment surplus among the divisions. Specifically, both divisions make investments with their initial endowments of capital, and the investment surplus is redistributed between divisions through negotiation. In their setting, each division faces an efficient project and a defensive project. The efficient project offers higher return, but is more prone to poaching by the other division, whereas the defensive project yields lower return, but better protection to the division itself. Rajan et al. (2000) show that as the difference in the products of productivity and initial capital increases, the divisions become more likely to choose the defensive project over the efficient one. This outcome is identified as the "power grabbing" problem. In this section, I incorporate the *ex post* sharing of investment surplus in my model, and show that the spillover effect also provides a solution to division managers' "power grabbing".

For simplicity, assume initial capital allocation is optimal, thus $C_{i,t} = C^*_{i,t}$ and $C_{j,t} = C^*_{j,t}$. Following the setting in Rajan et al. (2000), suppose the defensive project lowers the productivity by x, so, for example, by making the defensive investment, division *i*'s production outputs become $(\theta_{i,t} - x)k(C^*_{i,t})$. If both divisions choose the efficient projects, production outputs are split equally between them. If, suppose division i, chooses the efficient investment and division j does not, j will have the opportunity to grab division *i*'s surplus. Division i can defend itself, but at a greater cost than if a defensive project had been chosen. Specifically, if division j poaches, the production outputs of division i are given by $(\theta_{i,t} - y)k(C^*_{i,t})$, where $y >$

x. On the other hand, the surplus that division *j* grabs from division *i* is almost fully matched by the cost of poaching, therefore, its production outputs are given by $(\theta_{j,t} - x)k(C^*_{j,t}) + v$, where v is a very small number. To sum up, the payoffs division *i* under different investment scenarios are shown in the following table.

Payoff of Division i- without spillover

		Division *j* investment	
		Efficient	Defensive
Division *i* investment	Efficient	$\frac{1}{2}[\theta_{i,t}k(C^*_{i,t}) + \theta_{j,t}k(C^*_{j,t})]$	$(\theta_{i,t} - y)k(C^*_{i,t})$
	Defensive	$(\theta_{i,t} - x)k(C^*_{i,t}) + v$	$(\theta_{i,t} - x)k(C^*_{i,t})$

Given the payoffs shown above, the conditions for manager *i* to choose the efficient investment are that manager *j* is expected to do the same, and

$$\frac{1}{2}[\theta_{i,t}k(C^*_{i,t}) + \theta_{j,t}k(C^*_{j,t})] \geq (\theta_{i,t} - x)k(C^*_{i,t}) \tag{31}$$

Manager *j* also requires similar conditions in order to choose the efficient project, therefore, the condition for both divisions to make the efficient investments is:

$$\frac{1}{2}[\theta_{i,t}k(C^*_{i,t}) + \theta_{j,t}k(C^*_{j,t})] \geq \max[(\theta_{i,t} - x)k(C^*_{i,t}), (\theta_{j,t} - x)k(C^*_{j,t})] \tag{32}$$

For simplicity, define $z_{i,t} = \theta_{i,t} - x$. And suppose, without loss of generality, that $z_{i,t}k(C^*_{i,t}) > z_{j,t}k(C^*_{j,t})$. Simplifying (32) gives:

$$x[k(C^*_{i,t}) + k(C^*_{j,t})] \geq z_{i,t}k(C^*_{i,t}) - z_{j,t}k(C^*_{j,t}) \tag{33}$$

For any period *t*, optimal capital allocation is fixed, resulting in a fixed level of the left-hand side of (33). Therefore, inequality (33) implies that, in order for the efficient investments to be made in both divisions, the difference between the products of division productivity and investment capital cannot be too large. Rajan et al. (2000) interpret this as the inefficiencies caused by the diversity in resources and opportunities.

Now I incorporate the spillover effect in the analysis. With the presence of the spillover effect, suppose if division *j* pursues the efficient project, it generates a spillover gain for division *i* that equals a fraction, α, of division *j*'s outputs. At the same time, when the defensive project is chosen, no spillover will be generated. Thus the payoffs of division *i*, when both "power grabbing" and spillover are possible, are given in the following table.

<u>*Payoff of Division i- with spillover*</u>

		Division *j* investment	
		Efficient	Defensive
Division *i* investment	Efficient	$\frac{1}{2}(1+\alpha)[\theta_{i,t}k(C_{i,t}^{*})+\theta_{j,t}k(C_{j,t}^{*})]$	$(\theta_{i,t}-y)k(C_{i,t}^{*})$
	Defensive	$(\theta_{i,t}-x)k(C_{i,t}^{*})+\alpha\theta_{j,t}k(C_{j,t}^{*})+v$	$(\theta_{i,t}-x)k(C_{i,t}^{*})$

Now, the conditions for manager *i* to make the efficient investment are that manager *j* makes the efficient investment, and

$$\frac{1}{2}(1+\alpha)[\theta_{i,t}k(C_{i,t}^{*})+\theta_{j,t}k(C_{j,t}^{*})] \geq (\theta_{i,t}-x)k(C_{i,t}^{*})+\alpha\theta_{j,t}k(C_{j,t}^{*}) \quad (34)$$

Simplifying (34) gives:

$$(1-\alpha)[\theta_{i,t}k(C_{i,t}^*) - \theta_{j,t}k(C_{j,t}^*)] \leq 2xk(C_{i,t}^*) \tag{35}$$

Similarly, the conditions that apply to manager *j* are manager *i* chooses the efficient investment, and

$$(1-\alpha)[\theta_{j,t}k(C_{j,t}^*) - \theta_{i,t}k(C_{i,t}^*)] \leq 2xk(C_{j,t}^*) \tag{36}$$

In words, for both managers to make the efficient investments, conditions (35) and (36) must be satisfied. Again, without losing generality, assume $\theta_{i,t}k(C_{i,t}^*) > \theta_{j,t}k(C_{j,t}^*)$, so condition (36) is always satisfied. Given fixed levels of $\theta_{i,t}k(C_{i,t}^*) - \theta_{j,t}k(C_{j,t}^*), x$ and $k(C_{i,t}^*)$, the larger α is, the more likely it is for condition (35) to be satisfied. Therefore, even with the possibility of inter-divisional "power grabbing", the spillover effect can improve the efficiency of the internal capital market.

2.2.5 Empirical Implications

My model shows that the spillover effect is the key to solving the ICM inefficiencies. In practice, the size of the spillover largely depends on a firm's diversification strategy. Galbraith and Nathanson (1978) lay out three main diversification strategies that multiproduct firms use: unrelated diversification, related diversification, and vertical integration. Hill and Hoskisson (1987) summarize the economic benefits of each of these three strategies and propose implementation strategies to achieve these economic benefits. Unrelated diversification is generally associated with financial economies, including the co-insurance effect (Lewellen, 1971), cash flow reallocation, and the ability to overcome external market failures (Teece, 1982; Williamson, 1975). While unrelated diversification creates financial linkages between the divisions, by definition, there is no interdependence in the divisions' operations.

Related diversification is established with multiple divisions belonging to the same industry. This type of strategy is used to exploit synergistic economies (Hill and Hokisson (1987)). Synergy is also referred to as "economies of scope" and generally arises from inputs that are shared or jointly utilized by related business activities (Hill and Hokisson (1987), Teece (1980, 1982), and Willig (1978)). Thus one way that related diversification can help improve ICM efficiency is through inter-divisional sharing, in which case internal competition between the divisions is not necessary. In another way, as the example in Stein (1997), it is easier for the CEO to perform "winner picking" effectively when all the divisions belong to the same industry. While both mechanisms help improve ICM efficiency, neither of them do so by creating inter-divisional spillover.

Essentially, the spillover effect is created when different divisions are operationally linked. The vertical integration strategy creates such linkage. A unique feature of vertical integration is that the divisions are integrated along the supply chain and inter-division transactions are an integral part of the operations of the firm. Vertical integration is associated with vertical economies. From a contracting point of view, vertical economies arise with the elimination of transaction costs. From an operational point of view, vertical economies take the form of integration economies, as well as control over raw materials or outlets (Pfer and Salancik, 1978; Scherer, 1981). Hill and Hokisson (1987) argue that the realization of vertical economies by vertical integration is due to the fact that the recipient (downstream) division is a customer of the source (upstream) division. Interestingly, in the presence of this supplier-customer linkage, the demands, or revenue streams, of divisions become positively related. Therefore, an investment opportunity that increases the production outputs of one division is also likely to bring new additional outputs to other divisions along the supply chain, as I illustrated earlier in the example of the steel company. This is the spillover effect in the model. The idea that the spillover effect exists between suppliers and customers is supported by Cohen and Frazzini (2008), who use the supplier-customer economic links to predict future stock returns. Thus, I use the level of vertical integration as a proxy for the spillover effect. It is important to note that vertical integration is defined by the inter-divisional supplier-customer relation, and does not necessarily exclude the case in which two divisions are linked along the supply chain, and at the same time belong to the same industry.

To test the effect of vertical integration on ICM efficiency, I use two proxies for capital allocation efficiency: cash flow sensitivity of investments and innovative efficiency. I use cash flow sensitivity of investments similar to Shin and Stulz (1998). They argue that when internal

capital allocation is efficient, division-level investment should be less sensitive to the division's own cash flows when the division faces the best investment opportunity within a firm. This is because an efficient ICM will direct limited investment capital to the most productive project. I also measure ICM efficiency by innovative efficiency, as Seru (2014) argues that R&D activities embody a high degree of information asymmetry between the division managers and the CEO. In the presence of information asymmetry, the division researchers have the incentives to overstate their investment prospects to the corporate headquarters. This is akin to the influence cost identified by Meyer et al. (1992). Without an efficient ICM, the corporate headquarters may end up distributing limited capital to mediocre projects or be reluctant to endeavor in R&D activities in the first place. Therefore, R&D investments are expected to be less efficient within organizations where the ICM is inefficient.

2.3 DATA AND SAMPLE

2.3.1 Sample

The empirical tests are run using two samples: a base sample and an innovation sample. I test ICM efficiency using the approach of Shin and Stulz (1998) on the base sample, and test ICM efficiency using innovative efficiency on the innovation sample. As I will discuss later, I first construct a firm-level vertical integration coefficient (*VIC*), using segment industry information and the detailed Use Table of Benchmark Input-Output Accounts provided by the Bureau of Economic Analysis (BEA), from 1982 to 2007. To build both samples, I start with all multi-segment firms listed on the Compustat industry segment files between 1980 and 2007. I follow the procedure in Shin and Stulz (1998) to form the base sample. For each segment, I collect the following information: sales, operating profit (loss), depreciation, capital expenditures, identifiable total assets, and SIC code. Segment-years that do not contain complete information are excluded. Further, I eliminate segment-years in which any of the following ratios exceed one: current value of net capital expenditure (gross capital expenditure minus depreciation) over the previous year's segment assets, sales growth from the previous year's sales, cash flows to segment assets, and other segments' cash flows to the total assets of those segments. Cash flows are calculated as operating profit (loss) plus depreciation and amortization. In addition, I delete cases in which the smallest segment has the same 2-digit SIC code as the largest segment. Lastly I exclude financial firms (SIC codes 6000 to 6999). Then, I merge this data set with *VIC*, which will be defined in detail in the next section. This procedure yields 17,583 firms-years and 46,760 segment-years in the base sample.

To construct the innovation sample, I obtain innovation related data from the National Bureau of Economic Research (NBER). The NBER patent dataset covers patent grants information from 1967 to 2006. Using this data, I construct a measure of innovative efficiency. Then, I merge the firm-level financial data of all multi-segment firms listed on the Compustat industry segment file with the R&D data and *VIC*. Further, I exclude financial firms (SIC code 6000 to 6999). This procedure generates 26,282 firm-year observations in the innovation sample.

2.3.2 Variable Construction

2.3.2.1 Vertical Integration Coefficient (VIC)

I measure the degree of vertical integration based on commodity flows between industries in the U.S. economy. The BEA has published the Benchmark Input-Output tables (IO tables) between all producers and purchasers in the economy since 1947. The IO tables are primarily based on the Economic Census and are published every five years with a five-year delay. The latest IO tables available are for year 2007 (the 2012 IO tables will be published in year 2017). The BEA defines industries at the summary level and the detailed level. For each level, the IO tables include a Make Table, Use Table, Direct Requirement Table, and Total Requirement Table. My measure of vertical integration is built on the detailed Use Table for years 1982, 1987, 1992, 1997, 2002, and 2007. The numbers of industries reported in different years range from 411 to 478. The Use Table reports for each industry pair *m* and *n*, the dollar value of *m*'s output required to produce *n*'s total output, at the producer's price. Industries are defined by SIC code before 1997 and by NAICS code since 1997. SIC codes reported range from 2-digit to 4-digit, whereas NACIS codes reported range from 2-digit to 6-digit.

To construct *VIC*, I begin by dividing the segment data into six time periods, 1980-1982, 1983-1987, 1988-1992, 1993-1997, 1998-2002, and 2003-2007, and apply the Use Tables of years 1982, 1987, 1992, 1997, 2002, and 2007 to each time period respectively. Specifically, within each firm, I pair each division with each of the other divisions in the same firm. For example, a firm, *A*, with three divisions, *x*, *y*, and *z*, will have six division pairs, *xy*, *xz*, *yx*, *yz*, *zx*, and *zy*. Then, I match the division pairs to the Use Table by the divisions' industry codes. After the match, I am able to obtain the dollar value of commodities transferred between each division-

pair's industries. To illustrate, a_{xy} denotes the dollar value of output produced by division y's industry required to produce the total output of division x's industry. I divide a_{xy} by the dollar value of total output produced by division x's industry to get v_{xy}. v_{xy} represents the dollar value of output produced by division y's industry that is required to produce one dollar's worth of output in division x's industry. Similarly, I calculate v_{xz}, v_{yx}, v_{yz}, v_{zx}, and v_{zy}. In the step, I take the weighted average of v_{xy} and v_{xz} to obtain V_x. The weight used is the sales of division y and division z. V_x represents the dollar value of output produced by the industries of all the other divisions in firm A that is required to produce one dollar's worth of output in division x's industry. Accordingly, I calculate V_y and V_z. I define the vertical integration coefficient of firm A as the maximum of V_x, V_y and V_z, VIC_A = max $\{V_x, V_y, V_z\}$. Ahern and Harford (2014), Fan and Lang (2000), and Kumar (2013) have used a similar approach to measure vertical industry links. As mentioned earlier, industry codes reported in the Use Tables are not standardized and can range from 2-digit to 4-digit for SIC codes and 2-digit to 6-digit for NAICS codes. To obtain the most accurate and comprehensive match between the segment file and the Use Tables, for each division pair, I match with the divisions' primary SIC or NAICS codes first, and if no matches are found, I switch to the divisions' secondary SIC or NAICS codes. Furthermore, I start the match with the narrowest industry codes (4-digit SIC codes or 6-digit NAICS codes) and gradually loosen the matching criteria to the broadest industry codes (2-digit SIC codes or 2-digit NAICS codes).

By construction, *VIC* reflects the strongest supplier-customer relation that exists between the divisions within the same firm. One would expect *VIC* to be between 0 and 1, as it is not likely for a division to acquire more than one dollar's worth of inputs from other divisions in order to produce one dollar's worth of outputs. However, in reality, a *VIC* greater than 1 may

exist for several reasons. First, for a division with a high-level of inventory, not all outputs of its production are realized in sales. Following the calculation procedure, the dollar value of inputs acquired may be greater than the dollar value of sales for this division, resulting in a *VIC* greater than 1. Second, to get v_{xy}, I divide a_{xy} by the dollar value of total outputs produced by division *x*'s industry, where total output of division *x*'s industry is calculated by summing up this industry's supply to all the other industries in the economy provided by the Use Table. But this procedure can yield very low total outputs for industries that mostly produce consumer products or services, which are directly supplied to end consumers, such as the retailing or health care industries. As a result, for divisions that belong to such industries, the calculated *VIC* can be greater than 1. Less than 1% of the *VIC*s I calculated are greater than 1. Nevertheless, to avoid extreme outliers, I set *VIC* to 3 for values greater than 3.

2.3.2.2 Innovative Efficiency

Following Seru (2014), I use patent-based metrics to measure innovative efficiency. Trajtenberg (1990) and Griliches (1990) both demonstrate that whereas R&D intensity focuses on the expense incurred during the research and development process, patent-based metrics provide a better measure of the efficiency of R&D activities. Specifically, for each firm-year, I count the number of patents filed that were later granted. This simple measure of patent counts is biased for two reasons. First, as Hall, Jaffe, and Trajtenberg (2002) identify, a truncation bias exists toward the end of the sample period, because it takes an average of two years from the time when a patent is filed to the time when it is granted. Second, patent intensities vary across industries. To address these concerns, I follow Hall et al. (2001) and, in each year, divide the number of patents by the mean number of patents in the industry to which a firm belongs. I use this adjusted number of patents for each firm-year, *Patent*, as the measure of innovative efficiency. For firm-years for which no patent filed has been granted, *Patent* equals zero.

2.3.2.3 Other Variables

In my tests, I also employ a set of other segment or firm level variables. I construct the segment-level variables following Shin and Stulz (1998). The segment-level variables include: $Investment_{i,j,t}$, calculated as the capital expenditure of division *j* of firm *i* in year *t*, divided by the total assets of firm *i* in year *t*-1; $Sales\ Growth_{i,j,t}$, calculated as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t*, divided by the total assets of firm *i* in year *t*-1; and $Tobin's\ Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, calculated as the median Q of single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to the book value of assets.

Firm-level variables include: $LogAT_{i,t,}$ calculated as the natural log of firm *i*'s total assets in year *t*; $R\&D_{i,t}$, calculated as R&D expenditure, divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero)*;* $Profitability_{i,t}$, calculated as the ratio of *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$, calculated as the sum of long-term debt and debt in current liabilities, divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$, calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$, calculated as cash, divided by the total assets of firm *i* in year *t*; and $Capx_{i,t}$, calculated as capital expenditure, divided by the total assets of firm *i* in year *t*. I also control for 2-digit SIC industry level Herfindahl index, $HHI_{i,t}$. All accounting ratios are winsorized at 1% and 99% to eliminate extreme outliers.

2.3.3 Summary Statistics

Table 2.1 reports the summary statistics of the two samples. Panel A presents the summary statistics of both the firm-level and the segment-level variables for the base sample. The mean and median of $VIC_{i,t}$ are 0.1446 and 0.0189, respectively, with a standard deviation of 0.3942. $LogAT_{i,t}$ has a mean of 5.7280, a median of 5.8014 and a standard deviation of 2.4450. For the segment level variables, the mean (median) of $Investment_{i,j,t}$ is 0.0228 (0.0107), and the standard deviation is 0.0329; $Sales\ Growth_{i\ j,t}$ has a mean of 0.0708, a median of 0.0626, and a standard deviation of 0.2417; the mean, median, and standard deviation of $Cash\ Flow_{i,j,t}$ are 0.0496, 0.0317, and 0.0631, respectively; $Tobin's\ Q_{i,j,t}$ has a mean of 1.5018, a median of 1.3692, and a standard deviation of 0.4919.

Panel B reports the summary statistics for the innovation sample. $VIC_{i,t}$ has a mean of 0.1401, a median of 0.0227, and a standard deviation of 0.3620. The mean and median of $R\&D_{i,t}$ are 0.0205 and 0.0000, respectively, with the standard deviation being 0.0455. The mean, median, and standard deviation of $Patent_{i,t}$ are 0.4179, 0.0000, and 1.1654. $LogAT_{i,t}$ has a mean of 6.1244, a median of 6.2176, and a standard deviation of 2.3911. The mean of $Profitability_{i,t}$ is 0.1058, with the median and standard deviation being 0.1203 and 0.1296, respectively. $Leverage_{i,t}$ has a mean of 0.2709, a median of 0.2628, and a standard deviation of 0.1714. The mean, median and standard deviation of $Market\text{-}to\text{-}Book_{i,t}$ are 2.5714, 1.6356, and 3.8108. The mean of $Cash_{i,t}$ is 0.0652, and its median and standard deviation are 0.0284 and 0.0970, respectively. $Capx_{i,t}$ has a mean of 0.0668, a median of 0.0525, and a standard deviation of 0.0584. Lastly, the mean, median, and standard deviation of $HHI_{i,t}$ are 0.0768, 0.0528 and 0.0811, respectively.

2.3.4 Correlations

Table 2.2 presents the Pearson correlations among the key variables. In Panel A, I report the correlations for the base sample. At first glance, $VIC_{i,t}$ is negatively related to segment-level $Investment_{i,j,t}$, $Cash\ Flow_{i,j,t}$, and $Tobin's\ Q_{i,j,t}$. It is positively related to segment sales growth. What is also evident is that segment-level investments are strongly positively correlated with the segment's own cash flows and sales growth, although the magnitude of the correlation between $Investment_{i,j,t}$ and $Sales\ Growth_{i,j,t}$ is only 0.1413. As I will discuss in later section, I use the base sample to test the role of vertical integration in ICM capital allocation by examining how *VIC* moderates the dependence of segment-level investments on the segment's own cash flows, when the segment faces the best investment opportunity in the firm. This moderation effect cannot be observed in the univariate correlations.

Panel B reports the correlations for the innovation sample. It appears that *VIC* is positively related to firm size. Furthermore, higher *VIC* leads to lower R&D investments, but a higher number of patents produced. This seems to suggest that when the level of vertical integration increases, R&D activities become more productive, indicating higher capital allocation efficiency by the ICM in more vertically integrated organizations. In the following sections, I perform additional tests to examine whether this relation is robust.

2.3.5 Univariate Analysis

I divide both the base sample and the innovation sample into quartiles by the level of *VIC* and conduct univariate t-tests on the main variables. Table 2.3 reports the results. As mentioned in the previous section, I use the base sample to test the moderation effect of *VIC* on the dependence of segment-level investments on the segment's own cash flows, when the segment faces the best investment opportunity in the firm, and because this effect can only be observed in a multivariate setting, I will only focus the univariate results of the innovation sample in this section of the paper.[1] The results are presented in Panel B. When comparing the lowest *VIC* quartile with the highest *VIC* quartile, I observe that firms located in the highest *VIC* quartile do not have significantly different R&D intensity, but they produce a significantly larger number of patents each year. This evidence is consistent with what I observed in the correlations and suggests that more vertically integrated firms conduct more efficient R&D. In other words, the limited R&D capital is allocated to the more promising projects among all the divisions under higher degree of vertical integration, and thus yields higher return. Hence, the results seem to suggest that, as my model predicts, vertical integration increases ICM capital allocation efficiency.

[1] I report the univariate comparison of the base sample in Panel A for completeness sake only.

2.4 *VIC* AND INVESTMENT-CASH FLOW SENSITIVITY

To further examine the effect of vertical integration on internal resource allocation efficiency, I first employ an approach similar to the one used in Shin and Stulz (1998). Their paper investigates how capital investments at the segment level relate to the investment prospects of the segments. The rationale is that efficient internal capital allocation implies a lower investment-cash flow sensitivity for the segment with the best investment opportunity in a firm, because an efficient ICM should allow that segment to take advantage of a good investment opportunity, regardless of the amount of its own cash flows. However, one can only expect to observe this effect for the smallest segment in a firm, because, by definition, the largest segment is usually the segment that generates the most cash flows within the firm, thus its investments naturally depend primarily on the segment's own cash flows, without regard to its investment prospect. A positive change in the segment's investment outlook may not significantly change its reliance on its own cash flows. On the other hand, the smallest segment, due to its low priority in the firm, usually funds its own investment. However, when a good investment opportunity emerges, the smallest segment's own cash flows may not be sufficient to cover the investment outlay. Under these circumstances, if the internal capital market is efficient, capital will be directed from other segments to the smallest segment. Therefore, I should observe a significant decrease in the reliance of the smallest segment's investments on its own cash flows when a good opportunity arises.

I incorporate the level of vertical integration using this line of logic. Specifically, I run the following regression model:

$$Investment_{i,j,t} = \beta_1 \, Sales\ Growth_{i,j,t} + \beta_2 Cash\ Flow_{i,j,t} + \beta_3 Cash\ Flow_{i,other,t} + \beta_4 Tobin's\ Q_{i,j,t} + \beta_5 High\ Q_{i,j,t} * Cash\ Flow_{i,j,t} + \beta_6 High\ Q_{i,j,t} * Cash\ Flow_{i,other,t} + \beta_7 Tobin's\ Q_{i,other,t} + \beta_8 Segment\ Fixed\ Effects + \beta_9 Industry\ Fixed\ Effects + \beta_{10} Year\ Dummies + \varepsilon_{i,j,t} \quad (37)$$

Where $Cash\ Flow_{i,\ other,\ t}$ is calculated as the sum of cash flows of all segments in firm *i*, except for the cash flows of segment *j*, in year *t*, divided by the total assets of firm *i*, in year *t*-1; $High\ Q_{i,j,t}$ is a dummy variable that takes the value of 1 if segment *j* has the highest *Tobin's Q* among all the segments within firm *i* in year *t*, zero otherwise; $Tobin's\ Q_{i,other,t}$ is the highest *Tobin's Q* among all the segments within firm *i*, except for segment *j*, in year *t*; and other variables are calculated as described in section 2.3.2.

I run model (37) for the smallest and the largest segments that are located in the lowest and highest *VIC* quartiles. The expectation is that β_2 is positive and significant, as the investments of a segment depend, among other things, on its own cash flows. However, if an active internal capital market exists, I should expect β_5 to be negative and significant for the smallest segment, because as argued above, the ICM should lower the investment-cash flow sensitivity of the smallest segment, when that segment faces a good investment opportunity, relative to other investment projects within the firm. Furthermore, if vertical integration increases ICM efficiency, I should expect the magnitude of β_5 to be greater in the highest *VIC* quartile compared to the lowest *VIC* quartile. Also, as argued above, the effects of ICM may not be profound in the largest segment, so I do not have an expectation for the two subsamples of the largest segments.

The results are presented in Table 2.4. As expected, β_2 is positive and significant across all four subsamples, indicating that segments' own cash flows play an important role in determining segment level investments. Consistent with my theoretical prediction, I observe β_5 to be negative and significant for the two smallest segment subsamples. For the smallest segments located in the lowest *VIC* quartile, a 1% increase in segment *Cash Flow* leads to a 0.1031% increase in *Investment*. However, if the smallest segment has the highest *Tobin's Q* within the firm, the investment-cash flow sensitivity decreases by 0.0262%. This implies about a 25% decrease in investment-cash flow sensitivity. When I look at the results for the smallest segments located in the highest *VIC* quartile, the effects of the ICM appear to be much greater. First, a 1% increase in *Cash Flow* leads to approximately 0.0993% increase in *Investment*. However, if the smallest segment has the highest *Tobin's Q* within the firm, the investment-cash flow sensitivity decreases by 0.0436%, which is about a 44% decrease, compared to the 25% decrease for the smallest segments in the lowest *VIC* quartile. These findings suggest that while there is an active internal capital market, the ICM is more efficient in more vertically integrated firms.

To show further evidence of the effects of *VIC* on ICM efficiency, I add *VIC* and a three-way interaction term between *VIC*, *High Q*, and *Cash Flow* to model (37). To be specific, I run the following model separately for the smallest and largest segments:

$$Investment_{i,j,t} = \gamma_1 \, Sales\ Growth_{i,j,t} + \gamma_2 Cash\ Flow_{i,j,t} + \gamma_3 Cash\ Flow_{i,other,t} + \gamma_4 Tobin's\ Q_{i,j,t} + \gamma_5 VIC_{i,t} + \gamma_6 High\ Q_{i,j,t} * Cash\ Flow_{i,j,t} + \gamma_7 VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,j,t} + \gamma_8 High\ Q_{i,j,t} * Cash\ Flow_{i,other,t} + \gamma_9 VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,other,t} + \gamma_{10} Tobin's\ Q_{i,other,t} + \gamma_{11} Segment\ Fixed\ Effects + \gamma_{12} Industry\ Fixed\ Effects + \gamma_{13} Year\ Dummies + \varepsilon_{i,j,t} \quad (38)$$

I expect vertical integration to further lower cash flow sensitivity of the investments in the smallest segment of a firm, when that segment faces the best investment opportunity, and thus γ_7 to be negative and significant for the smallest segment subsample.

The results of this analysis are presented in Table 2.5. Consistent with the expectation, γ_7 is negative and significant at 5% level. I interpret the economic importance of this coefficient as follows: while the best investment opportunity within the firm reduces the cash flow sensitivity of the smallest segment's investments, a 1% increase in *VIC* enhances the effect of a good investment opportunity by further reducing its cash flow sensitivity by 0.0353%. Moving from the first to the third *VIC* quartile of the base sample produces about an 8.34% increase in *VIC* and this increase brings approximately 0.29% decrease in investment-cash flow sensitivity, for given levels of *Cash Flow* and *High Q*. Economically, when holding *VIC* and *Cash Flow* constant, having the best investment opportunity within the firm lowers the investment-cash flow sensitivity of the smallest segment by 0.88%. And this decrease is further magnified by about 33% for firms located in the third *VIC* quartile, comparing to firms in the first *VIC* quartile. Because the role of an efficient ICM is to reduce cash flow sensitivity of investments, especially for small segments, this finding suggests, again, that capital allocation is more efficient within more vertically integrated firms. Overall, the evidence presented in Tables 2.4 and 2.5 supports my model's main prediction that vertical integration improves ICM efficiency.

2.5 *VIC* AND INNOVATIVE EFFICIENCY

In this section, I present further evidence on the link between vertical integration and ICM efficiency by examining the efficiency of R&D investments. As Seru (2014) suggests, R&D activities are characterized by a high degree of information asymmetry between the divisions and the corporate headquarters, which hinders the efficiency of internal capital allocation. Therefore, higher innovative efficiency is an indication of a more efficient internal capital market. I incorporate vertical integration to this rationale. Specifically, I test the following models:

$$R\&D_{i,t} = \eta_1 VIC_{i,t} + \eta_2 LogAT_{i,t} + \eta_3 Profitability_{i,t} + \eta_4 Market\text{-}to\text{-}Book_{i,t} + \eta_5 Cash_{i,t} + \eta_6 Capx_{i,t} + \eta_7 HHI_{i,t} + \eta_8 HHI^2_{i,t} + \eta_9 Industry\ Fixed\ Effects + \eta_{10} Year\ Dummies + \varepsilon_{i,t} \quad (39)$$

$$Patent_{i,t} = \lambda_1 VIC_{i,t} + \lambda_2 LogAT_{i,t} + \lambda_3 Profitability_{i,t} + \lambda_4 Market\text{-}to\text{-}Book_{i,t} + \lambda_5 Cash_{i,t} + \lambda_6 Capx_{i,t} + \lambda_7 HHI_{i,t} + \lambda_8 HHI^2_{i,t} + \lambda_9 R\&D_{i,t} + \lambda_{10} Industry\ Fixed\ Effects + \lambda_{11} Year\ Dummies + \varepsilon_{i,t} \quad (40)$$

The results of regressions (39) and (40) are presented in Table 2.6. First, I note that *VIC* is negatively related to *R&D*, indicating that as the level of vertical integration increases, R&D intensity decreases, although the economic significance in the decrease in *R&D* seems trivial. However, when holding *R&D* constant, I find that *VIC* is positively related to *Patent*. Specifically, for a given level of R&D intensity, a 1% increase in *VIC* leads to 0.0462% more adjusted patents produced. In other words, R&D investments are more efficient when firms are more vertically integrated. This suggests that under higher degree of vertical integration, R&D

capital is allocated to the more productive projects, indicating a more efficient internal capital market.

To more directly examine how much vertical integration increases innovative efficiency, I add an interaction term between *VIC* and *R&D*. I run the following model:

$$Patent_{i,t} = \zeta_1 VIC_{i,t} + \zeta_2 R\&D_{i,t} + \zeta_3 VIC_{i,t} * R\&D_{i,t} + \zeta_4 LogAT_{i,t} + \zeta_5 Profitability_{i,t} + \zeta_6 Market\text{-}to\text{-}Book_{i,t} + \zeta_7 Cash_{i,t} + \zeta_8 Capx_{i,t} + \zeta_9 HHI_{i,t} + \zeta_{10} HHI^2_{i,t} + \zeta_{11} Industry\ Fixed\ Effects + \zeta_{12} Year\ Dummies + \varepsilon_{i,t} \tag{41}$$

I expect ζ_2 and ζ_3 to be positive and significant. A positive ζ_2 indicates that higher R&D intensity leads to more patents produced and a positive ζ_3 indicates that vertical integration enhances the positive effects of R&D intensity on the number of patents. The results are presented in Table 2.7. Consistent with the expectation, I observe that 1% increase in *R&D* leads to 1.9606% more adjusted patents produced. More importantly, as the level of *VIC* increases by 1%, the positive effects of *R&D* on *Patent* increases further by 2.5157%. Therefore, holding R&D intensity constant, moving from the first to the third *VIC* quartile in the innovation sample leads to 0.24 more patents produced. This is equivalent to an approximately 12% increase in innovative efficiency. It appears that R&D investments are more efficient as the level of vertical integration increases, implying the limited R&D capital is distributed to the more promising opportunity, yielding better innovation outcome. Overall, the evidence presented in Tables 2.6 and 2.7 provides additional evidence that, as the level of vertical integration increases, the internal capital market becomes more efficient.

2.6 ROBUSTNESS

My measure of vertical integration, *VIC*, reflects the strongest inter-divisional vertical link within a firm and minimizes the noise caused by inter-divisional links that are non-vertical. However, this implies that this measure should best describe the level of vertical integration for firms with relatively few divisions, because for firms with a large amount of divisions, this measure may not capture all inter-divisional links (i.e., the non-vertical links). I find that 50% of the sample consists of firms with three or fewer divisions. Therefore, although I do not tabulate the results, I repeat my analyses using firms with three divisions, or fewer. As expected, I find results similar to those reported earlier in the paper. For the investment-cash flow sensitivity test, while having the best investment opportunity within the firm reduces the cash flow sensitivity of the smallest segment's investment, I find that a 1% increase in *VIC* enhances the effects of a good investment opportunity by further reducing its flow sensitivity by 0.0344%. Economically, this means that moving from the first to the third *VIC* quartile of the sample, which results in a 6.08% increase in *VIC*, leads to an approximately 0.21% decrease in investment-cash flow sensitivity, for given levels of *Cash Flow* and *High Q*. This implies that, when holding *VIC* and *Cash Flow* constant, having the best investment opportunity within the firm lowers the cash flow sensitivity of the smallest segment by 1.36%. And, this decrease is further magnified by about 15% for firms located in the third *VIC* quartile, compared to firms in the first *VIC* quartile. These results are significant at 10% level. For the innovative efficiency test, I find that a 1% increase in *R&D* leads to 0.82% more adjusted patents (*Patents*) produced. In addition, as the level of *VIC* increases by 1%, the positive effects of *R&D* on *Patent* increase further by 2.7454% more patent produced. The results remain significant at 1% level. Overall, the results found for the subsample of firms with three or fewer divisions are similar to those reported earlier in the paper.

I also conduct my analyses using a weighted average *VIC*, *wVIC*, which is calculated as the weighted average of bilateral vertical links between all divisions in the firm, using division sales as the weights. In untabulated tests, I obtain slightly weaker, but qualitatively similar results. For the investment-cash flow sensitivity test, while having the best investment opportunity within the firm reduces the cash flow sensitivity of the smallest segment's investment, I also find when *wVIC* increases by 1%, the effects of a good investment opportunity are enhanced by an additional 0.0334% reduction in investment-cash flow sensitivity. Economically, moving from the first to the third *wVIC* quartile of the sample increases *wVIC* by 4.20%, which leads to an approximately 0.14% decrease in investment-cash flow sensitivity, for given levels of *Cash Flow* and *High Q*. Therefore, while holding *wVIC* and *Cash Flow* constant, having the best investment opportunity within the firm lowers the cash flow sensitivity of the smallest segment's investments by 1.18%, and this decrease is further magnified by about 12% for firms located in the third *wVIC* quartile, compared to firms in the first *wVIC* quartile. These results are significant at 10%. For the innovative efficiency test, I find that a 1% increase in *R&D* leads to 0.87% more adjusted patents (*Patents*) produced. In addition, for a given *R&D* level, when the level of *wVIC* increases by 1%, the positive effects of *R&D* on *Patent* increase further by 1.7659% more patents produced. These results are significant at 5%. Overall, using *wVIC* as the measure of vertical integration yields similar results that support the prediction of my model.

2.7 CONCLUSION

The purpose of an internal capital market is to overcome the overinvestment problem that occurs when all available investment opportunities are funded as stand-alone projects. And this function is performed through the “winner picking” of the corporate headquarters. However, with the presence of information asymmetry between the divisions and the corporate headquarters, the outcome of “winner picking” can be substantially influenced by the division managers various influence efforts. This can lead to inefficient capital allocation when the objectives of the managers and the objective of the CEO and the firm differ. The literature has documented a large amount of evidence of the capital allocation inefficiencies. However, a solution to this problem has not been proposed.

If the misalignment of interests between the agents and the firm is the cause of the ICM inefficiencies, to mitigate this problem, we must start from aligning the objectives of the agents with the objective of the firm. I show in my model that the inter-divisional spillover effect can perform such a function. By allowing the production of one division to benefit from other divisions’ investments, the spillover effect creates a positive interdependence in the divisions’ wellbeing. As the spillover effect becomes larger, this interdependence increases, and the objectives of the division managers approach the objective of the CEO and the firm. Empirically, I measure the size of the spillover effect by the degree of vertical integration. I provide evidence that higher level of vertical integration is associated with more efficient internal capital markets. While existing theories have identified various mechanisms that can cause the ICM inefficiencies, such as influence cost, rent-seeking and power-grabbing, in some respect, all these mechanisms originate from the same fact the firm and its agents have different objectives. And it is important to note that by aligning the interests of different parties, my model addresses the

various causes identified by the inefficient ICM theories in general. Therefore, the model can be applied as a general solution to mitigate the capital misallocation problem faced by diversified firms.

Figure 2.1. Timing Capital Allocation Process

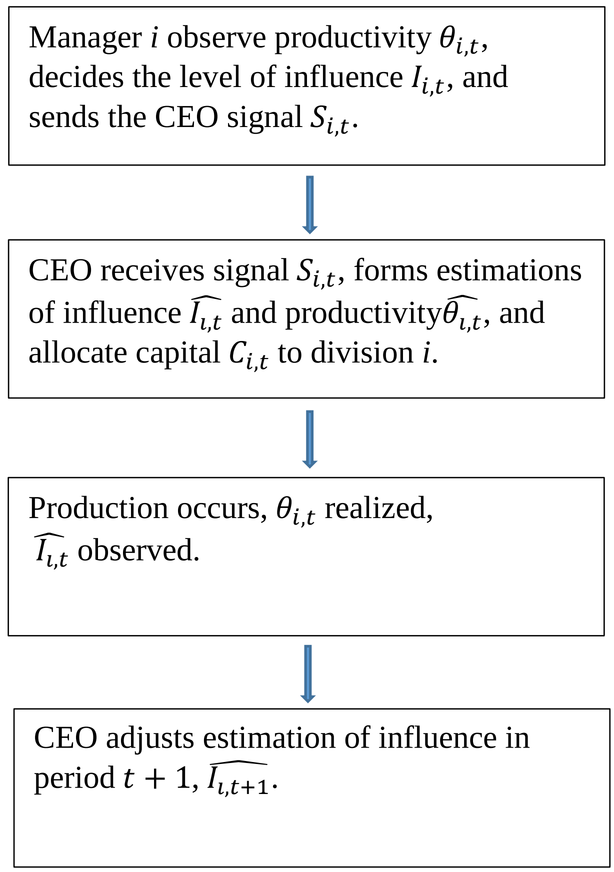

Table 2.1 Summary Statistics

This table reports the summary statistics of the key variables for the base sample and the innovation sample. $VIC_{i,t}$ is calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers; $LogAT_{i,t,}$ is calculated as the natural log of firm *i*'s total assets in year *t*; $Investment_{i,j,t}$, is calculated as the capital expenditure of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Sales\ Growth_{i,j,t}$ is calculate as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, is calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; *Tobin's* $Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, is calculated as the median Q of single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to the book value of assets; $Patent_{i,\ t}$ is calculated as the number of patents filed by firm *i* in year *t* that were later granted, divided by the mean number of patents in the industry to which firm *i* belongs in year *t; $R\&D_{i,t}$*, is calculated as R&D expenditure divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero)*; $Profitability_{i,t}$* is calculated as the ratio *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$ is calculated as the sum of long-term debt and debt in current liability divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$ is calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$ is calculated as cash divided by the total assets of firm *i* in year *t*; $Capx_{i,t}$ is calculated as capital expenditure divided by the total assets of firm *i* in year *t*; and $HHI_{i,t}$ is the 2-digit SIC industry level Herfindahl index of firm *i* in year *t*.

Panel A: Base Sample						
Variables	***N***	***Mean***	***Median***	***25%***	***75%***	***Standard Deviation***
Firm Level Variables						
$VIC_{i,t}$	17,583	0.1446	0.0189	0.0022	0.0856	0.3942
$LogAt_{i,t}$	17,583	5.7280	5.8014	4.0250	7.5580	2.4450
Segment Level Variables						
$Investment_{i,\ j,\ t}$	46,760	0.0228	0.0107	0.0036	0.0273	0.0329
$Sales\ Growth_{i,\ j,\ t}$	46,760	0.0708	0.0626	-0.0432	0.1792	0.2417
$Cash\ Flow_{i,\ j,\ t}$	46,760	0.0496	0.0317	0.0097	0.0748	0.0631
Tobin's $Q_{i,\ j,\ t}$	46,760	1.5018	1.3692	1.1678	1.6983	0.4919

Panel B: Innovation Sample						
Variables	***N***	***Mean***	***Median***	***25%***	***75%***	***Standard Deviation***
$VIC_{i,\ t}$	26,282	0.1401	0.0227	0.0033	0.0998	0.3620
$R\&D_{i,\ t}$	26,282	0.0205	0.0000	0.0000	0.0222	0.0455
$Patent_{i,\ t}$	26,282	0.4179	0.0000	0.0000	0.0990	1.1654
$LogAT_{i,\ t}$	26,282	6.1244	6.2176	4.3490	7.9470	2.3911
$Profitability_{i,\ t}$	26,164	0.1058	0.1203	0.1668	0.0729	0.1296
$Leverage_{i,\ t}$	26,244	0.2709	0.2628	0.1426	0.3797	0.1714
$Market\text{-}to\text{-}Book_{i,\ t}$	24,299	2.5714	1.6356	1.0660	2.6410	3.8108
$Cash_{i,\ t}$	23,211	0.0652	0.0284	0.0109	0.0764	0.0970
$Capx_{i,\ t}$	25,836	0.0668	0.0525	0.0299	0.0849	0.0584
$HHI_{i,\ t}$	26,282	0.0768	0.0528	0.0777	0.0349	0.0811

Table 2.2 Pearson Correlation Matrix

This table reports the Pearson correlations between the key variables for the base sample (Panel A) and the innovation sample (Panel B). $VIC_{i,t}$ is calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers; $LogAT_{i,t,}$ is calculated as the natural log of firm *i*'s total assets in year *t*; $Investment_{i,j,t}$, is calculated as the capital expenditure of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Sales\ Growth_{i,j,t}$ is calculate as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, is calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Tobin's\ Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, is calculated as the median Q of single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to the book value of assets; $Patent_{i,t}$ is calculated as the number of patents filed by firm *i* in year *t* that were later granted, divided by the mean number of patents in the industry to which firm *i* belongs in year *t; $R\&D_{i,t}$*, is calculated as R&D expenditure divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero)*; $Profitability_{i,t}$* is calculated as the ratio *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$ is calculated as the sum of long-term debt and debt in current liability divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$ is calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$ is calculated as cash divided by the total assets of firm *i* in year *t*; $Capx_{i,t}$ is calculated as capital expenditure divided by the total assets of firm *i* in year *t*; and $HHI_{i,t}$ is the 2-digit SIC industry level Herfindahl index of firm *i* in year *t*. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Panel A: Base Sample					
Variables	$VIC_{i,t}$	$Investment_{i,j,t}$	$Sales\ Growth_{i,j,t}$	$Cash\ Flow_{i,j,t}$	$Tobin's\ Q_{i,j,t}$
$VIC_{i,t}$	1				
$Investment_{i,j,t}$	-0.0224***	1			
$Sales\ Growth_{i,j,t}$	0.0149***	0.1413***	1		
$Cash\ Flow_{i,j,t}$	-0.0230***	0.5315***	0.1672***	1	
$Tobin's\ Q_{i,j,t}$	-0.0501***	-0.0135***	0.0239***	0.0211***	1

Table 2.2 (Continued) Pearson Correlation Matrix

Panel B: Innovation Sample										
Variables	$VIC_{i,t}$	$R\&D_{i,t}$	$Patent\ Count_{i,t}$	$LogAT_{i,t}$	$Profitability_{i,t}$	$Leverage_{i,t}$	$Market\text{-}to\text{-}Book_{i,t}$	$Cash_{i,t}$	$Capx_{i,t}$	$HHI_{i,t}$
$VIC_{i,\ t}$	1									
$R\&D_{,\ t}$	-0.0532***	1								
$Patent_{i,\ t}$	0.0540***	0.0461***	1							
$LogAT_{i,\ t}$	0.1229***	-0.2185***	0.3401***	1						
$Profitability_{i,\ t}$	0.0420***	-0.4694***	0.0847***	0.3847***	1					
$Leverage_{i,\ t}$	0.0434***	-0.2423***	-0.0112***	0.2318***	0.0998***	1				
$Market\text{-}to\text{-}Book_{i,\ t}$	-0.0345***	0.2710***	-0.0137***	-0.1994***	-0.3285***	0.0037	1			
$Cash_{i,\ t}$	-0.0519***	0.3277***	-0.0486***	-0.2773***	-0.3350***	-0.3622***	0.1991***	1		
$Capx_{i,\ t}$	-0.0166***	-0.0710***	-0.0131***	0.0088***	0.0714***	0.0707***	0.0350***	-0.1049***	1	
$HHI_{i,\ t}$	-0.0027	-0.1079***	-0.0601***	-0.1428***	-0.0096***	-0.0070**	-0.0198***	-0.0216***	-0.0035	1

Table 2.3 Univariate Analysis

This table reports the T-tests of the difference in the key variables between the highest *VIC* quartile and the lowest *VIC* quartile for the base sample (Panel A) and the innovation sample (Panel B). $VIC_{i,t}$ is calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers; $LogAT_{i,t}$, is calculated as the natural log of firm *i*'s total assets in year *t*; $Investment_{i,j,t}$, is calculated as the capital expenditure of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Sales\ Growth_{i,j,t}$ is calculate as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, is calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Tobin's\ Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, is calculated as the median Q of single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to the book value of assets; $Patent_{i,t}$ is calculated as the number of patents filed by firm *i* in year *t* that were later granted, divided by the mean number of patents in the industry to which firm *i* belongs in year *t*; $R\&D_{i,t}$, is calculated as R&D expenditure divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero); $Profitability_{i,t}$ is calculated as the ratio *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$ is calculated as the sum of long-term debt and debt in current liability divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$ is calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$ is calculated as cash divided by the total assets of firm *i* in year *t*; $Capx_{i,t}$ is calculated as capital expenditure divided by the total assets of firm *i* in year *t*; and $HHI_{i,t}$ is the 2-digit SIC industry level Herfindahl index of firm *i* in year *t*. T-statistics are reported in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Panel A: Base Sample						
Variables	***VIC Q1***	***VIC Q2***	***VIC Q3***	***VIC Q4***	***Difference (Q4-Q1)***	***T-Statistics***
Firm Level Variables						
$VIC_{i,t}$	0.0016	0.0146	0.0608	0.5479	0.5464***	(51.50)
$LogAT_{i,t}$	5.4215	6.0042	6.1170	6.3818	0.9602***	(19.06)
Segment Level Variables						
$Investment_{i,j,t}$	0.0260	0.0225	0.0215	0.0212	-0.0047***	(-10.93)
$Sales\ Growth_{i,j,t}$	0.0660	0.0740	0.0680	0.0752	0.0092***	(2.90)
$Cash\ Flow_{i,j,t}$	0.0592	0.0485	0.0449	0.0459	-0.0133***	(-15.51)
$Tobin's\ Q_{i,j,t}$	1.5023	1.5014	1.4925	1.5108	0.0085	(1.31)
Panel B: Innovation Sample						
Variables	***VIC Q1***	***VIC Q2***	***VIC Q3***	***VIC Q4***	***Difference (Q4-Q1)***	***T-Statistics***
$VIC_{i,t}$	0.0016	0.0137	0.0588	0.4856	0.4840***	(65.33)
$R\&D_{i,t}$	0.0193	0.0207	0.0219	0.0203	0.0010	(1.24)
$Patent_{i,t}$	0.3418	0.4144	0.4894	0.4253	0.0835***	(4.30)
LogAT	5.6195	6.0582	6.3580	6.4581	0.8386***	(20.05)
$Profitability_{i,t}$	0.0998	0.1055	0.1081	0.1097	0.0099***	(4.20)
$Leverage_{i,t}$	0.2739	0.2663	0.2732	0.2702	-0.0037	(-1.22)
$Market\text{-}to\text{-}Book_{i,t}$	2.6035	2.6066	2.4773	2.5992	-0.0043	(-0.06)
$Cash_{i,t}$	0.0662	0.0678	0.0623	0.0645	-0.0017	(0.94)
$Capx_{i,t}$	0.0640	0.0655	0.0686	0.0691	0.0051***	(5.06)
$HHI_{i,t}$	0.0751	0.0791	0.0784	0.0746	-0.0005	(-0.37)

Table 2.4 *VIC* and ICM Efficiency: Cash Flow-Investment Sensitivity I

This table reports the regression results of model (37) for the smallest and largest segments in the base sample. The dependent variable is $Investment_{i,j,t}$, calculated as the capital expenditure of division j of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1. $VIC_{i,\ t}$ is calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers. The independent variables include: $Sales\ Growth_{i,j,t}$, calculate as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Tobin's\ Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, calculated as the median Q for single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to book value of assets; $Cash\ Flow_{i,\ other,\ t}$, calculated as the sum of cash flows of all segments in firm *i*, except for the cash flows of segment *j*, in year *t*, divided by the total assets of firm *i*, in year *t*-1; $High\ Q_{i,j,\ t}$,a dummy variable that takes the value of 1 if segment *j* has the highest *Tobin's Q* among all segments within firm *i* in year *t*, zero otherwise; $High\ Q_{i,\ j,\ t}*Cash\ Flow_{i,\ j,\ t}$, the interaction between $High\ Q_{i,j,\ t}$ and $Cash\ Flow_{i,j,t}$; $High\ Q_{i,\ j,\ t}*\ Cash\ Flow_{i,\ other,\ t}$, the interaction between $High\ Q_{i,j,\ t}$ and $Cash\ Flow_{i,\ other,\ t}$; and $Tobin's\ Q_{i,\ other,\ t}$, the highest *Tobin's Q* among all segments within firm *i*, except for segment *j*, in year *t*. T-statistics are reported in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

	Smallest Segment		***Largest Segment***	
Independent Variables	***VIC Q1***	***VIC Q4***	***VIC Q1***	***VIC Q4***
$Sales\ Growth_{i,\ j,\ t}$	0.0025**	-0.0003	0.0099***	0.0133***
	(2.31)	(-0.36)	(3.35)	(4.30)
$Cash\ Flow_{i,\ j,\ t}$	0.1031***	0.0993***	0.0921***	0.1541***
	(8.56)	(6.82)	(7.07)	(10.17)
$Cash\ Flow_{i,\ other,\ t}$	0.0114**	0.0101**	0.0697***	0.0580***
	(2.40)	(2.43)	(3.92)	(3.07)
$Tobin's\ Q_{i,\ j,\ t}$	0.0008	-0.0015	0.0016	-0.0015
	(0.77)	(-1.53)	(0.64)	(-0.59)
$High\ Q_{i,\ j,\ t}*Cash\ Flow_{i,\ j,\ t}$	-0.0262**	-0.0436**	-0.0011	-0.0148
	(-1.96)	(-2.56)	(-0.09)	(-0.96)
$High\ Q_{i,\ j,\ t}*\ Cash\ Flow_{i,\ other,\ t}$	0.0055	0.0047	0.0514**	0.0382*
	(1.07)	(1.10)	(2.33)	(1.70)
$Tobin's\ Q_{i,\ other,\ t}$	0.0007	0.0008**	0.0001	0.0002*
	(0.93)	(2.10)	(0.56)	(1.74)
Segment Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
N	3,860	2,797	4,439	3,321
R-Squared	0.7337	0.8590	0.7357	0.7892

Table 2.5 *VIC* and ICM Efficiency: Cash Flow-Investment Sensitivity II

This table reports the regression results of model (38) for the smallest and largest segments in the base sample. The dependent variable is $Investment_{i,j,t}$, calculated as the capital expenditure of division j of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1. The independent variables include: $VIC_{i,t}$, calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ is truncated at 3 to avoid extreme outliers; $Sales\ Growth_{i,j,t}$, calculate as the sales growth of division *j* of firm *i* from year *t*-2 to year *t*-1; $Cash\ Flow_{i,j,t}$, calculated as the sum of operating profit and depreciation and amortization of division *j* of firm *i* in year *t* divided by the total assets of firm *i* in year *t*-1; $Tobin's\ Q_{i,j,t}$, Tobin's Q of division *j* of firm *i* in year *t*, calculated as the median Q for single-division firms in segment *j*'s 2-digit SIC industry in year *t*, where Q is calculated as the ratio of the book value of assets minus the book value of equity plus the market value of equity to book value of assets; $Cash\ Flow_{i,other,t}$, calculated as the sum of cash flows of all segments in firm *i*, except for the cash flows of segment *j*, in year *t*, divided by the total assets of firm *i*, in year *t*-1; $High\ Q_{i,j,t}$,a dummy variable that takes the value of 1 if segment *j* has the highest *Tobin's Q* among all segments within firm *i* in year *t*, zero otherwise; $High\ Q_{i,j,t} * Cash\ Flow_{i,j,t}$, the interaction between $High\ Q_{i,j,t}$ and $Cash\ Flow_{i,j,t}$; $VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,j,t}$, the interaction between $VIC_{i,t}$, $High\ Q_{i,j,t}$ and $Cash\ Flow_{i,j,t}$; $High\ Q_{i,j,t} * Cash\ Flow_{i,other,t}$, the interaction between $High\ Q_{i,j,t}$ and $Cash\ Flow_{i,other,t}$; $VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,other,t}$, the interaction between $VIC_{i,t}$, $High\ Q_{i,j,t}$ and $Cash\ Flow_{i,other,t}$; and $Tobin's\ Q_{i,other,t}$, the highest *Tobin's Q* among all segments within firm *i*, except for segment *j*, in year *t*. T-statistics are reported in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Independent Variables	***Smallest Segment***	***Largest Segment***
$Sales\ Growth_{i,j,t}$	0.0011**	0.0101***
	(2.03)	(7.09)
$Cash\ Flow_{i,j,t}$	0.1053***	0.1276***
	(15.85)	(19.32)
$Cash\ Flow_{i,other,t}$	0.0170***	0.0563***
	(7.12)	(6.69)
$Tobin's\ Q_{i,j,t}$	0.0006	0.0031***
	(1.05)	(2.75)
$VIC_{i,t}$	0.0004	0.0003
	(0.73)	(0.32)
$High\ Q_{i,j,t} * Cash\ Flow_{i,j,t}$	-0.0088	-0.0002
	(-1.12)	(-0.03)
$VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,j,t}$	-0.0353**	-0.0011
	(-2.33)	(-0.08)
$High\ Q_{i,j,t} * Cash\ Flow_{i,other,t}$	0.0011	0.0174*
	(0.42)	(1.66)
$VIC_{i,t} * High\ Q_{i,j,t} * Cash\ Flow_{i,other,t}$	-0.0000	-0.0319
	(-0.01)	(-1.60)
$Highest\ Q_{i,other,t}$	0.0004	0.0001
	(1.54)	(1.17)
Segment Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Year Dummies	Yes	Yes
N	12,672	14,827
R-Squared	0.6875	0.7094

Table 2.6 *VIC* and ICM Efficiency: Innovative Efficiency I

This table reports the regression results of models (39) and (40) using the innovation sample. The dependent variables are $R\&D_{i,t}$, calculated as R&D expenditure divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero); and $Patent_{i,\ t}$, calculated as the number of patents filed by firm *i* in year *t* that were later granted, divided by the mean number of patents in the industry to which firm *i* belongs in year *t*. The independent variables include: $VIC_{i,t}$, calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers; $LogAT_{i,t,}$ calculated as the natural log of firm *i*'s total assets in year *t*; $Profitability_{i,t}$, calculated as the ratio *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$, calculated as the sum of long-term debt and debt in current liability divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$, calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$, calculated as cash divided by the total assets of firm *i* in year *t*; $Capx_{i,t}$, calculated as capital expenditure divided the total assets of firm *i* in year *t*; $HHI_{i,t}$, the 2-digit SIC industry level Herfindahl index of firm *i* in year *t*; $HHI\_Square_{i,\ t}$, the square of $HHI_{i,t}$; and $R\&D_{i,t}$, calculated as R&D expenditure divided by total assets for firm *i* in year *t* (I replace missing R&D expenditure with zero). T-statistics are reported in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

	Dependent Variable	
Independent Variables	$R\&D_{i,\ t}$	$Patent_{i,\ t}$
$VIC_{i,\ t}$	-0.0019***	0.0462**
	(-2.59)	(2.45)
$LogAT_{i,\ t}$	0.0022***	0.2467***
	(15.09)	(66.29)
$Profitability_{i,\ t}$	-0.1015***	-0.0845
	(-47.87)	(-1.46)
$Leverage_{i,\ t}$	-0.0316***	-0.5236***
	(-18.67)	(-11.84)
$Market\text{-}to\text{-}Book_{i,\ t}$	0.0012***	0.0172***
	(17.58)	(9.82)
$Cash_{i,t}$	0.0569***	-0.1118
	(18.99)	(-1.43)
$CAPX_{i,\ t}$	0.0553***	0.3943***
	(11.33)	(3.11)
$HHI_{i,\ t}$	-0.0151	0.3884
	(-0.78)	(0.78)
$HHI\_Square_{i,\ t}$	0.0476	-0.4046
	(1.18)	(-0.39)
R&D		2.222***
		(12.32)
Industry Fixed Effects	Yes	Yes
Year Dummies	Yes	Yes
N	21,043	21,043
R-squared	0.4687	0.4240

Table 2.7 *VIC* and ICM Efficiency: Innovative Efficiency II

This table reports the regression results of model (41) using the innovation sample. The dependent variable is $Patent_{i,t}$, calculated as the number of patents filed by firm *i* in year *t* that were later granted, divided by the mean number of patents in the industry to which firm *i* belongs in year *t*. The independent variables include: $R\&D_{i,t}$, calculated as R&D expenditure divided by the total assets of firm *i* in year *t* (I replace missing R&D expenditure with zero); $VIC_{i,t}$, calculated using the BEA Benchmark Use Tables of the years 1982, 1987, 1992, 1997, 2002 and 2007; $VIC_{i,t}$ greater than 3 is set 3 to avoid extreme outliers; $R\&D_{i,t} * VIC_{i,t}$, the interaction between $R\&D_{i,t}$ and $VIC_{i,t}$; $LogAT_{i,t}$, calculated as the natural log of firm *i*'s total assets in year *t*; $Profitability_{i,t}$, calculated as the ratio *EBITDA* to total assets of firm *i* in year *t*; $Leverage_{i,t}$, calculated as the sum of long-term debt and debt in current liability divided by the total assets of firm *i* in year *t*; $Market\text{-}to\text{-}Book_{i,t}$, calculated as the ratio of the market value of equity to the book value of equity of firm *i* in year *t*; $Cash_{i,t}$, calculated as cash divided by the total assets of firm *i* in year *t*; $Capx_{i,t}$, calculated as capital expenditure divided the total assets of firm *i* in year *t*; $HHI_{i,t}$, the 2-digit SIC industry level Herfindahl index of firm *i* in year *t*; and $HHI\_Square_{i,t}$, the square of $HHI_{i,t}$;. T-statistics are reported in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Independent Variables	$\boldsymbol{Patent_{i,t}}$
$VIC_{i,t}$	0.0206
	(1.03)
$R\&D_{i,t}$	1.9606***
	(10.19)
$R\&D_{i,t} * VIC_{i,t}$	2.5157***
	(3.90)
$LogAT_{i,t}$	0.2465***
	(66.25)
$Profitability_{i,t}$	-0.0807
	(-1.39)
$Leverage_{i,t}$	-0.5226***
	(-11.82)
$Market\text{-}to\text{-}Book_{i,t}$	0.0171***
	(9.77)
$Cash_{i,t}$	-0.1097
	(-1.40)
$CAPX_{i,t}$	0.3947***
	(3.11)
$HHI_{i,t}$	0.3482
	(0.70)
$HHI\_Square_{i,t}$	-0.3306
	(-0.32)
Industry Fixed Effects	Yes
Year Dummies	Yes
N	21,043
R-squared	0.4244

Chapter 3: Why Does Vertical Integration Destroy Firm Value?

3.1 INTRODUCTION

The link between diversification and firm value is the subject of a large literature. Diversification can have positive effects on firm value if it is associated with greater debt capacity (Lewellen, 1971), greater operating efficiency (Chandler, 1977), more efficient resource allocation (Weston, 1970), and/or reduced underinvestment (Stulz, 1990). Oppositely, diversification could have negative effects on firm value if it creates information asymmetry between central and division managers (Harris, Kriebel and Raviv, 1982; Myerson, 1982), leads to value-destroying investments (Jensen, 1986), overinvestment in segments with poor investment opportunities (Stulz, 1990), and/or cross-subsidization to failing segments (Meyer, Milgrom and Roberts, 1992). It is therefore not surprising that, empirically, it is not clear whether diversification is positively or negatively related to firm value. Some studies document a "diversification discount" (Berger and Ofek, 1995; Comment and Jarrell, 1994; Liebeskind and Opler, 1993). Others argue that the "diversification discount" is not as severe as documented, because these earlier studies ignore the endogeneity issue in corporate diversification (Campa and Kedia, 2002; Marksimovic and Phillips, 2002; Villalonga, 2004). While the valuation effects of diversification have been extensively studied, differences between various diversification strategies have received much less attention. Particularly, an often overlooked diversification strategy is vertical integration, in which (part of) the supply chain is owned by a company and inter-divisional transactions are an integral part of the firm's operation. In this light, it is

important to note that that over 25% of all Compustat firms are multi-division firms and that a large number of them are substantially vertically integrated.

Theoretically, vertical integration can be motivated as it may reduce transaction costs, improve incentives, and limit the holdup problem between upstream and downstream firms along the supply chain, especially when it is difficult to contract (Williamson, 1975, 1985). Additionally, vertical integration may be a result of financial institution and credit market imperfections (Acemoglu, Johnson and Mitton, 2009; Kumar, Rajan and Zingales, 1999; Rajan and Zingales, 1998). Here, a lack of financial development limits the entries of potential entrepreneurs and the survivors in the market are mostly large firms, which are more likely to produce their own inputs and/or market their own outputs. This may also explain why capital-intensive industries tend to be more vertically integrated (Acemoglu, Johnson and Mitton, 2009). Although vertical integration has been studied theoretically, there is limited empirical work that directly examines its effects on valuation and performance. Somewhat related, there is a strand of literature that studies the effects of related diversification on firm profitability and value (Amit and Livnat, 1988; Montegomery, 1982; Palepu, 1985; Rumelt, 1974; Rumelt 1982). These studies adopt measures of relatedness calculated based on proportional sales of the different SIC industry groups within the firm (e.g., the Berry-Herfindahl index or the Jacquemin and Berry (1979) entropy measure). However, the type of relatedness captured by SIC classification is quite ambiguous. On one hand, segments belonging to the same SIC industry can share inputs and investment opportunities, which constitutes a lateral relation; on the other hand, they can also be vertically linked when they engage in internal transactions. Therefore, the relatedness measures employed in these studies cannot isolate the effects of vertical integration. And given the

prevalence of vertically integrated firms, this is an important omission in the extant diversification literature.

In this paper, I examine vertical integration in detail. Specifically, I construct a measure of vertical integration, and relate it to firm value to investigate the valuation effects of this diversification strategy. Furthermore, I also explore the channels through which vertical integration may affect firm value. Using Input-Output accounts of dollar flows between all industries in the U.S. economy (from the Bureau of Economic Analysis), I construct a vertical integration coefficient (*VIC*) to measure the level of vertical integration of a firm, and find that it is negatively related to firm value. Economically, when I bifurcate the multi-segment firms into vertically integrated and laterally integrated groups based on the sample median *VIC*, I find that, on average, vertically integrated firms experience a significant discount of approximately 1.56%, relative to laterally integrated firms and compared to firms located in the lowest *VIC* quartile, firms located in the highest *VIC* quartile exhibit a significant discount of approximately 3.34%. This finding is similar to those reported by Fan and Lang (2000), but their sample period ends in 1997 (based on the 1992 IO tables), whereas my sample period includes a much more recent sample period (1980-2007 using the IO tables from 1982 to 2007). More importantly, new to the literature, I also investigate the possible causes of this additional value discount associated with vertical integration. I argue that a unique feature of vertical integration is the high frequency of internal transactions. And several types of inefficiencies may arise when divisions engage in such transactions. First, internal transactions can occur at less favorable prices comparing to the market price, which leads to lower profitability. Moreover, cross-subsidization from the profitable divisions to the losing divisions are more likely when the divisions are operationally linked through internal transactions, which further reduces firm value. Consistent with these

arguments, I find that vertical integration is associated with lower gross profit margins and more cross-divisional subsidization.

This study contributes to the literature by filling the void of diversification strategy in the extant corporate diversification literature. Although, at least dating back to the work of Coase (1937), a sizable literature examines firm boundaries, diversification activities, and the valuation effects associated therewith, there is a paucity of research on the differences between various diversification strategies. The existing literature has provided some evidence on the effects of related vis-a-vis unrelated diversification, in which the degree of relatedness largely depends SIC industry classifications, and thus can broadly capture both lateral and vertical inter-divisional linkages. Yet, very little empirical research has isolated the effects of vertical integration from other diversification strategies, and no literature investigates the sources of the additional value discount associated with vertical integration. To the best of my knowledge, this paper is the first to do so. The only existing studies that focus on the effects of vertical integration are Fan and Lang (2000), and Kumar (2013). However, Kumar (2013) only examines the effects of vertical integration on division-level productivity; and neither paper investigates the cause of the valuation difference associated with vertical integration.

The paper is organized as follows. Section 3.2 reviews the related literature and develops the main research questions. Section 3.3 describes the sample and variable construction. Sections 3.4 and 3.5 present empirical evidence on the valuation effects of vertical integration, compared to lateral integration, and the sources of the valuation differences. Section 3.6 provides robustness tests. Section 3.7 concludes the study.

3.2 Related Literature and Theoretical Development

3.2.1 Diversification and Firm Value

Early literature examining firm diversification focuses on the potential benefits thereof. For example, Lewellen (1971) argues that due to the imperfect correlation between earnings streams, diversified firms have reduced default risk and greater debt capacity, which is value-creating due to the increase of interest tax shield. Additional tax advantages may stem from diversification as well. Majd and Myers (1987), for example, identify gains arising from tax loss carryback and carryforwards provisions. These tax benefits will accrue to a diversified firm as long as one or more segments of a conglomerate experiences losses in some years. Other potential benefits of diversification may also exist. Weston (1970) argues that diversified firms allocate resources more efficiently through a larger internal capital market. Built on this argument, Stulz (1990) contends that a larger internal capital market may reduce underinvestment and that therefore diversified firms make more positive NPV investments.

Perhaps as a reaction to the increase in corporate refocusing, restructuring, and divestitures in the 1980s, more recent research focuses on the potential costs associated with diversification. For example, Harris, Kriebel and Raviv (1982) and Myerson (1982) point out that the information asymmetry between central and divisional managers may lead to inefficient resource allocation in diversified firms. Jensen (1986) argues that when lines of business have access to excess free cash flow and borrowing power, value-destroying investments may be undertaken. Stulz (1990) raises a similar argument in that overinvestment in segments with poor investment opportunities may occur in diversified firms. Finally, Meyer, Milgrom and Roberts

(1992) argue that due to cross-subsidization, unprofitable segments may create greater value losses for diversified firms as compared to these same firms if they were stand-alone firms. A number of studies also provide empirical evidence of the value-destroying effects of diversification (i.e., the diversification discount). Comment and Jarrell (1995) and Liebeskind and Opler (1992) document that there are positive abnormal returns when firms increase focus. Berger and Ofek (1995) and Lang and Stulz (1994) also document a negative relation between several firm-value measures and diversification. More recently, Singhal and Zhu (2013) argue that, although the likelihood of bankruptcy decreases with diversification, diversified firms still bear higher bankruptcy costs, as measured by the time spent in Chapter 11 bankruptcy and inefficient segment investments. They conclude that diversification provides benefits to managers' job security, rather than to the firm.

The most recent literature focuses on methodological issues and contends that there may not be a diversification discount. For example, Marksimovic and Phillips (2002) develop a profit-maximizing neoclassic model of optimal firm size and growth, and show that compared to stand-alone firms, multi-segment firms do not exhibit lower resource allocation efficiency but face different growth opportunities. They also argue that the "diversification discount" is in fact consistent with profit maximization. Campa and Kedia (2002) argue that the documented discount of diversified firms is not *per se* evidence that diversification destroys value, but that firms choose to diversify. They find a strong negative correlation between a firm's choice to diversify and firm value and the diversification discount always decreases, and sometimes turns into a premium after using fixed effects, instrumental variables, and a Heckman selection model to control for endogeneity and self-selection. Similarly, Villalonga (2004) argues that, overall, diversification is not value-destroying after controlling for self-selection. Graham, Lemmon and

Wolf (2002) study the value effect of diversification in a merger and acquisition setting, and argue that the reduction in excess value of the acquiring firm occurs because firms acquire already discounted business units, not because diversification is value-destroying.

3.2.2 Related vs. Unrelated Diversification

Most of the literature discussed in the previous section investigates value effects associated with diversification. However, existing literature does not differentiate different diversification strategies. The effects of related versus unrelated diversification are much more extensively discussed in the organizational science and management literature. Most studies tend to measure the degree of business relatedness by "the fraction of a firm's revenues attributable to its largest group of *somehow* related business" (Rumelt, 1982). Some argue that related diversification is preferential when compared to unrelated diversification. For example, Rumelt (1974, 1982) argues that related diversification has more positive valuation effects than unrelated diversification because common skills and resources may create value in related markets. Montgomery (1982), using different measures of relatedness, also finds that unrelated diversification is less successful than related diversification. Moreover, using the Jacquemin-Berry entropy measure of diversification and line-of-business data, Palepu (1985) finds that firms with predominantly related diversification show significantly higher profit growth than firms with predominantly unrelated diversification. Amit and Livnat (1988) study the different risk-return characteristics associated with related and unrelated diversification strategies and find that related diversification characterizes high risk - high return firms, whereas unrelated diversification characterizes low risk - low return firms. In addition, Nayyar (1993) points out that the effects of reputation and economies of scope also lead to better performance of related diversification.

A central discussion in this literature is how to properly measure business relatedness. The most dominant diversification measure is the Jacquemin and Berry (1979) entropy measure.

Used in a large number of studies, this measure comprises of a related diversification component and an unrelated diversification component. The related diversification within an industry is calculated as the weighted sum of the shares of each segment within that industry. And industries are usually defined by SIC codes. For example, it may measure the extent of diversification into four-digit SIC industries for a given two-digit SIC industry. While this measure captures the "similarities" or "relatedness" between business segments *per se*, it does not necessarily capture inter-divisional vertical links. Segments located in the same two-digit SIC industries may relate to each other in that they share common resources or skills. Alternatively, business segments can be interdependent through a supplier-customer relationship. In other words, a diversified firm can be integrated through internal transactions along the supply chain that is owned internally, which is not captured by the entropy measure. Other measures of business relatedness include the cross-correlation between capital expenditure or cash flows of business segments (Ferris, Kim and Kisabunnarat, 2003). Although these measures, to some level, capture the degree of co-movement of divisions, the effects of supply chain relations within the firm is not directly incorporated.

A more appropriate to measure vertical integration is to use the industry Input-Output data provided by the Bureau of Economic Analysis (BEA). This data provides trade flows between approximately 500 industries, accounting for all sectors in the economy. Fan and Lang (2000) use this data and develop a measure of diversification that can capture the extent of vertical integration within a firm. In testing their measure, the authors provide evidence that vertical integration is not always value-enhancing. However, they provide no explanation of their findings. Using the same measure, Kumar (2013) investigates the costs associated with vertical integration. He shows that when segments are vertically related, core business may shift

productivity gains toward itself from other segments, either through its disproportionate influence on decision making at the headquarters level or by using direct influence on other segments. Such a mechanism could lead to various inefficiencies. Kumar (2013) uses business segments as the unit of observation in his study and does not explore the link between vertical integration and firm value directly. The use of industry Input-Output data is not limited to these studies. In the merger literature, Fan and Goyal (2006) find that vertical mergers generate positive wealth effects that are significantly larger than those of diversified mergers. Using the same data, Ahern and Harford (2014) find that stronger product market connections lead to a greater incidence of cross-industry mergers.

3.2.3 Vertical Integration and Firm Value

Although the research described in the previous sections discusses the effects of diversification and business relatedness on firm value, it does not investigate the valuation effects of vertical integration vis-à-vis lateral integration. The main difference between these two strategies is whether the supply chain is internally integrated into the operations of the firm. Theoretically, there are two primary motives for vertical integration. First, Williamson (1975, 1985) develops a theory of Transaction Cost Economics (TCE). According to this theory, internal organization of firm activities improves incentives and limits agency costs. As such, vertical integration is designed to reduce transaction costs and holdup problems between upstream and downstream firms, especially when it is hard to write long-term contracts. Second, vertical integration may be related to financial institution and credit market imperfections. This occurs when the lack of financial development limits entries of potential entrepreneurs. In this case survivors in the market are mostly large firms, which are more likely to produce their own inputs or market their own outputs (Acemoglu, Johnson, and Mitton, 2009; Kumar, Rajan and Zingales, 1999; Rajan and Zingales, 1998). Incorporating both lines of reasoning, Acemoglu, Johnson, and Mitton (2009) show that vertical integration is more prevalent in countries with greater contracting costs and in more capital-intensive industries.

In addion to potential benefits of vertical integration, there may be costs associated with vertical integration. First, as discussed by Kumar (2013), in diversified firms, supporting segments may be forced to compromise their productivity for the benefits of the core business. And this problem is more severe in vertically integrated firms as the core business in such firms can exert greater influence on other segments through internal transactions. Second, when

segments are ordered to purchase from or to sell to other segments within the same firm, internal transactions may not occur at the optimal price. Specifically, a segment may be able to supply its products at a higher price in the market than the price at which it supplies to other divisions in the same firm. Alternatively, a segment may be able to purchase its inputs at a lower cost from a market cost leader than the cost it incurs in an internal transaction. In either case, internal transactions result in lower overall profit margins. Third, because of the lower profit margin resulted from internal transactions, a vertically integrated firm is more likely to have segment(s) experiencing losses. Therefore it is more likely that there is a need for cross-subsidization.

Hence, there are possible costs and benefits associated with vertical integration and the valuation effects are not a priori clear. In this paper I investigate whether the positive or the negative effects dominate, and I explore what mechanisms may drive these valuation effects.

3.3 SAMPLE AND VARIABLE CONSTRUCTION

3.3.1 Data and Sample

To construct my sample, I start with all firms listed on the Compustat industry segment files between 1980 and 2007.[2] As explained later, I construct a firm-level vertical integration coefficient (*VIC*), using the segment information and the detailed Use Tables of Benchmark Input-Output Account, provided by the Bureau of Economic Analysis (BEA) from 1982 to 2007. I merge *VIC* with Compustat firm-level financial data and delete observations with missing or negative total assets, book equity, and/or total sales. I also exclude financial firms (SIC codes 6000 to 6999) and utility firms (SIC codes 4900 to 4999). This procedure results in a sample of 39,865 multi-division firm-years, 105,143 single-division firm-years, and a total of 145,008 firm-year observations between 1980 and 2007.

[2] FASB 131 in 1997 changed the focus of segment reporting from industries to internal reporting lines. The main results do not change when I run our tests using the data for the 1980 to 1997 period.

3.3.2 Variable Construction

3.3.2.1 Vertical Integration Coefficient (VIC)

I measure the degree of vertical integration using the Benchmark Input-Output tables between all producers and purchasers published by The BEA. The BEA has published the IO tables since 1947, primarily based on Economic Census data, and they capture the commodity flows between industries in the U.S. economy. The IO tables are published every five years with a five-year delay and the latest IO tables available are for year 2007 (i.e., the IO Tables for year 2012 will be available in 2017). Industries are defined both at the summary level and the detailed level. At each level, the IO tables include Make Table, Use Table, Direct Requirement Table, and Total Requirement Table. I use the detailed Use Table for years 1982, 1987, 1992, 1997, 2002, and 2007 as the input for measuring the level of vertical integration. The number of industries covered in these reports ranges from 411 to 478. For each industry pair *i* and *j*, the Use Tables report the dollar value of *i*'s output required to produce *j*'s total output, at the producer's price. The Use Table defines industries by SIC code before 1997 and by NAICS code since 1997. SIC codes range from 2-digit to 4-digit, whereas NACIS codes range from 2-digit to 6-digit.

To construct *VIC*, I first divide the segment data into six time periods, 1980-1982, 1983-1987, 1988-1992, 1993-1997, 1998-2002, and 2003-2007, and apply the six Use Tables to each time period, accordingly. Specifically, for each division within a multi-division firm, I create a pair with each of the other divisions in the same firm. For example, within a firm, *A*, with three divisions, *x*, *y*, and *z*, there will be six division pairs, *xy*, *xz*, *yx*, *yz*, *zx*, and *zy*. Then I match the

Use Table data to each division pair by the divisions' industry codes. This procedure allows me to obtain the dollar value of commodities transferred between each division-pair's industries. To illustrate, suppose that a_{xy} denotes the dollar value of division *y*'s industry's output purchased by division *x*'s industry to produce its total output. I divide a_{xy} by the dollar value of division *x*'s industry's total output to get v_{xy}. v_{xy} is the dollar value of division *y*'s industry's output required to produce one dollar's worth of output in division *x*'s industry. I also calculate v_{xz}, v_{yx}, v_{yz}, v_{zx}, and v_{zy} following the same procedure. Then I take the weighted average of v_{xy} and v_{xz} to obtain V_x, with the weights being the sales of division *y* and division *z*. V_x represents the dollar value of output of the industries that all the other divisions in firm *A* belong to, required to produce one dollar's worth of output in division *x*'s industry. Similarly, I calculate V_y and V_z. And the vertical integration coefficient (*VIC*) of firm *A* is the maximum of V_x, V_y and V_z, $VIC_A = \max\{V_x, V_y, V_z\}$. To maximize and obtain the most accurate match between the segment file and the Use Tables, I start the matching with the divisions' primary NACIS or SIC codes first, and change to the divisions' secondary NACIS or SIC codes if no match can be found using the primary industry codes. Similarly, I first match using the narrowest industry codes (6-digit NAICS or 4-digit SIC codes) and gradually loosen this matching criterion to the broadest industry codes (2-digit NACIS or 2-digit SIC codes).

VIC describes the strongest customer-supplier relationship that exists between different divisions within the same firm. For single-division firms, *VIC* equals zero. There are several important issues to note with regards to *VIC*. First, *VIC* is usually between 0 and 1, however, a *VIC* greater than 1 may occur. For example, in industries with high-levels of inventory, where not all output of production is realized in sales, the dollar value of input purchased may be greater than the dollar value of sales realized, which results in *VIC* greater than 1. Second, to get

v_{xy}, I divide a_{xy} by the dollar value of total output of division *x*'s industry, and I calculate total output of division *x*'s industry by summing up this industry's sales to all the other industries in the economy recorded in the Use Table. But for industries that mostly produce consumer products or services, which are directly supplied to end consumers, this calculation may result in very low total output, for example, the retail or health care industries. Therefore, for such industries, the calculated *VIC* can be greater than 1. In my final sample, less than 1% of the observations have a *VIC* greater than 1. Nevertheless, I set *VIC* to 3 for values greater than 3, to avoid extreme outliers. Based on *VIC*, I classify multi-division firms in the sample into two groups. For each year, if a firm's *VIC* is above the median, the firm is classified as *Vertical Integration* for that year, *Lateral Integration* otherwise.

Table 3.1 presents the mean *VIC* of the full sample, and the mean and median of the multi-division sample, and the number of observations of each sample, over time. The highest mean *VIC* of the full sample and multi-division sample occurs in 1980, when the mean *VIC* of the full sample is 0.1003 and the mean *VIC* of the multi-division sample is 0.3652. The lowest mean *VIC* of the full sample and multi-division sample are 0.0110 and 0.0437, respectively, observed in year 2003. The median *VIC* of the multi-division sample shows a different distribution. For this subsample, the highest median *VIC* is 0.0474, which occurs in year 1994, whereas the lowest median *VIC* is 0.0061, which occurs in year 1987.

3.3.2.2 Firm Value

I employ two measures of firm value in this study. Following, Lang and Stulz (1994), I construct the first measure, labeled *Tobin's q*. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks, divided by the book value of total assets. Following Berger and Ofek (1995) and Campa and Kedia (2002) I also construct a measure based on the percentage difference between a firm's total value and the sum of imputed values for its divisions as stand-alone units. To calculate a division's imputed value, I multiply the division's sales by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in the particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of the market value of common equity, long-term and short-term debt, and preferred stocks. A multi-division firm's imputed value is the sum of the imputed value of all divisions. The imputed value of a firm represents the value the firm would have if its divisions operated as stand-alone firms. Then, I calculate *ExValue_sale* as the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales.

3.3.2.3 Other Variables

Following Campa and Kedia (2002), I also include several variables in my regressions to control for firm size, profitability, investment, and leverage. *LogAT* is the logarithm of total assets and *LogAT1* and *LogAT2* are the values of *LogAT* with one-year and two-year lags, respectively. *EBIT/Sale*, *EBIT/Sale1*, and *EBIT/Sale2* are the ratio of earnings before interest and taxes divided by total sales, and its one-year, and two-year lags. *CAPX/Sale*, *CAPX/Sales1*, and *CAPX/Sales2* are the ratio of capital expenditure, divided by total sales, and its one-year, and two-year lags. *Leverage* is calculated as the ratio of long-term debt plus debt in current liabilities, divided by total assets.[3]

[3] I winsorize firm value and control variables at 1% and 99%.

3.3.3 Summary Statistics and Univariate Analysis

Table 3.2 presents the summary statistics of the main variables for the full sample, and subsamples of multi-division firms, single-division firms, *Vertical Integration* firms, and *Lateral Integration* firms. The mean and median of *VIC* are 0.0381 and 0.0000 for the full sample, and 0.1385 and 0.0222 for the multi-divisional sample. The *Vertical Integration* subsample has a mean *VIC* of 0.2738, with a median of 0.0992, whereas the *Lateral Integration* subsample has a mean *VIC* of 0.0084, with a median of 0.0039.

Consistent with the documented “diversification discount”, multi-division firms (Panel B) have lower values than single-division firms (Panel C), reflected in the mean and median of both valuation measures. Also evident from the table is that multi-division firms are larger in size and have higher leverage. For the single-division sample, the mean (median) of *LogAT* is 3.8939 (3.8147), and the mean (median) of *Leverage* is 0.2096 (0.1606), whereas for the multi-division sample, the mean (median) of *LogAT* is 5.7477 (5.7319), and the mean (median) of *Leverage* is 0.2575 (0.2421). The higher leverage of multi-division firms is the consistent with a coinsurance effect (Lewellen, 1971). Panel D and Panel E of Table 3.2 provide the summary statistics of the *Vertical Integration* and *Lateral Integration* samples. There is evidence that *Vertical Integration* firms have lower value, as reflected in *Tobin’s q* and *ExValue_sale*. For example, the mean *Tobin’s q* is 1.3633 for the *Vertical Integration* sample and 1.3985 for the *Lateral Integration* sample.

To further confirm the statistical significance of the valuation difference, in Table 3.3, I compare the two valuation measures between *Vertical Integration* and *Lateral Integration* using a univariate t-test. As shown in the table, the means of *Tobin’s Q* and *ExValue_sale* of *Vertical*

Integration are significantly lower than the means of the *Lateral Integration* sample firms. The differences in means for these two measures are significant at 5% level, or better. Overall, the analysis so far suggests that the costs of vertical integration outweigh the potential benefits and lead to an additional discount for vertically integrated firms.

3.3.4 Correlations

Table 3.4 presents the Pearson correlation matrix of the main variables. Not surprisingly, the two firm value measures are highly correlated. The main focus of this table is the correlations between *VIC* and the two firm value variables. *VIC* has a negative and significant correlation with *Tobin's q* and *ExValue_sale*. These correlations suggest that vertical integration appears to be value-destroying. In the next section, I investigate whether these results hold up in a regression framework.

3.4 DIVERSIFICATION STRATEGY AND FIRM VALUE

3.4.1 Diversification Discount

I begin the regression analysis by examining the "diversification discount" documented in the literature. Table 3.5 presents the estimation of the following model using the full sample:

$$Firm\ Value_{i,t} = \alpha Multi_{i,t} + \beta Firm\ Controls_{i,t} + \gamma Industry\ Fixed\ Effects + \eta Firm\ Fixed\ Effects + \theta Year\ Dummies \quad (1),$$

where *Multi* is a dummy variable that takes the value of 1 if a firm reports operations in multiple business segments, and zero otherwise. *Firm Value* is measured by *Tobin's q* and *ExValue_sale*, and *Firm Controls* is a vector of control variables described in Section 3.3.2.3. Following Campa and Kedia (2002), I include firm fixed effects and year dummies. I also control for industry fixed effects to account for unobservable industry variables that affect valuation. The estimation results in Table 3.5 columns *(1)* and *(2)* show that comparing to single-division firms, multi-division firms exhibit a discount of 6.97% (*Tobin's q*) to 21.86% (*ExValue_sale*). Therefore, there exists a diversification discount in my sample, consistent with the findings in the extant literature.

3.4.2 Vertical Integration and Firm Value

To investigate the impact of vertical integration on firm value, I first estimate the following model using the full sample:

$$\textit{Firm Value}_{i,t} = \alpha \textit{Vertical Integration}_{i,t} + \beta \textit{Firm Controls}_{i,t} + \gamma \textit{Industry Fixed Effects} + \eta \textit{Firm Fixed Effects} + \theta \textit{Year Dummies} \quad (2),$$

where *Vertical Integration* is proxied by *VIC*. The results using the full sample are shown in Panel A of Table 3.6. *VIC* is negatively and significantly related to *Tobin's q* and *ExValue_sale*. A 1% increase in *VIC* leads to a discount of approximately 0.07%.

To more directly compare *Vertical Integration* and *Lateral Integration*, I limit my analysis to the multi-division subsample. In Table 3.6 of Panel B, columns *(1)* and *(2)* present the estimates of model *(2)* using all multi-division firms. As shown in the table, *VIC* is negatively related to *Tobin's q* and *ExValue_sale*, although the coefficient on the *ExValue* variable is not significant at the 10% level. Economically, a 1% increase in *VIC* leads to a decrease in firm value of approximately 0.06% (*Tobin's q*).

In untabulated tests, I first measure vertical integration by the dummy variable, *Vertical*, which takes the value of 1 if a firm is classified as *Vertical Integration* as described in section 3.3.2.1, zero otherwise. *Vertical* is negatively and significantly related with *ExValue_sale*. The coefficient on this variable indicates that compared to *Lateral Integration*, *Vertical Integration* exhibits a discount of 1.56%. Furthermore, I limit my sample to only firms located in the top and bottom *VIC* quartiles. I define dummy variable *HighVertical*, which takes the value of 1 if a firm

locates in the top *VIC* quartile, zero otherwise. *HighVertical* is negatively and significantly related to *ExValue_sale*. On average, compared to firms located in the bottom *VIC* quartile, firms located in the top *VIC* quartile exhibit a discount of approximately 3.34%.

3.5 CAUSES OF THE VERTICAL INTEGRATION DISCOUNT

The above analyses suggest the existence of a diversification discount. Furthermore, comparing to *Lateral Integration*, *Vertical Integration* is associated with a further decrease in value. In this section, I investigate the sources of the additional discount associated with *Vertical Integration*.

3.5.1 Vertical Integration and Profit Margin

One potential reason why *Vertical Integration* imposes a bigger discount in firm value, relative to *Lateral Integration* is that vertically integrated firms may forego optimal market prices and instead, purchase input and sell output internally at a suboptimal price level. This argument is similar to the productivity argument raised in Kumar (2013). Kumar (2013) argues that when firms are vertically related, supporting divisions may be forced to comprise their productivity for the benefit of the core business. Similarly, when divisions are ordered to purchase from, or sell to other divisions within the same firm, a compromise has to be made in terms of price. Specifically, a division may be able to supply its products at a higher price in the market than the price at which it supplies to other divisions in the same firm. Alternatively, a division may be able to purchase its inputs at a lower cost from a market cost leader than the cost it incurs from an internal transaction. When internal transactions are carried out at a suboptimal prices, a firm's profit margin will decrease, which in turn will have a negative effect on firm value.

To test this hypothesis, I first establish the relation between gross profit margin and firm value. Panel A of Table 3.7 shows the estimates of regressions in which firm value is regressed on firm gross profit margin and other control variables. I calculate gross profit margin (*GrossMargin*) as sales minus cost of goods sold, divided by sales. After controlling for firm and industry fixed effects and including year dummies, I find that gross profit margin is positively and significantly related to both measures of firm value. A 1% increase in profit margin leads to an increase in firm value of approximately 0.02% (*Tobin's q*) to 0.03% (*ExValue_sale*). After establishing the positive relation between gross profit margin and firm value, I investigate

whether there is a relation between vertical integration and gross profit margin. Panel B of Table 3.7 shows the regression estimates. *VIC* is significantly and negatively related to gross profit margin. When the level of vertical integration increases by 1%, gross profit margin decreases by more than 0.08%. And, as gross profit margin is value-enhancing, the lower gross profit margin of vertically integrated firms leads to lower firm value.

3.5.2 Vertical Integration and Cross-subsidization

Higher cross-subsidization may also cause the discount associated with *Vertical Integration*. According to Meyer, Milgrom and Roberts (1992), an unprofitable segment can create a bigger loss in a diversified firm than it would as a stand-alone firm because a business line cannot have negative value as a stand-alone firm, but can have negative value if it is a part of a conglomerate. Jensen (1989, 1991, and 1993) also provides theoretical support for this cross-subsidization argument. According to Jensen, mechanisms that constrain cross-subsidization in LBO associations are one important source of their value gain. Cross-subsidization can be more severe in *Vertical Integration* than *Lateral Integration*. The reason is that because of the lower profit margin resulting from internal transactions, a vertically integrated firm is more likely to have division(s) experiencing losses. Therefore, it is more likely that there is a need for cross-subsidization. This problem can be mitigated in laterally integrated firms, where internal transactions are not common.

To investigate whether cross-subsidization imposes a more severe problem in *Vertical Integration* than in *Lateral Integration*, I adopt the approach used in Berger and Ofek (1995). Specifically, I investigate whether the presence of negative cash flows introduces a more negative effect on firm value under *Vertical Integration* than under *Lateral Integration*. If cross-subsidization is more severe in vertically integrated firms than in laterally integrated firms, having a negative cash flow division should lead to more negative impact on firm value for *Vertical Integration* relative to *Lateral Integration*. I proxy cash flows using operating income before depreciation (*OIBDPS*). Following Berger and Ofek (1995), I first construct a conditional excess value measure, *Conditional_ExValue_sale*. Different from *Exvalue_sale* used in previous

sections, for the conditional excess value measure, the imputed value of each segment is calculated separately for divisions with positive *OIBDPS* and divisions with negative *OIBDPS*. The imputed value of divisions with positive *OIBDPS* is calculated using the median capital-to-sales multiplier of single-division firms with positive *OIBDPS* in a given 3-digit SIC industry and the imputed value of divisions with negative *OIBDPS* is calculated using the median capital-to-sales multiplier of single-division firms with negative *OIBDPS* in a given 3-digit SIC industry. According to Berger and Ofek (1995), the reason why the conditional excess value measure is more appropriate for testing the effect of cross-subsidization is that, with the unconditional excess value measure, actual value is always expected to be less than the imputed value if a negative cash flow division exists, because market price is a function of discounted cash flows. However, the conditional excess value measure conditions on the sign of *OIBDPS* and reflects the effect of negative cash flows itself on firm value (Berger and Ofek, 1995).

To investigate whether *Vertical Integration* exhibits more cross-subsidization than *Lateral Integration*, I estimate the following model separately for the *Vertical Integration* subsample and the *Lateral Integration* subsample:

$$Conditional\_ExValue\_sale = \alpha Negative\ Cash\ Flow_{i,t} + \beta Firm\ Controls_{i,t} + \gamma Industry\ Fixed\ Effects + \eta Firm\ Fixed\ Effects + \theta Year\ Dummies \quad (3),$$

where *Negative Cash Flow* is proxied by *NumNegCF*, which is the number of negative cash flow divisions within a firm, and *NegCF*, which is a dummy variable that takes the value of 1 if a firm has at least one negative cash flow division, zero otherwise. Also, following Berger and Ofek (1995), I control for *LogAT* and *CAPX/Sale*.

Panel A of Table 3.8 shows the regression estimates. This test is run on the multi-division subsample and the availability of divisional cash flows has substantially reduced the sample size. The results show that, both measures of *Negative Cash Flow* have more negative effects on *Conditional_ExValue_sale* for the *Vertical Integration* subsample than for the *Lateral Integration* subsample. One more negative cash flow division leads to a 25.16% discount measured by *Conditional_ExValue_sale* under *Vertical Integration*, but only a 19.21% discount under *Lateral Integration*. Furthermore, having negative cash flow division(s) leads to a 42.50% discount under *Vertical Integration*, but only 37.72% discount under *Lateral integration*. To show the statistical power of the effect that the level of vertical integration has on cross-subsidization, I add an interaction term of *Negative Cash Flow* with *VIC* and run the regression on the multi-division subsample. The result is presented in Table 3.8 Panel B. Consistent with the results in Panel A, *NumNegCF* and *NegCF* are negatively and significantly related to *Conditional_ExValue_sale*. Furthermore, the interaction terms are also negative and significant, indicating that the negative impact on firm value of negative cash flow divisions is further enhanced by the level of vertical integration. Overall, the results support the argument that cross-subsidization imposes a more severe problem under *Vertical Integration* than under *Lateral Integration*, which leads to a bigger discount for vertically integrated firms.

3.6 ROBUSTNESS

So far the tests have used *VIC* to measure the level of vertical integration. Since *VIC* measures the strongest inter-divisional vertical relation in a firm, one can argue that this measure only captures two divisions in a firm and ignores the divisions that may exhibit weaker vertical links. To address this concern, I adopt an alternative measure of vertical integration, *wVIC*, which is the weighted average inter-divisional vertical relation between all divisions within the firm, using division sales as the weights. In general, *wVIC* has a lower value than *VIC*. The mean and median for the full sample are 0.0225 and 0.0000, whereas the multi-division subsample has a mean (median) *wVIC* of 0.0828 (0.0120). I regress *Tobin's q* on *wVIC* using model (*2*), for both the full sample and multi-division sample. Table 3.9 reports these regressions. The results continue to hold. For the full sample, a 1% increase in *wVIC* leads to a decrease in *Tobin's q* of approximately 0.1%. Similarly, for the multi-division sample, a 1% increase in *wVIC* leads to an approximately 0.07% decrease in *Tobin's q*. Overall, the discount associated with vertical integration reported above is robust to the alternative measure of vertical integration.

3.7 CONCLUSION

My study documents that vertical integration is negatively related to firm value. To be specific, using a vertical integration coefficient (*VIC*) constructed with Industry Benchmark Input-Output accounts of dollar flows between all industries in the U.S. economy provided by the Bureau of Economic Analysis (BEA), I find that compared to laterally integrated firms, vertical integration is associated with a significant discount of approximately 1.56%. Even more strikingly, compared to firms located in the lowest *VIC* quartile, firms located in the highest *VIC* quartile exhibit a significant larger discount of 3.34%. This vertical integration discount is robust to an alternative measure of *VIC*. I also find that there are two important sources of this additional discount: lower profit margins and more cross-subsidization.

Table 3.1 Vertical Integration by Year

This Table presents the mean and median of *VIC* for the full sample and multi-division sample by year. The full sample consists of 145,008 firm-year observations between 1980 and 2007 and the multi-division sample consists of 39,865 firm-year observations between 1980 and 2007. *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers.

Year	***N- Full Sample***	***Mean- Full Sample***	***N- Multi-division Sample***	***Mean- Multi-division Sample***	***Median Multi-division Sample***
1980	3,470	0.1003	953	0.3652	0.0267
1981	3,579	0.0927	923	0.3593	0.0261
1982	3,809	0.0778	922	0.3215	0.0253
1983	4,728	0.0188	1,540	0.0576	0.0079
1984	4,786	0.0172	1,460	0.0563	0.0073
1985	4,943	0.0179	1,374	0.0644	0.0071
1986	5,177	0.0157	1,311	0.0620	0.0063
1987	5,244	0.0151	1,257	0.0630	0.0061
1988	5,185	0.0397	1,329	0.1549	0.0202
1989	5,039	0.0372	1,248	0.1503	0.0191
1990	5,008	0.0365	1,231	0.1485	0.0208
1991	5,158	0.0365	1,221	0.1540	0.0184
1992	5,494	0.0341	1,245	0.1504	0.0182
1993	5,920	0.0331	1,268	0.1547	0.0451
1994	6,266	0.0337	1,276	0.1653	0.0474
1995	6,837	0.0298	1,299	0.1570	0.0437
1996	7,223	0.0284	1,304	0.1571	0.0433
1997	6,994	0.0307	1,332	0.1612	0.0459
1998	6,894	0.0491	2,342	0.1445	0.0307
1999	6,708	0.0616	2,740	0.1509	0.0309
2000	6,466	0.0667	2,670	0.1615	0.0338
2001	5,760	0.0653	2,464	0.1527	0.0353
2002	5,352	0.0682	2,315	0.1577	0.0320
2003	3,940	0.0110	991	0.0437	0.0159
2004	3,922	0.0111	982	0.0443	0.0168
2005	3,804	0.0112	968	0.0442	0.0168
2006	3,680	0.0124	963	0.0473	0.0168
2007	3,621	0.0118	937	0.0457	0.0168

Table 3.2 Summary Statistics

This Table presents summary statistics for the full sample, and the single-division, multi-division, *Vertical Integration*, and *Lateral Integration* subsamples, for the sample period of 1980-2007. *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total assets. *ExValue_sale* is the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all segments. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. *LogAT* is the logarithm of total assets. *EBIT/Sale* is the ratio of earnings before interest and taxes divided by total sales. *CAPX/Sale* is the ratio of capital expenditure divided by total sales. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets.

Panel A: Full Sample				
Variable	***N***	***Mean***	***Median***	***Std Dev***
VIC	145,008	0.0381	0.0000	0.2033
Tobinq	127,048	1.9162	1.1669	2.2646
ExValue_sale	122,503	0.0438	-0.0270	1.1673
LogAT	145,007	4.4035	4.2744	2.3511
EBIT/Sale	140,729	-0.5696	0.0526	3.0929
CAPX/Sale	138,708	0.1909	0.0449	0.5853
Leverage	144,525	0.2227	0.1904	0.2004
Panel B: Multi-division Sample				
Variable	***N***	***Mean***	***Median***	***Std Dev***
VIC	39,865	0.1385	0.0222	0.3694
Tobinq	36,852	1.3815	0.9816	1.4500
ExValue_sale	35,816	-0.2577	-0.2405	0.9869
LogAT	39,865	5.7477	5.7319	2.3209
EBIT/Sale	39,854	-0.0571	0.0647	1.0988
CAPX/Sale	39,261	0.0982	0.0436	0.2700
Leverage	39,730	0.2575	0.2421	0.1832
Panel C: Single-division Sample				
Variable	***N***	***Mean***	***Median***	***Std Dev***
VIC	105,143	0.0000	0.0000	0.0000
Tobinq	90,196	2.1346	1.2856	2.4900
ExValue_sale	86,687	0.1684	0.0000	1.2124
LogAT	105,142	3.8939	3.8147	2.1532
EBIT/Sale	100,875	-0.7721	0.0459	3.5670
CAPX/Sale	99,447	0.2274	0.0457	0.6666
Leverage	104,795	0.2096	0.1606	0.2051
Panel D: Vertical Integration Sample				

Variable	**N**	*Mean*	*Median*	*Std Dev*
VIC	19,211	0.2783	0.0992	0.4953
Tobinq	17,745	1.3633	0.9764	1.3983
ExValue_sale	17,184	-0.2755	-0.2480	0.9765
LogAT	19,211	6.0337	6.0487	2.3466
EBIT/Sale	19,205	-0.0483	0.0649	1.0744
CAPX/Sale	18,879	0.1001	0.0462	0.2664
Leverage	19,137	0.2605	0.2457	0.1812

Panel E: Lateral Integration Sample

Variable	*N*	*Mean*	*Median*	*Std Dev*
VIC	20,654	0.0084	0.0039	0.0105
Tobinq	19,107	1.3985	0.9866	1.4963
ExValue_sale	18,632	-0.2413	-0.2315	0.9961
LogAT	20,654	5.4817	5.4483	2.2645
EBIT/Sale	20,649	-0.0654	0.0645	1.1211
CAPX/Sale	20,382	0.0965	0.0413	0.2733
Leverage	20,593	0.2547	0.2387	0.1850

Table 3.3 Univariate Analysis

This table presents the univariate comparison in firm valuation between the *Vertical Integration* sample and the *Lateral Integration* sample, for the sample period of 1980-2007. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total asset. *ExValue_sale* is the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all divisions. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

	Vertical Integration	***Lateral Integration***	***Difference (Vertical - Lateral)***	***T-statistic***
Tobinq	1.3633	1.3985	-0.0352**	(-2.34)
ExValue_sale	-0.2755	-0.2413	-0.0343***	(-3.28)

Table 3.4 Correlation Matrix

This Table presents the Pearson Correlations between main variables. *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total assets. *ExValue_sale* is the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all divisions. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. *LogAT* is the logarithm of total assets. *EBIT/Sale* is the ratio of earnings before interest and taxes divided by total sales. *CAPX/Sale* is the ratio of capital expenditure divided by total sales. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

	VIC	*Tobinq*	*ExValue_sale*	*LogAT*	*EBIT/Sale*	*CAPX/Sale*	*Leverage*
VIC	1						
Tobinq	-0.0531***	1					
ExValue_sale	-0.0423***	0.5344***	1				
LogAT	0.1122***	-0.2377***	-0.1059***	1			
EBIT/Sale	0.0319***	-0.2800***	-0.4898***	0.1981***	1		
CAPX/Sale	-0.0299***	0.1555***	0.4089***	-0.0955***	-0.5609***	1	
Leverage	0.0435***	-0.2242***	-0.0684***	0.1919***	0.1097***	-0.0002	1

Table 3.5 Diversification Discount

This table presents the regression estimates of model (*1*) using the full sample. *Multi* is a dummy variable that takes the value of 1 if a firm reports operations in multiple business segments, and zero otherwise. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total assets. *ExValue_sale* is logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all divisions. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. *LogAT* is the logarithm of total assets, and *LogAT1* and *LogAT2* are the value of *LogAT* with one-year and two-year lags, respectively. *EBIT/Sale*, *EBIT/Sale1*, *EBIT/Sale2* are the ratio of earnings before interest and taxes divided by total sales, and its one-year and two-year lags. *CAPX/Sale*, *CAPX/Sales1*, *CAPX/Sales2* are the ratio of capital expenditure divided by total sales, and its one-year and two-year lags. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%.

	(1)	***(2)***
	Tobinq	***ExValue_sale***
Multi	-0.0697***	-0.2186***
	(-4.61)	(-29.92)
LogAT	0.2577***	0.4899***
	(20.57)	(80.86)
LogAT1	-0.4157***	-0.3558***
	(-26.00)	(-46.03)
LogAT2	-0.2195***	-0.1519***
	(-19.67)	(-28.20)
EBIT/Sale	-0.0373***	-0.1250***
	(-12.20)	(-84.85)
EBIT/Sale1	-0.0138***	-0.0240***
	(-3.98)	(-14.39)
EBIT/Sale2	-0.0287***	-0.0150***
	(-8.89)	(-9.67)
CAPX/Sale	0.0477***	0.2049***
	(3.17)	(28.28)
CAPX/Sale1	-0.0435***	0.0570***
	(-3.04)	(8.26)
CAPX/Sale2	0.0274**	0.0536***
	(2.03)	(8.26)
Leverage	-0.8091***	-0.0001
	(-22.86)	(-0.01)
Industry Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Year Dummy	Yes	Yes
N	106,225	105,217
R^2	0.5882	0.7223

Table 3.6 Vertical Integration and Firm Value

This table presents the regression estimates of model (*2*) using the full sample (Panel A), and the multi-division sample (Panel B). *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total asset. *ExValue_sale* is the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all divisions. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. *LogAT* is the logarithm of total assets, and *LogAT1* and *LogAT2* are the value of *LogAT* with one-year and two-year lags, respectively. *EBIT/Sale*, *EBIT/Sale1*, *EBIT/Sale2* are the ratio of earnings before interest and taxes divided by total sales, and its one-year and two-year lags. *CAPX/Sale*, *CAPX/Sales1*, *CAPX/Sales2* are the ratio of capital expenditure divided by total sales, and its one-year and two-year lags. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%.

Panel A: Full Sample

	(1)	***(2)***
	Tobinq	***ExValue_sale***
VIC	-0.0683***	-0.0700***
	(-3.03)	(-6.35)
LogAT	0.2547***	0.4798***
	(20.37)	(78.96)
LogAT1	-0.4165***	-0.3585***
	(-26.05)	(-46.16)
LogAT2	-0.2204***	-0.1555***
	(-19.76)	(-28.75)
EBIT/Sale	-0.0374***	-0.1254***
	(-12.25)	(-84.75)
EBIT/Sale1	-0.0137***	-0.0238***
	(-3.96)	(-14.15)
EBIT/Sale2	-0.0285***	-0.0144***
	(-8.83)	(-9.23)
CAPX/Sale	0.0485***	0.2079***
	(3.23)	(28.55)
CAPX/Sale1	-0.0426***	0.0601***
	(-2.97)	(8.66)
CAPX/Sale2	0.0287**	0.0581***
	(2.13)	(8.91)
Leverage	-0.8135***	-0.0148
	(-23.00)	(-0.86)
Industry fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes

Year dummies	Yes	Yes
N	106,225	105,217
R^2	0.5881	0.7197

Panel B:Mmulti-division Subsample

	(1)	***(2)***
	Tobinq	***ExValue_sale***
VIC	-0.0635***	-0.0141
	(-3.46)	(-1.15)
LogAT	0.2470***	0.4724***
	(13.00)	(37.51)
LogAT1	-0.3618***	-0.3782***
	(-15.23)	(-24.04)
LogAT2	-0.1146***	-0.0835***
	(-6.73)	(-7.41)
EBIT/Sale	-0.0840***	-0.1086***
	(-7.96)	(-15.70)
EBIT/Sale1	-0.0183*	-0.0329***
	(-1.80)	(-4.93)
EBIT/Sale2	0.0239***	0.0186***
	(2.75)	(3.23)
CAPX/Sale	0.0475	0.3267***
	(1.31)	(13.69)
CAPX/Sale1	-0.0706**	0.0751***
	(-2.14)	(3.44)
CAPX/Sale2	0.0857***	0.0841***
	(2.79)	(4.16)
Leverage	-0.6206***	0.2330***
	(-12.22)	(6.90)
Industry fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Year dummies	Yes	Yes
N	34462	33473
R^2	0.6578	0.7155

Table 3.7 Vertical Integration and Profit Margin

This table presents the results of the regression analysis of vertical integration and profit margin. In Panel A, firm value variables are regressed on *GrossMargin* and control variables. In Panel B, *GrossMargin* is regressed on *VIC* and control variables. *GrossMargin* is sales minus cost of goods sold divided by sales. *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total assets. *ExValue_sale* is the logarithm of the ratio of a firm's actual total capital to its imputed value calculated based on total sales. A multi-division firm's imputed value is the sum of the imputed value of all divisions. A division's imputed value is the division's sales multiplied by the 3-digit SIC industry median capital-to-sales multiplier. The median capital-to-sales multiplier is the median ratio of capital to sales of all single-division firms in that particular 3-digit SIC industry a division belongs to, where total capital is calculated as the sum of market value of common equity, long-term and short-term debt, and preferred stocks. *LogAT* is the logarithm of total assets, and *LogAT1* and *LogAT2* are the value of *LogAT* with one-year and two-year lags, respectively. *EBIT/Sale*, *EBIT/Sale1*, *EBIT/Sale2* are the ratio of earnings before interest and taxes divided by total sales, and its one-year and two-year lags. *CAPX/Sale*, *CAPX/Sales1*, *CAPX/Sales2* are the ratio of capital expenditure divided by total sales, and its one-year and two-year lags. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Panel A: Gross Margin and Firm Value		
	(1)	***(2)***
	Tobinq	***ExValue_sale***
GrossMargin	0.0157**	0.0308***
	(2.02)	(8.20)
LogAT	0.2540***	0.4787***
	(20.31)	(78.79)
LogAT1	-0.4162***	-0.3576***
	(-26.03)	(-46.05)
LogAT2	-0.2208***	-0.1559***
	(-19.79)	(-28.84)
EBIT/Sale	-0.0439***	-0.1382***
	(-9.90)	(-64.35)
EBIT/Sale1	-0.0139***	-0.0241***
	(-4.00)	(-14.35)
EBIT/Sale2	-0.0286***	-0.0146***
	(-8.85)	(-9.33)
CAPX/Sale	0.0487***	0.2081***
	(3.24)	(28.60)
CAPX/Sale1	-0.0420***	0.0612***
	(-2.93)	(8.82)
CAPX/Sale2	0.0291**	0.0587***
	(2.16)	(9.00)
Leverage	-0.8139***	-0.0151
	(-23.01)	(-0.88)
Industry fixed effects	Yes	Yes
Firm fixed dffects	Yes	Yes
Year dummies	Yes	Yes
N	106,225	105,217
R^2	0.5881	0.7198

Panel B: VIC and Gross Margin	
	GrossMargin
VIC	-0.0844***

	(-5.14)
LogSale	0.5328***
	(151.16)
Industry fixed effects	Yes
Firm fixed effects	Yes
Year dummies	Yes
N	140736
R^2	0.6505

Table 3.8 Vertical Integration and Cross-subsidization

This table presents the regression analysis of vertical integration and cross-subsidization. Panel A presents the regression estimates of model (*3*), using the *Vertical Integration* subsample and *Lateral Integration* subsample. Panel B presents the regression estimates with interaction terms using the multi-division subsample. The dependent variable *Condition_ExValue_sale* is calculated based on the imputed value of each division that is calculated separately for divisions with positive *OIBDPS* and divisions with negative *OIBDPS*. The imputed value of divisions with positive *OIBDPS* is calculated using the median capital-to-sales multiplier of single-division firms with positive *OIBDPS* in a given 3-digit SIC industry and the imputed value of divisions with negative OIBDPS is calculated using the median capital-to-sales multiplier of single-division firms with negative *OIBDPS* in a given 3-digit SIC industry. *NumNegCF* is the number of negative cash flow divisions within a firm, and *NegCF* is a dummy variable that takes the value of 1 if a firm has at least one negative cash flow division, zero otherwise. *LogAT* is the logarithm of total asset. *CAPX/Sale* is the ratio of capital expenditure divided by total sales. *NumNegCF*VIC* and *NegCF*VIC* are the interactions between *NumNegCF*, *NegCF* and *VIC*. *VIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *VIC* is set to 3 for values greater than 3, to avoid extreme outliers. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Panel A				
Dependent Variable: Conditional_ExValue_sale				
	Vertical		***Lateral***	
	(1)	***(2)***	***(3)***	***(4)***
NumNegCF	-0.2516***		-0.1921***	
	(-11.84)		(-7.67)	
NegCF		-0.4250***		-0.3772***
		(-11.54)		(-9.03)
LogAT	0.1182***	0.1172***	0.1227***	0.1224***
	(10.24)	(10.15)	(11.29)	(11.28)
CAPX/Sale	0.4793***	0.4818***	0.4755***	0.4783***
	(14.99)	(15.07)	(15.32)	(15.42)
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N	16,776	16,776	18,268	18,268
R^2	0.7425	0.7424	0.7396	0.7401

Panel B		
Dependent Variable: Conditional_ExValue_sale		
	(1)	***(2)***
NumNegCF	-0.1946***	
	(-11.31)	
*NumNegFC*VIC*	-0.1687***	
	(-4.23)	
NegCF		-0.3724***
		(-12.89)
*NegCF*VIC*		-0.2344***
		(-3.14)
LogAT	0.1100***	0.1095***
	(15.11)	(15.05)
CAPX/Sale	0.4881***	0.4889***
	(24.16)	(24.20)

Industry fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Year dummies	Yes	Yes
N	35044	35044
R^2	0.6947	0.6949

Table 3.9 Robustness

This table presents the regression estimates of model (*2*) using the full sample (Column 1), and the multi-division sample (Column 2). *wVIC* is calculated using BEA Benchmark Use Tables of years 1982, 1987, 1992, 1997, 2002 and 2007. *wVIC* is set to 3 for values greater than 3, to avoid extreme outliers. *Tobin's q* is calculated as the sum of the market value of common stocks and the book value of debt and preferred stocks divided by the book value of total assets. *LogAT* is the logarithm of total assets, and *LogAT1* and *LogAT2* are the value of *LogAT* with one-year and two-year lags, respectively. *EBIT/Sale*, *EBIT/Sale1*, *EBIT/Sale2* are the ratio of earnings before interest and taxes divided by total sales, and its one-year and two-year lags. *CAPX/Sale*, *CAPX/Sales1*, *CAPX/Sales2* are the ratio of capital expenditure divided by total sales, and its one-year and two-year lags. *Leverage* is calculated as the ratio of long-term debt plus debt in current liability divided by total assets. T-statistics are presented in parentheses. ***, **, and * denote significance level at 1%, 5% and 10%, respectively.

Dependent Variable: Tobin's Q		
	(1)	***(2)***
	Full Sample	***Multi-division Sample***
wVIC	-0.0966***	-0.0681**
	(-3.00)	(-2.56)
LogAT	0.2546***	0.2511***
	(20.34)	(13.34)
LogAT1	-0.4178***	-0.3613***
	(-26.11)	(-15.33)
LogAT2	-0.2194***	-0.1084***
	(-19.65)	(-6.42)
EBIT/Sale	-0.0360***	-0.0484***
	(-11.73)	(-4.11)
EBIT/Sale1	-0.0124***	-0.0091
	(-3.56)	(-0.87)
EBIT/Sale2	-0.0286***	0.0232***
	(-8.85)	(2.62)
CAPX/Sale	0.0502***	0.0465
	(3.32)	(1.23)
CAPX/Sale1	-0.0401***	-0.0627*
	(-2.78)	(-1.81)
CAPX/Sale2	0.0263*	0.0827***
	(1.94)	(2.67)
Leverage	-0.8096***	-0.6095***
	(-22.88)	(-12.16)
Industry fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Year dummies	Yes	Yes
N	105802	34039
R^2	0.5893	0.6640

Chapter 4: Conclusion

Corporate diversification has been a long-debated topic in the finance literature. Existing studies provide a large amount of theoretical arguments and empirical evidence on the benefits and costs of diversification. However, in this debate, the differences between diversification strategies have not received much attention. To fill this gap in the literature, my dissertation investigates the advantages and disadvantages of a particular diversification strategy: vertical integration. Chapters 2 and 3 focus on two of the most debated topics in the diversification literature, in the context of vertical integration: the efficiency of the internal capital market in capital allocation, and the valuation effects of corporate vertical integration.

In Chapter 2, I model the mechanism of how vertical integration helps align the objectives of corporate internal agents with the objective of the firm, and thus mitigates the capital misallocation problem caused by the various value-destroying behaviors of the self-interested agents. I also provide empirical evidence that higher level of vertical integration is associated with lower cash flow-investment sensitivity, and greater innovative efficiency. The evidence indicates a more efficient ICM created under vertical integration.

In Chapter 3, “Why Does Vertical Integration Destroy Firm Value?”, I continue to investigate the valuation effect of vertical integration. The literature identifies numerous factors that contribute to the “diversification discount”, such as inefficient ICM, cross-subsidization, and higher cost incurred in the bankruptcy procedure, etc. Since firm value is not influenced by a single factor, the more efficient ICM within vertically integrated firms may not warrantee a higher firm value. In this chapter, I first document a further discount associated with vertical integration, versus lateral integration, and then explore the sources of this discount. My empirical results show that vertically integrated firms are relatively lower valued firms. The difference in

firm value can be significant. For example, compared to firms located in the lowest *VIC* quartile, firms located in the highest *VIC* quartile exhibit a significant larger discount of approximately 3.34%. I also conduct tests to investigate the reasons of the discount. And I find that the two important sources of this additional discount associated with vertical integration are lower profit margins and more cross-subsidization.

Overall, my dissertation sheds light on both sides of corporate vertical integration. Despite that this diversification strategy facilitates efficient internal resource allocation, it is not always value-enhancing. Although not directly tested, the practical implication suggested in my dissertation is that firms should weigh the benefits and costs of vertical integration differently at various stages of their development. While the advantage of having an efficient internal capital is more important for firms which are conducting expansion, and face various investment opportunities associated with high levels of information asymmetry and uncertainty, the costs of low profit margin and cross-subsidization may prevail when firms enter a more mature stage. Therefore, it may be justified that mature firms divest losing divisions, to prevent a further discount in firm value.

References

Acemoglu, Daron., Simon Johnson and Todd Mitton, 2009, Determinants of vertical integration: financial development and contracting costs, *Journal of Finance*, 64, 1251-1290.

Ahern, Kenneth R., and Jarrad Harford, 2014, The importance of industry links in merger waves, *Journal of Finance,* 69, 527-576.

Alchian, Armen, 1969, "Corporate management and property rights", *Economic policy and the regulation of corporate securities,* Henry Manne, ed. (American Enterprise Institute, Washington, D.C.), 337-360.

Amit, Raphael and Joshua Livnat, 1988, Diversification and the risk-return trade-off, *The Academy of Management Journal*, 31, 154-166.

Berger, Philip G. and Eli Ofek, 1995, Diversification's effect on firm value, *Journal of Financial Economics*, 37, 39-65.

Campa, Jose M. and Simi Kedia, 2002, Explaining the diversification discount, *Journal of Finance*, 57, 1731-1762.

Chandler, Alfred D. Jr., 1977, *The visible hand* (Harvard University Press, Cambridge, Massachusetts).

Coase, Ronald H., 1937, The nature of the firm, *Economica*, 4, 386-405.

Cohen, Lauren, and Andrea Frazzini, 2008, Economic links and predictable returns, *Journal of Finance*, 63, 1977-2011.

Comment, Robert and Gregg A. Jarrell, 1995, Corporate focus and stock returns, *Journal of Financial Economics*, 37, 67-87.

Donaldson, Gordon, 1984, *Managing corporate wealth* (Praeger Publishers, New York).

Fan, Joseph P. H. and Vidhan K. Goyal, 2006, 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 measure of relatedness: An application to corporate diversification, *Journal of Business*, 73, 629-660.

Ferris, Stephen P., Kenneth A. Kim and Pattanaporn Kitsabunnarat, 2003, The costs (and benefits?) of diversified business groups: the case of Korean chaebols, *Journal of Banking and Finance*, 27, 251-273.

Galbraith, Jay R., and Daniel A. Nathanson, 1978, *Strategy implementation: structure systems and process* (West Publishing Co., St. Paul, MN).

Gertner, Robert H., David S. Scharfstein, and Jemery C. Stein, 1994, Internal versus external capital markets, *Quarterly Journal of Economics*, 109, 1211-1230.

Graham, John R., Michael L. Lemmon and Jack G. Wolf, 2002, Does corporate diversification destroy value?, *Journal of Finance*, 57, 695-720.

Griliches, Zvi, 1990, Patent statistics as economic indicators: A survey, *Journal of Economic Literature*, 28, 1661-1707.

Hall, Brownyn H., Adam B. Jaffe, and Manuel Trajtenberg, 2002, The NBER patent citations data file: Lessons, insights, and methodological tools (MIT Press, Massachusetts).

Harris, Milton, Charles H. Kriebel and Arthur Raviv, 1982, Asymmetric information, incentives and intrafirm resrouce allocation, *Management Science*, 28, 604-620.

Hill, Charles W. L., and Robert E. Hoskisson., 1987, Strategy and structure in the multiproduct firm, *Academy of Management Rview*, 12, 331-341.

Hovakimian, Gayane, 2011, Financial constraints and investment efficiency: Internal capital allocation across the business cycle, *Journal of Financial Intermediation*, 20, 264-283.

Hubbard, R. Glenn, and Darius Palia, 1999, A reexamination of the conglomerate merger wave in the 1960s: An internal capital markets view, *Journal of Finance*, 54, 1131-1152.

Jacquemin, Alexis P. and Charles H. Berry, 1979, Entropy measure of diversification and corpoarte growth, *Journal of Industrial Economics*, 27, 359-369.

Jensen, Michael C., 1986, Agency cost of free cash flow, *American Economic Review*, 76, 323-329.

Jensen, Michael C., 1989, Eclipse of the public corporation, *Harvard Business Review*, 67, 61-74.

Jensen, Michael C., 1991, Corporate control and politics of finance, *Journal of Applied Corporate Finance*, 4, 13-33.

Jensen, Michael C., 1993, The modern industrial revolution, exit, and the failure of internal control systems, *Journal of Finance*, 48, 831-880.

Khanna, Naveen, and Sheri Tice, 2001, The bright side of internal capital markets, *Journal of Finance*, 56, 1489-1528.

Kumar, K.rishna B. , Raghuram G. Rajan and Luigi Zingales, 1999, What determines firm size, Working Paper, National Bureau of Economic Research.

Kumar, M. V. Shyam, 2013, The Cost of related diversification: the impact of core business on the productivity of related segments, *Organizational Science*, 24, 1827-1846.

Lamont, Owen, 1997, Cash flow and investment: Evidence from the internal capital markets, *Journal of Finance*, 52, 83-109.

Lang, Larry H. P. and Rene M. Stulz, 1994, Tobin's q, Corporate diversification and firm performance, *Journal of Political Economy*, 102, 1248-1280.

Lewellen, Wilbur G., 1971, A pure financial rationale for the conglomerate merger, *Journal of Finance*, 26, 521-537.

Liebeskind, Julia andTim C. Opler, 1992, The causes of corporate refocusing, Working Paper, Southern Methodist University .

Majd, Saman and Stewart C. Myers, 1987, "Tax asymmetries and a crporate income tax reform" *Effects of taxation on capital accumulation*, M. Feldstein (University of Chicago Press, Chicago, Illinois).

Marksimovic, Vojislav and Gordon Phillips, 2002, Do conglomerate firms allocate resources inefficiently across Industries? Theory and Evidence, *Journal of Finance*, 57, 721-767.

Matsusaka, John G., and Vikram Nanda, 2002, Internal capital markets and corporate refocusing, *Journal of Financial Intermediation,* 11, 176-211.

Meyer, Margaret, Paul Milgrom, and John Roberts, 1992, Organizational prospects, influence costs and ownership changes, *Journal of Economics and Management Strategy*, 1, 9-35.

Montgomery, Cynthia A., 1982, The measurement of firm diversification: some new empirical evidence, *The Academy of Management Journal*, 25, 299-307.

Myerson, Roger B., 1982, Optimal coordination mechanisms in generalized principal-agent problems, *Journal of Mathematical Economics*, 10, 67-81.

Nayyar, Praveen R., 1993, Stock market reactions to related diversification moves by service firms seeking benefits from information asymmetry and economies of scope, *Strategic Management Journal*, 14, 469-591.

Palepu, Krishna, 1985. Diversification strategy, profit performance and entropy measure, *Strategic Management Journal* 6, 239-355.

Palia, Darius, 1999, Corporate governance and the diversification discount: evidence from panel data, Working paper, University of Chicago and Columbia University.

Peyer, Urs C, 2002, Internal and external capital markets, Working Paper, INSEAD - Finance.

Pfeffer, Jeffery, and Gerald R. Salancik, 1978, *The external control of organizations* (Harper & Row, New York).

Rajan, Raghuram, Henri Servaes, Henri and Luigi Zingales, Luigi, 2000, The cost of diversity: The diversification discount and inefficient investment, *Journal of Finance*, 55, 35-80.

Rumelt, Richard P., 1974, *Strategy, structure and economic performance* (Harvard Business Press, Cambridge, Massachusetts).

Rumelt, Richard P., 1982, Diversification strategy and profitability, *Strategic Management Journal*, 3, 359-369.

Scharfstein, David S., and Jeremy C. Stein, 1998, The dark side of internal capital markets II: Evidence from diversified conglomerates, Working Paper, MIT and NBER No. 6352.

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.

Scherer, Frederic M., 1981, *Industrial market structure and economic performance* (Rand McNally, Chicago).

Seru, Amit, 2014, Firm boundaries matter: evidece from conglomerates and R&D activities, *Journal of Financial Economics*, 111, 381-405.

Shin, Hyun-Han., and Rene M. Stulz, 1998, Are internal capital market efficient?, *Quarterly Journal of Economics*, 113, 531-552.

Singhal, Rajeev and Yun (Ellen) Zhu, 2013, Bankruptcy risk, costs and corporate diversification, *Journal of Banking and Finance*, 37, 1475-1489.

Stein, Jeremy C., 1997, Internal capital markets and the competition for corporate resources, *Journal of Finance,* 52, 111-133.

Stein, Jeremy C., 2003, "Agency, information and corporate investment", *Handbook of the economics of finance,* George Constantinides, Milton Harris, and Rene Stulz (Elsevier, Amsterdam), 111-165.

Stulz, Rene M., 1990, Management discretion and optimal financing policies, *Journal of Financial Economics*, 26, 3-27.

Teece, David J., 1980, Economies of scope and the scope of the enterprise, *Journal of Economic Behaviror and Organization,* 1, 223-247.

Teece, David J., 1982, Towards an economic theory of the multiproduct firm, *Journal of Economic Behaviror and Organization,* 3, 39-63.

Trajtenberg, Manuel, 1990, A penny for your quotes: Patent citations and the value of information, *Rand Journal of Economics,* 21, 172-187.

Villalonga, Belen, 2004, Does diversification cause "diversification discount"?, *Financial Management*, 33, 5-27.

Weston, J. Fred, 1970, The nature and significance of conglomerate firms, *St. John's Law Review,* 44, 66-80.

Williamson, Oliver E, 1970, *Corporate control and business behavior* (Prentice-Hall, New Jersey).

Williamson, Oliver E., 1975, *Markets and hierarchies: analysis and antitrust implications* (Collier and Macmillan Publishers, Inc., New York).

Williamson, Oliver E., 1985, *The economic institutions of capitalism* (Free Press, New York).

Williamson, Oliver E., 1986, *Economic organization: firms, markets and policy control* (New York University Press, New York).

Willig, Robert D., 1978, Technology and market structure, *American Economic Review,* 69, 346-351 .

Yan, An, 2006, Value of conglomerates and capital market conditions, *Financial Management*, 35, 5-30.

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