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Three Essays in Capital Investment and Governance

by

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ABSTRACT

This thesis presents three separate essays on capital investment and corporate governance. They include: (a) the consequences of acquiring overinvested firms during the post-bubble period in the US economy, (b) the appropriateness of corporate leadership structure in the US, and (c) the importance of financial and legal development for the return on R&D investment.

In the first essay, I examine whether there was any real economic gain from overinvestment following the US stock price bubble in the late 1990s. I find that several firms eventually acquired a number of overinvested firms at a relatively low price after the end of the speculative bubble. Furthermore, acquirers significantly improved their total factor productivity and operating performances during the post-acquisition period. I therefore suggest that overinvested assets of the late 1990s played a valuable role in corporate America even after the burst of the bubble in the stock market.

In the second essay, I investigate the question of whether splitting the roles of Chief Executive Officer and Chairman of the Board will improve a firm's overall performance and whether the board of directors usually makes the right decision about leadership structure. I find that both combined and separate leadership firms employed an appropriate leadership structure for their own circumstances in the recessionary period (i.e., 2005), but not so during the boom time (i.e., 2000). However, under different business conditions, either of the leadership structures can produce relatively higher firm value.

In the third essay, I identify the channel through which finance and law may matter for economic growth. Results show that the degree to which the financial market and legal environment of a country influence the growth in productivity depends on whether R&D activities are heavily concentrated on either the government or the business sector of that country. Further analyses reveal that the rate of return on government-initiated R&D remains insignificant even in the presence of a high-functioning financial market and a strong legal environment across emerging and developed countries. In contrast, an active financial market and strong rights of shareholders and creditors are crucial for increasing the return of business-sector R&D.

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CHAPTER 1

INTRODUCTION

In this thesis, I present three separate essays related to capital investment and corporate governance. In Chapter 2, I examine the underlying rationale of acquiring overinvested firms by several other US firms and the subsequent effects of acquiring such firms on future productivity and operating performances of acquirers during the post-bubble period in the US economy (i.e., 2000-2004). In Chapter 3, I investigate the question of whether splitting the roles of CEO (Chief Executive Officer) and COB (Chairman of the Board) will improve a firm's overall performance and whether its board of directors makes the right decision about leadership structure under different economic conditions. Furthermore, I examine whether a given leadership structure, combined or separate, works well for all types of firms in different business environments. Finally, in Chapter 4, I investigate whether the rate of return on R&D (Research and Development) investment is fundamentally related to financial and legal environments across emerging and developed countries. In particular, I determine how importantly and to what extent both stock and credit markets, as well as the legal rights of their respective stakeholders, might improve the effectiveness of R&D activities initiated by the government and business sectors in different countries.

The main research agenda in Chapter 2 is to examine whether there was any real economic gain from overinvestment following the stock price bubble in the late 1990s. My evidence shows that the speculative bubble in the US stock market during the period 1995-2000 encouraged managers of overvalued firms to overinvest in physical assets. As an example, the Joint Economic Committee of the US Congress reported in their study on July 2003 that the US telecommunication industry borrowed $800 billion and issued $450 billion worth of new bonds during the period 1996-1999. During the same time, the telecom industry invested in roughly 39 million miles of fiber-optic lines throughout the US. However, by the end of 2000, the whole industry lost a total $27.9 billion, and several telecom firms with a combined net worth of $230 billion declared bankruptcy. Such an incidence applied to several US industries. I in fact find that the tendency to overinvest in plants and machinery was very attractive across many US industries during the bubble-period. As a result, my evidence shows that several other US firms eventually acquired a number of these overinvested firms at a relatively low price after the end of the price bubble. I also find that these target firms had highly productive infrastructures already in place. As a result, acquiring firms significantly improved their total factor productivity and operating performances during the post-acquisition period. Evidence therefore suggests that overinvested assets of the late 1990s, which were highly productive and were eventually acquired by other firms, played a valuable role in the US economy even after the burst of the speculative bubble in the stock market.

While examining the appropriateness of corporate leadership structure across US firms under different economic and business conditions in Chapter 3, it has come to my attention that both media and lawmakers usually evaluate the importance of combined versus separate roles of CEO and COB differently. For instance, the business press claims that many of the problems in recent corporate scandals are partially attributable to corporate boards' rubber-stamping decisions made by individuals who assume the dual roles of CEO and COB under a combined leadership structure. As a corrective measure, regulators and shareholder activists advocate splitting the roles of CEO and COB in publicly-held corporations. There is also mixed evidence about the effectiveness of combined versus separate leadership on firm performance in extant literature (see Simpson and Gleason, 1999; Brickley, Coles and Jarrell, 1997; and Coles, McWilliams and Sen, 2001). However, the fact is that the combined leadership structure remains popular in corporate America. By using a two-stage regression approach that controls for a self-selection bias, I finally find that both combined and separate leadership firms employed an appropriate leadership structure for their own circumstances in the recessionary period (i.e., 2005), but not so during the boom time (i.e., 2000). The overall results, however, do not extend to all firms when I partition 2005 sample according to several firm-specific and industry-level attributes (such as, firm size, capital structure, market share, equity type and exchange listing). I find that either one of these two structures works well, depending on a firm's individual business conditions. These findings offer a plausible explanation for the prevalence of combined or separate leadership structure among subsets of firms in 2005. Just as importantly, they identify conditions that support the opposing views proposed by the agency and organization theorists about the effectiveness of combined leadership structure.

In Chapter 4, I determine a channel through which finance and law may matter for economic growth. Results show that the degree to which the financial market and legal environment of a country influence the growth in total factor productivity depends on whether R&D activities are heavily concentrated on either the government or the business sector of that country. For instance, while R&D projects were mainly initiated by the business sectors in developed economies, their education sectors earned higher return on R&D investment during the period 1998-2006. In contrast, R&D activities in emerging countries were primarily conducted by their government sectors during the same period; however, the business entities of these countries generated the highest return on R&D investment at that time. Further analyses reveal that the rate of return on government-initiated R&D remains insignificant even in the presence of a high-functioning financial market and a strong legal environment across emerging and developed countries. Nevertheless, an active stock market and strong rights of minority shareholders significantly increase the effectiveness of R&D by business entities in developed economies. Similarly, highly developed equity and credit markets, as well as strong legal rights to shareholders and creditors, are crucial for improving the return of business-sector R&D in emerging countries. I therefore conclude that financial and legal development may enhance the productivity growth of an economy by increasing the rate of return on R&D investment by the private sector.

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CHAPTER 2

OVERINVESTMENT IN THE LATE '90s: WAS IT A TOTAL LOSS FOR CORPORATE AMERICA?[1]

2.1 INTRODUCTION

Overvaluation of stocks allows managers of individual firms to increase investments in plants and machinery.[2] Furthermore, managers' willingness to cater to investor sentiment[3] and their interest in empire building[4] also encourage them to overinvest when stock prices begin to rise. Such incidents are eventually followed by mergers, acquisitions and takeovers.[5] We therefore often assume that firms' overinvestment following stock price bubble is bad.[6] The crucial questions are then: what are the underlying rationales that encourage acquiring firms to acquire overinvested firms? Furthermore, what is the post-merger effect of overinvested assets on future performance of acquiring firms? Up to this point, these questions have not been answered.[7] In this paper, we therefore investigate whether there is any real economic gain from overinvestment following stock

[1] This chapter is co-authored with Vikas Mehrotra, Associate Professor in Finance, Department of Finance and Management Science, School of Business, University of Alberta.

[2] See Baker, Stein and Wurgler (2003), Shleifer and Vishny (2003), Polk and Sapienza (2009) and Barro (1990).

[3] See Jensen (2005), Martin (2005) and Belson (2005).

[4] The tendency to empire building is emphasized by Jensen (1993, 1986) and Donaldson (1984), among many others.

[5] See Dong, Hirshleifer, Richardson and Teoh (2006) and Rhodes-Kropf, Robinson and Viswanathan (2004).

[6] See Jensen (1986), Kaplan (1989) and Smith (1990).

[7] Healy, Palepu and Ruback (1992) and McGuikin and Nguyen (1995) also examine the post-merger changes in operating performances of acquiring firms. However, their analyses are not restricted to overinvested target firms and are also not based on the recessionary period after the burst of the speculative bubble in the US stock market.

price bubble in subsequent years. In particular, we examine how overinvested assets of the late ′90s, which were eventually acquired by other firms, influenced total factor productivity and operating performances of their acquiring firms during the critical years in the US economy (i.e., 2000-2004).

Our evidence suggests that a remarkable increase in US stock prices during the second half of the 1990s was followed by a tremendous growth in physical investments across all technical and non-technical US industries.[8] In the middle of 2000, when the speculative bubble in the US equity market finally burst, the number of bankruptcy filings by publicly traded companies began to rise.[9] As a result, several other US firms eventually acquired the existing infrastructures of these firms at varying price-to-replacement-value ratios. Among all publicly traded firms in 1999, we find 898 firms that were in fact acquired by other US firms during the post-bubble period.[10] We categorize them as either overinvested or underinvested target firms by comparing their total capital expenditures (*CAPEX*) relative to sales (*SALES*) in 1999 with their respective industry-median ratio of *CAPEX* to *SALES* in 2001.[11] Among them, we find 484

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[8] Campello and Graham (2007) find that high-tech firms allocated their funds towards investment while other non-tech firms channeled the issuance proceeds towards both investment and cash savings in the late ′90s.

[9] According to the US Federal Deposit Insurance Corporation, bankruptcy filings increased by 46% in 2001 compared to the previous years. That accounted for roughly US$259 billion of assets into bankruptcy.

[10] In this sub-sample, both acquirers and target firms are non-financial and non-utility US firms.

[11] 2001 is the first complete year after the end of the speculative bubble in the late ′90s. Furthermore, according to our evidence (shown in Figure 2.2), 2001 is the year when both stock prices (measured by the market-to-book ratio) and physical investments (measured by the ratio of capital expenditure to sales) of publicly traded firms reached their mean-reverting levels (i.e., the averages of both variables are calculated over the period 1971-2004). We therefore consider 2001 a benchmark year to estimate the firm-level deviation in fixed investment in sample years. However, for a robustness check, we also consider three other criteria of overinvestment. We initially sort all firms into descending order based on three individual measures including (1) the ratio of *CAPEX* to sales, (2) the ratio of *CAPEX* to assets and (3) the ratio of *CAPEX* to plant,

(414) firms that were actually over (under)invested during the bubble period. 61% (39%) of these overinvested firms were also over (under)valued[12] in 1999.[13]

By using two distinct definitions of premium (discussed below), we estimate the price differences in acquiring over versus underinvested target firms. With respect to pre- and post-announcement day stock prices (e.g., -1, +1), we find that overinvested target firms were acquired at a premium of 15%, whereas underinvested target firms were purchased at a premium of 18%, on average, significant at the 1%. Furthermore, relative to the peak-bubble year-end stock prices[14], we find that overinvested target firms were finally sold at a higher discount than underinvested firms (26% versus 7%, on average, significant at the 1%). This evidence suggests that acquiring firms became able to acquire overinvested physical infrastructures of target firms at a relatively low price.

Finally, by using Solow residual as a proxy of total factor productivity (*TFP*)[15], we also find that overinvested target firms were highly productive relative to underinvested target firms during the late ′90s. Most notably, acquirers of overinvested firms were less productive relative to their target firms during the pre-bubble crash period. Further analysis reveals that acquirers that invested less

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property and equipment, in 1999. We then choose firms that belong to the top quintile (the highest 25^{th} percentile) as overinvested firms. We find qualitatively similar results.

[12] We identify overvalued firms if their market-to-book (*MB*) ratios in a given year are greater than their respective industry-median market-to-book in 2001. For a robustness check, we also consider the industry-median *MB* in 1999 as a benchmark. Results remain qualitatively similar.

[13] Stocks of overinvested firms were overvalued in different year(s) during the period 1995-1999. For instance, out of 30 individual sample industries, we find that a significant number of firms in one, seven, eighteen and four different industries were overvalued in 1995, 1996, 1997 and 1999, respectively.

[14] This is a stock price of a firm on the last trading day of the peak year of its respective industry.

[15] The same measure is also used in Faleye, Mehrotra and Morck (2006), Schoar (2002), Maksimovic and Phillips (2001) and Lichtenberg (1992). We also estimate the growth in total factor productivity (*TFPGR*) by using growth-accounting approach. Results remain qualitatively similar.

relative to their industry peers in the late ′90s in fact acquired highly productive but overinvested target firms. A significant difference in productivity between acquirers and overinvested target firms indeed attracted the former to acquire the latter during the post-bubble period. In comparing post-acquisition performances of acquirers of over and underinvested firms, we find that acquirers of overinvested firms significantly improved their operating margins and cash flows after acquiring overinvested firms. Most importantly, their *TFP* increased significantly during the post-bubble period compared to acquirers of underinvested firms, which suggests that physical infrastructures of overinvested firms significantly improved the level of efficiency of their acquiring firms during the post-acquisition period.[16] This evidence leads us to conclude that overinvestment in productive real assets following the overvaluation of stocks during the late ′90s played a valuable role in the US economy even after the burst of the bubble.

We organize the rest of the paper as follows: We briefly review the relevant literature and develop our hypothesis in section 2.2. We explain the data in section 2.3, measurement of individual variables in section 2.4 and research methodology in section 2.5. We discuss our empirical findings in section 2.6 followed by several robustness checks in section 2.7. We finally conclude the paper in section 2.8.

[16] The finding remains robust after adjusting for self-selection bias.

2.2 LITERATURE REVIEW

In this section, we briefly discuss several relevant articles from extant literature that explain the stock market driven investment; the consequences of overinvestment on economic welfare; and the post-merger outcomes of acquiring firms. We finally construct our hypothesis following the key findings in these papers.

2.2.1 Overvaluation and Overinvestment

Overvaluation of stocks allows managers to raise adequate funds from equity markets at minimal cost (see Baker and Wurgler 2002; Chirinko and Schaller 2006). Because external markets are easily accessible, managers finally end up with excess investment (Jensen 2005). Furthermore, some managers might be interested in running large firms, as opposed to profitable ones, when they find abundant free cash in their hands (Jensen 1986). Baker, Stein and Wurgler (2003) find that after controlling for firm fundamentals, investment growth rates are much more sensitive to measures of mispricing for firms that are highly dependent on external equity financing. By using discretionary accruals as a measure of stock mispricing, Polk and Sapienza (2009) also find that overpriced firms tend to overinvest after controlling for investment opportunities and financial slack of individual firms. Likewise, Barro (1990) finds that lagged stock returns have significant predictive power in explaining the growth rate of real fixed investment after controlling for individual firm characteristics. In addition to these fundamental explanations of valuation and investment, Jensen (2005) argues that investment growth also correlates with investor sentiment. In particular, he suggests that managers may sometimes invest aggressively during the period of overvaluation of stocks to cater to shareholders' expectations about expanding their firms relative to others. Therefore, excessive investment by firms is most likely when stock prices begin to rise.

2.2.2 Speculative Bubble, Investment and Welfare

Speculative bubble and its impact on economic welfare has already been the subject of an important theoretical debate. For instance, Tirole (1985) argues that bubbles arise only in dynamically inefficient equilibria, when too much capital is being accumulated. Such over-accumulation of capital finally leads to economic welfare by increasing investment in physical assets. Some authors, however, point out that speculative bubbles have more nefarious effects in dynamic models with externalities (see Grossman and Yanagawa, 1993; King and Ferguson, 1993). In settings in which long-term growth is driven by investments in physical and human or knowledge capital, the existence of an unproductive asset can be harmful to growth. These authors, therefore, claim that as speculative bubbles attract savings away from more productive uses, they in fact lower growth and welfare. Finally, in a dynamic growth model, Olivier (2000) shows that speculative bubbles in equity markets can be growth-enhancing, because they raise the market value of firms and thus enhance entrepreneurship, innovations, investments and growth. Simultaneously, he suggests that such bubble of stock prices might reduce economic welfare if firms divert their increased wealth into unproductive uses. The above findings suggest that firms' physical investments only in productive assets during the period of speculative bubble in a stock market ought to be welfare-enhancing.

2.2.3 Merger and Acquisition

Several studies related to merger-and-acquisition explain the underlying reasons and subsequent impact of a merger on a firm's future performance. Among them, Mitchell and Lehn (1990) find that firms that make poor investment decisions are more likely to be taken over by others. Furthermore, Lang, Poulsen and Stulz (1995) find that asset sales are followed by poor firm level performance. Likewise, Jensen (1986) argues that some firms may become takeover targets because their managers inefficiently allocate abundant funds to unprofitable investments. While studying the post-acquisition outcome for acquiring firms, Healy, Palepu and Ruback (1992) find that merged firms experience significant improvements in asset productivity relative to their industries, leading to higher operating cash flow returns without reducing excess capital and R&D (research and development) investments. In a study about takeover as a discipline device, Servaes (1994) argues that new management does not normally reduce capital expenditure after a takeover. Likewise, McGuikin and Nguyen (1995) find that ownership change is generally associated with the transfer of plants with above average productivity. Therefore, transferred plants experience further improvement in productivity. More importantly, though these papers address post-acquisition consequences of acquiring firms, the underlying results are not limited to acquirers of overinvested firms. In contrast, we examine post-acquisition outcomes mainly for the latter group of firms.

In summary, the above studies suggest three crucial points: First, overinvestment is most likely during the period of overvaluation of stocks. Second, such investment in productive assets can be value-enhancing. Third, due to poor operating performances, overinvested firms are likely to be acquired by other firms. Therefore, we posit that acquirers of overinvested, but highly productive, target firms might be able to improve their own productivity during the post-acquisition period. By examining this hypothesis, particularly in the period of economic slowdown, we investigate whether overinvestment in productive assets during the late ′90s contributed to improving acquiring firms' performance in future years.

2.3 DATA AND SAMPLE PERIOD

Speculative bubble in the late ′90s is unique in that the rise in technology stocks fueled a run-up in equity prices in other non-tech sectors of the economy (see Brooks and Katsaris 2005; Caballero, Farhi and Hammour 2006). Therefore, the overvaluation in the late ′90s spread throughout the economy and thus an increase in real investment of fixed assets resulting from high valuation of stocks became endemic across all industries. To understand the extent to which overinvestment by firms reacts to overvaluation of their stocks across all industries during the period of stock price bubble, we therefore consider 1995-2004 as a perfect sample period. In our sample, we include all US firms listed in NYSE, AMEX and

NASDAQ during the period of 1995-2004, except firms in financial and utility industries. Following the 2-digit SIC, we categorize our sample firms into 30 different industries. We collect financial data and stock prices as well as year-end outstanding shares of sample firms from CRSP/COMPUSTAT merged database and CRSP daily/annual data series, respectively. We collect merger-related information, such as bidder and target firms' names, announcement dates and offering prices of acquisition, from individual volumes of Mergerstat Review. We restrict our sample to those firms that have complete data published in the above three sources. As a result, our total sample size varies from the lowest of 4,540 in 2004 to the highest of 6,251 in 1997.

2.4 MEASUREMENT OF VARIABLES

We consider the following two distinct criteria to identify overinvested firms in each sample year. First, we define a firm as an overinvested firm if its ratio of capital expenditure in plant, property and equipment (*CAPEX*) to sales (*SALES*) in a given year is greater than its respective industry-median ratio of *CAPEX* to *SALES* in 2001.[17] Second, we sort all sample firms of each year in descending order based on their capital expenditures in that year and select only those firms that belong to the top-quintile (the first 25th percentile) of capital expenditure as

[17] Using other benchmarks, such as *CAPEX*/*ASSET* or *CAPEX*/*PPE*, may result in sample selection bias in choosing over (under)invested sample firms. For instance, high *CAPEX* in 1999 increased industry-wide total assets in the following year (i.e., 2000). Furthermore, since total industry-level *CAPEX* in 2001 also declined in the US economy, it is obvious that total number of overinvested firms during the period 1995-1999 were much higher relative to the industry-median ratio of *CAPEX* to *ASSET* in 2001. This explanation also holds in the case of *CAPEX*/*PPE*. In contrast, both *CAPEX* and *SALES* simultaneously declined in 2001; therefore, it is difficult to predict total number of overinvested firms in the late ′90s relative to industry-median *CAPEX*/*SALES* in 2001 *ex-ante*. We therefore choose *CAPEX*/*SALES* as a benchmark to avoid any bias while selecting our sample of over (under)invested firms.

overinvested firms. In this case, *CAPEX* is weighted by three separate measures (one at a time) including the firm's sales, total assets, or fixed assets at the end of the previous year.[18]

We consider 2001 a benchmark year in relation to the first criterion for two important reasons. First, the boom-bust valuation cycle of the late ′90s in the US equity market continued from early 1996 to the middle of 2000, and therefore 2001 is the first complete year after the end of the speculative bubble of the late ′90s. Second, we find that both stock prices (measured by market-to-book ratio) and capital investment (measured by the ratio of *CAPEX* to *SALES*) of US firms reached their respective mean-reverting levels in 2001, as shown in Figure 2.[19,20] Similar to the definition of over (under)investment, we also define over (under)valued firms as firms whose market-to-book (*MB*) ratios in a given year are larger (smaller) than their respective industry-median *MB* in 2001.[21,22] In the end, since any benchmark is arbitrary, we chose several of them to determine the robustness of our results.

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[18] While it is easier to measure total gains to acquirers of overinvested firms, it is hard to accurately estimate total costs (both direct and indirect costs) of overinvestment because of overvaluation of stocks. It is therefore empirically difficult to calculate the net present value of overinvestment.

[19] Since NASDAQ was incorporated in 1971, we consider the 34-year time series data of all publicly traded firms in NYSE, AMEX and NASDAQ (starting from 1971 to 2004) to calculate the mean-reverting levels of *MB* and *CAPEX*/*SALES*. We find that the average *MB* and *CAPEX/SALES* are 1.50 and 0.044 in 2001, respectively.

[20] We also observe that both *MB* and *CAPEX*/*SALES* reached their respective mean-reverting levels in 1989. Using 1989 as a benchmark year to determine over (under)invested firms also provides us qualitatively similar findings.

[21] For a robustness check, we also define a firm as overvalued if its market value of stocks is greater than its book value in a given year. Our results are qualitatively similar.

[22] By definition, *MB* is the ratio of a firm's market value (measured by stock price times the year-end outstanding shares) to its book value (equal to total assets less total liabilities and preferred stocks plus deferred taxes and convertible debt), and the industry-median *MB* is estimated by calculating the median of *MB*s of all firms belonging to an industry.

We consider all sample firms of 1999 as possible candidates for merger and acquisition over the next five years (i.e., 2000-2004), because this is the last full year of the speculative bubble of the late ′90s. Among them, we find 898 firms that were acquired by other firms during the period 2000-2004. Out of 898 firms, we find 484 (54%) firms that overinvested during the bubble period, whereas the remaining 414 (46%) firms underinvested during the same period relative to their industry-median ratio of *CAPEX* to *SALES* in 2001.[23,24] In fact, we find that several of these acquired firms were purchased by either the same acquiring firms or other private firms. As a result, our actual sample of acquiring firms reduces to 445 firms. Among them, we find 242 (203) firms that acquired over (under)invested firms throughout the period 2000-2004.

We use two different measures[25] to calculate the premium paid to shareholders of target firms, which helps us to examine the difference in purchasing prices of overinvested and underinvested target firms. The first measure of premium is the change in stock prices between the day-before-announcement and the day-after-announcement of acquisition. Therefore, the premium is defined as follows

[23] Relative to the industry-median ratio of *CAPEX* to *SALES* in 2001, 56% (44%) of all sample firms in 1999 overinvested (underinvested).

[24] Based on the first and the fourth quintiles of *CAPEX*/*SALES* (*CAPEX*/*ASSET*) in 1999, the total number of over and underinvested target firms were 170 (177) and 184 (189), respectively. Our findings on the premium/discount paid to shareholders of these groups of over and underinvested target firms are qualitatively similar. We could not examine the change in productivity because of limited number of observations under each category.

[25] We also calculate premium/discount by taking the difference between (i) pre- and post-announcement date *Q*-ratios and (ii) acquirers' offering prices and market values of stocks of acquired firms on the day-before-announcement. As additional robustness checks, we also calculate premium/discount by comparing stock prices between (-5, +5), (-1, +5) and (-5, +1), where + (-) implies the stock price on a particular day after (before) the announcement of acquisition. Since the results are qualitatively similar, we do not report them in the table to conserve space.

$$P_A = log[P(+1)/P(-1)] \quad (1)$$

where $P(+1)$ and $P(-1)$ are the stock prices on the day-after and the day-before-announcement of acquisition, respectively. Our second measure of premium is the difference in stock prices between the day-after-announcement and the last trading day of the peak-bubble year. Therefore, the premium paid to shareholders of target firms is calculated as follows

$$P_P = log[P(+1)/P(peak)] \quad (2)$$

where $P(peak)$ is the stock price on the last trading day of a peak year in target firms' industry, and $P(+1)$ is the stock price on the day-after-announcement of merger. Since the total number of target firms in each industry differs significantly, we finally calculate the sample-size-weighted-average premiums for both over and underinvested target firms.

We estimate firm-level total factor productivity (*TFP*) for four different groups of firms including: (i) acquirers of overinvested firms, (ii) acquirers of underinvested firms, (iii) overinvested target firms and (iv) underinvested target firms. Following Lichtenberg (1992) and Lichtenberg and Siegel (1990), *TFP* is defined as output per unit of total input, where total input is an index of individual factors of production. Therefore,

$$\varepsilon_i = Y_i/f(L_i, K_i) \quad (3)$$

In equation (3), ε_i denotes *TFP* of firm *i*, Y_i is net sales of firm *i*, *f*(.) implies total input, L_i is the number of employees of firm *i*, and K_i is the net plant, property and equipment of firm *i*. Unlike Schoar (2002) and Lichtenberg (1992)[26], we do

[26] These papers are based on plant-level analyses. Lichtenberg (1992) also mentions that using plant-level total factor productivity as a left-hand side variable in a multivariate regression model

not include material inputs in the production function, since this information is not widely available at firm-level in COMPUSTAT. We can then rearrange (3) to look like a production function such as follows:

$$Y_i = \varepsilon_i \times f(L_i, K_i) \tag{4}$$

We assume that *f*(.) is a Cobb-Douglas function of *L* and *K*. We therefore re-write equation (4) as follows:

$$Y_i = \varepsilon_i \times L_i^{\alpha} K_i^{\beta} \tag{5}$$

From the logarithmic transformation of the above function, we get,

$$log(Y_i) = log\varepsilon_i + \alpha logL_i + \beta logK_i = \alpha logL_i + \beta logK_i + u_i \tag{6}$$

where $log\varepsilon_i = u_i$. Following Faleye, Mehrotra and Morck (2006), Lichtenberg and Siegel (1990) and Lichtenberg (1988, 1992), we finally consider the residual term from the OLS (ordinary least square) estimation of the above model (6) as a measure of firm-level *TFP*. In the estimated model (6), the coefficients, α and β, are marginal productivity of labor and marginal productivity of capital, respectively. We also impose the condition of constant returns to scale in production while estimating the residuals from the above model. We then calculate the median of residuals for individual groups of firms to assign their respective *TFP* in each year for the period 1995-2004. Since the estimated coefficients of labor and capital can vary by industry, this specification is regressed by taking industry dummies into account to absorb industry fixed effects in each year.

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might not be controlled adequately for other fundamentals due to a lack of several plant-specific accounting measures. Therefore, it may limit the sample size and perhaps results in sample bias in estimated results.

2.5 RESEARCH METHODOLOGY

We examine the differences in *TFP*s between acquirers of overinvested and underinvested firms with and without controlling for their firm-specific characteristics. In univariate analysis, we initially calculate the median level of *TFP* for each group of firms at each sample year. We then compare the cross-sectional and time-varying changes in productivity between them. Furthermore, we sort out four different types of acquisitions: (i) overinvested acquirers acquiring overinvested target firms, (ii) overinvested acquirers acquiring underinvested firms, (iii) underinvested acquirers acquiring overinvested firms and (iv) underinvested acquirers acquiring underinvested firms. We then estimate *TFP*s of corresponding target firms under each type of acquisition for the period 1995-1999.[27] This analysis allows us to determine which acquirers made an appropriate choice while acquiring either over or underinvested firms.

In the case of multivariate analysis, we initially estimate the following model using a panel data set for the period 2000-2004 to observe which type of acquirers gained the highest level of productivity after completing their acquisitions:

$$TFP_i = \alpha_0 + \alpha_1 TYPE_i + + \alpha_2 QL_i + \alpha_3 QK_i + \alpha_4 SIZE_i + \alpha_5 MKTSH_i + u_i \qquad (7)$$

In the above model, *TYPE* is a dummy variable that is equal to 1 if a firm acquired an overinvested firm and 0 if a firm acquired an underinvested firm during the period 2000-2004. To control for *TFP*, we consider labor quality (*QL*), defined as a firm's net sales at *t* divided by its total number of employees at *t-1*;

[27] Since all target firms were eventually acquired during the period 2000-2004, we consider pre-acquisition *TFP*s of these firms.

the quality of existing capital (*QK*), measured by dividing a firm's net sales at *t* by its net plant, property and equipment at *t-1*; the firm size (*SIZE*), calculated by taking a log value of a firm's total assets at the beginning of the year; and the firm's market share (*MKTSH*), defined as a ratio of a firm's sales to its industry's aggregate sales in the previous year. We also include both industry and year dummy variables to absorb both industry- and time-specific differences in *TFP*. In the estimated model (7), α_1 measures the differences in *TFP* between acquirers of over and underinvested target firms during the period 2000-2004. We expect that high quality of labor and capital will enhance a firm's productivity, and that large firms will remain highly productive. We also predict that firms with a high market share might be less productive. We estimate the result after clustering all observations by firm. To test the significance of each coefficient, we also calculate *t*-statistics by using heteroskedasticity-consistent-standard error.

We further extend this model by substituting *TYPE* in model (7) with two different dummy variables (one at a time). In that case, we consider either *TYPE1* or *TYPE2* instead of *TYPE* in the above model. We define *TYPE1* as a dummy variable that is equal to 1 if an overinvested target firm was acquired by an underinvested acquiring firm and 0 if an overinvested target firm was acquired by an overinvested acquiring firm in 2000-2004. Likewise, *TYPE2* is another dummy variable that is equal to 1 (0) when an underinvested acquiring firm acquired an over (under) invested target firm during the post-bubble period. The estimated coefficient of *TYPE1* measures the difference in productivity between over and underinvested acquirers, which resulted from acquiring overinvested target firms, while the coefficient of *TYPE2* determines whether acquiring overinvested instead of underinvested firms resulted in higher productivity for underinvested acquiring firms.

Since the type of acquisition (*TYPE*) is not randomly assigned between two groups of acquirers in the above model (7), the estimated coefficient of *TYPE* might be biased due to an identification problem. Following Heckman (1979), we therefore estimate a two-stage regression model to control for sample-selection bias.[28] We set the first-stage regression model as follows:

$$TYPE_i = \beta_0 + \beta_1 OCF_i + \beta_2 MB_i + \beta_3 LEV_i + \beta_4 SIZE_i + \beta_5 INVDEV_i + e_i \qquad (8\text{-}1)$$

where *TYPE* is equal to 1 (0) if an acquiring firm acquired an over (under)invested firm during the period 2000-2004. Each of the explanatory variables in the model reflects the financial performance of acquiring firms in 1998-1999. Among them, *OCF* is a ratio of operating cash flows (measured by operating income before depreciation less interest expense, taxes and dividend on common stocks) to total assets; *MB* is a ratio of market value (calculated by multiplying year-end stock price by year-end outstanding shares) to book value of equity (equal to total assets less total liabilities and preferred stocks plus deferred taxes and convertible debt); *LEV* is a ratio of total long-term debt to book-value of equity; *SIZE* is the logarithm of total assets, and *INVDEV* is the difference between an acquirer's investment (*CAPEX*/*SALES*) and its respective industry-median *CAPEX*/*SALES*. We estimate (8-1) using the probit regression method and take the estimates into account to compute the Inverse Mill Ratio (λ). In the second-stage regression, we regress the level of productivity of acquiring firms in

[28]See Maddala (1983) for a detailed discussion of self-selection bias in a latent variable model.

2004 on λ and other determinants (using the sample data of 2003-2004) separately for acquirers of over and underinvested firms. Industry dummy variables are also included in the model to absorb industry-specific fixed effects. Therefore, the second-stage regression becomes:

$$TFP_i = \gamma_0 + \gamma_1 QL_i + \gamma_2 QK_i + \gamma_3 SIZE_i + \gamma_4 MKTSH_i + \gamma_5 \lambda_i + v_i \quad (8\text{-}2)$$

Following Chaney, Jeter and Shivakumar (2004), we then estimate the benefit (or cost) associated with an acquisition of either an over or underinvested firm for each acquiring firm as *TFP* observed for a firm minus the expected *TFP* that would have been observed had the alternative type of target firm been acquired. Formally, it is expressed by the following two equations:

$$Y_i^{OIA} - E(Y_i^{UIA} | TYPE_i = OIA) = Y_i^{OIA} - \beta_i^{UIA} . X_i^{OIA} - \beta_{i,\lambda}^{UIA} . \lambda_i^{OIA} \quad (9\text{-}1)$$

$$Y_i^{UIA} - E(Y_i^{OIA} | TYPE_i = UIA) = Y_i^{UIA} - \beta_i^{OIA} . X_i^{UIA} - \beta_{i,\lambda}^{OIA} . \lambda_i^{UIA} \quad (9\text{-}2)$$

Equations (9-1) and (9-2) are calculated separately for individual acquirers of either overinvested or underinvested target firms, respectively. Here, Y_i^{OIA} and Y_i^{UIA} imply observed *TFP*s of acquirers of overinvested (*OIA*) and underinvested (*UIA*) firms, respectively. *X*s are the explanatory variables that are obtained from sample acquirers of a particular type of target firms, and the βs are taken from the estimated model of acquirers of alternative target firms. For instance, in equation (9-1), the expected *TFP* of acquirers of overinvested firms is obtained by multiplying the actual values of explanatory variables by parameters β_{ji} and $\beta_{j\lambda}$, estimated from the regression (9-2) involving acquirers of underinvested firms (assigned by *j*). We finally take the average of estimates obtained from (9-1) and

(9-2) to calculate the difference in average benefit (or cost) associated with acquisition of over versus underinvested target firms, respectively.

2.6 EMPIRICAL FINDINGS

2.6.1 Overvaluation and Overinvestment

Table 2.1 reports the time-varying changes of market index returns, market-to-book ratios, IPO issuances and the percentage of overvalued as well as overinvested firms from 1995 to 2004. We find that the value-weighted average return of stocks traded in NYSE, AMEX and NASDAQ was 25%, on average, during the period 1995-1999 (the highest was 33% in 1995 followed by 28% in 1997 and 24% in 1999). It decreased to -1.0%, on average, in the period 2000-2004 (the lowest was -22% in 2002 followed by -12% in both 2000 and 2001). Likewise, the average market-to-book (*MB*) ratio of all stocks traded in NYSE, AMEX and NASDAQ was initially 2.002 during the period 1995-1999 (the highest was 2.216 in 1997 followed by 2.132 in 1996 and 1.892 in 1999). It finally declined to 1.675, on average, over the period 2000-2004 (the lowest level of *MB* was 1.280 in 2002 followed by 1.500 in 2000). Furthermore, a total of 2,439 (75%) firms across all industries issued new IPOs in the period 1995-1999 and the level of issuances declined to 798 (25%) over the period 2000-2004.[29] Therefore, we see a downward change in market returns, market valuation of stocks and IPO issuances after the end of stock price bubble in the middle of 2000.

[29] We collected data on IPO issuances from the website of Jay Ritter.

We also observe that a large fraction of overvalued firms invested extensively in physical assets, particularly in plants, property and equipment, during the period 1995-1999. In contrast, a smaller fraction of overvalued firms overinvested during the period 2000-2004. Based on the 2001 industry-median *MB* and *CAPEX*/*SALES* ratios as two separate benchmarks of firm valuation and fixed investment, respectively, we find that 60% of overvalued firms invested above the industry median in 1995-1999, which declined to 49% during the period 2000-2004, on average, significantly different at the 1% level.[30,31] Therefore, the speculative bubble in the late ′90s resulted in excessive investment by overvalued firms. Such evidence of overvaluation and overinvestment in the late ′90s is consistent with earlier findings that reveal a positive link between high market valuation of stocks and fixed investment of their respective firms (see Polk and Sapienza 2009; Jensen 2005; and Baker, Stein and Wurgler 2003).

[Insert Table 2.1 about Here]

2.6.2 Price Comparison between Overinvested and Underinvested Target Firms

Table 2.2 includes the total premium or discount earned by shareholders of both overinvested and underinvested target firms after the announcement of their

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[30] For a robustness check, we also compare firm-level investment (*CAPEX*/*SALES*) with industry-median investment (*CAPEX*/*SALES*) in an industry-year. It reveals that 61% of overvalued firms, on average, overinvested during the period 1995-1999, which declined to 49%, on average, during the period 2000-2004.

[31] Sector-wise analysis (not reported in the paper) also exhibits similar findings. As an example, the median *MB* in the telecommunication and broadcasting industry was 3.5 in 1999 and 1.1 in 2002. Furthermore, a total 180 (8) new IPOs were issued in 1995-1999 (2000-2004). Finally, the highest of 45% of overvalued firms in telecom industry invested above the industry-median level of *CAPEX*/*SALES* in 1999, which went down to the lowest of 12% in 2002.

acquisitions by other firms. First, we select over and underinvested target firms by comparing their investment in 1999 with the industry-median level of capital expenditure in 2001. We find that relative to the pre-announcement day stock price, shareholders of overinvested target firms earned a premium of 15%, on average. In contrast, shareholders of underinvested firms gained a premium of 18%, on average, which is significantly higher than the former at the 1% level.[32] Furthermore, relative to the peak year-end stock prices of sample firms in an industry, we find that overinvested target firms were acquired at a discount of 26%, on average, while underinvested target firms were acquired at a discount of 7%, on average, significant at the 1% level.

Second, we select over and underinvested target firms that belong to the first (the highest) and the last (the lowest) quintiles of capital expenditure in 1999, respectively. While using *CAPEX/SALES* ratio as a measure of investment, we find that shareholders of over and underinvested target firms earned a premium of 14% and 18%, respectively, relative to their pre-announcement-day stock prices, significantly different at the 10%. Likewise, compared to the peak year-end stock prices, we find that overinvested and underinvested target firms were sold at a discount of 36% versus 3%, respectively, which is significantly different at the 1% level. Furthermore, while using *CAPEX/ASSET* as a measure of firms' capital expenditures, we find that over (under)invested target firms were acquired at a premium of 23% (29%) relative to their pre-announcement day stock prices,

[32] For a robustness check, we also compare the offering price and the market value of target firms on the day-before-announcement of acquisition. We find that overinvested firms across all industries were sold at a premium of 19%, on average. In contrast, shareholders of underinvested target firms earned a premium of 26%, on average, significantly higher at the 1% level.

significant at the 1%. However, they were sold at a discount of 16% (versus 10% in the case of underinvested firms) compared to their peak year-end stock prices, significant at the 10%. Finally, while defining investment by *CAPEX*/*PPE* ratio, we find that over (under)invested firms were sold at a 25% premium (versus a 29% premium) relative to their pre-announcement day stock prices, and at a 20% discount (versus a 12% discount) with respect to their peak year-end stock prices. The numbers are significantly different at the 5% and 10%, respectively.

In summary, our findings reveal that overinvested firms of the late ′90s were acquired at a lower price compared to underinvested target firms. This evidence is in fact robust, using several arbitrary methods to define premium and over versus underinvested firms.

[Insert Table 2.2 about Here]

2.6.3 Time- and Cross-sectional Differences in Total Factor Productivity

Table 2.3 reports the estimated total factor productivity (*TFP*) of acquirers and target firms during the period 1995-2004. Without controlling for firm fundamentals, we find that acquiring firms significantly improved their productivity during the post-bubble period (i.e., 2002-2004). More precisely, *TFP* of acquiring firms that purchased overinvested target firms increased from 0.005, on average, during the period 1995-1999 to 0.043, on average, in 2002-2004, significantly different at the 1% level.[33] Similarly, *TFP* of acquiring firms that

[33] Because of the recession in the US economy, the 9/11 incident and several corporate scandals in both 2000 and 2001, we do not include these two years to avoid other economy- and industry-specific forces that may adversely affect firm-level productivity. However, all five years (i.e.,

owned underinvested target firms increased from 0.007, on average, during the period 1995-1999 to 0.024, on average, during the period 2002-2004, significant at the 1% level. However, the change in *TFP*s between pre- and post-acquisition periods is significantly higher in the case of the former than the latter (0.038 versus 0.017, which is significantly different at the 10% level). Interestingly, we find that acquirers of overinvested firms were insignificantly different in productivity from acquirers of underinvested firms before their acquisitions in the bubble period (0.005 versus 0.007, on average, in 1995-1999). However, the former group of firms became more productive than acquirers of underinvested firms after acquiring overinvested firms during the post-bubble period (0.043 versus 0.024, on average, in 2002-2004, significant at the 10%). Comparing productivity differences between over and underinvested target firms before their mergers, we also find that average *TFP* of overinvested target firms was significantly higher than that of underinvested target firms (0.109 versus -0.014 during the period 1995-1999, significant at the 1%).[34] Finally, the result reveals that acquirers of over (under)invested firms were in fact less (more) productive than their respective target firms during the pre-acquisition period (the mean differences in *TFP* of the former and the latter group of firms were -0.104 and 0.021 during the period 1995-1999, respectively, significant at the 1%).

2000-2004) are considered in the multivariate analysis by including year dummies in the model (discussed below) to absorb time-specific effects on firm-level productivity.

[34] We also investigate whether overinvested target firms are different from overinvested non-target firms (not reported in the table). We find that overinvested target firms were less productive than overinvested non-target firms (0.109 versus 0.126, significant at the 1%). Most importantly, overinvested target firms were financially much weaker than non-target firms (operating margins and cash flows with respect to total assets of target and non-target firms were -0.071 versus 0.029, significant at the 1%, and -0.025 versus 0.001, significant at the 10%, respectively). These differences in *TFP* and operating performances between target and non-target firms also explain why a specific group of overinvested firms was finally acquired by others.

[Insert Table 2.3 about Here]

As is evident in Table 2.4, overinvested target firms acquired by underinvested acquirers were the most productive firms during the period 1995-1999. Their average productivity was 0.017, on average. In contrast, the average *TFP* of the remaining overinvested target firms acquired by overinvested acquirers was 0.002, which is significantly lower than the former at the 10%. In addition, a number of other underinvested acquirers chose underinvested instead of overinvested target firms for acquisition during the post-bubble period. The evidence shows that these underinvested target firms were much less productive than overinvested target firms (average *TFP* of the former and the latter were 0.000 versus 0.017, significant at the 1%). Therefore, among all acquiring firms, acquirers that invested less during the bubble period, but finally acquired overinvested firms, indeed chose the highly productive target firms.

[Insert Table 2.4 about Here]

Table 2.5 includes the estimated results of *TFP* differences between acquirers of over and underinvested target firms during the post-bubble period (i.e., 2000-2004), after controlling for other firm-specific factors. We find, similarly, that acquirers of overinvested firms were 0.055 units more productive than acquirers of underinvested target firms during the period 2000-2004, significant at the 1%. After randomizing the acquisition type of acquirers in the second-stage regression model (reported in Table 2.6), we also find that acquirers of overinvested firms gained more in *TFP* by choosing overinvested target firms instead of underinvested target firms. More precisely, the average benefit (cost) underlying the acquisition of over and underinvested firms were 0.004 and -0.122, respectively, which is significantly different at the 1% level. Thus, the productivity of acquirers of overinvested firms was marginally higher by 0.004, on average, than their alternative choice of acquiring underinvested firms. In contrast, acquirers of underinvested firms achieved less in productivity, by 0.122, compared to their alternative choice of acquiring overinvested firms. In summary, our results exhibit that the productive assets of overinvested firms of the late ′90s played an important role in increasing overall *TFP* of their acquirers when the US economy was poor.

[Insert Table 2.5 and 2.6 about Here]

Table 2.7 reports further details in the change of *TFP*s of different acquirers following their acquisitions during the post-bubble period. Model (1) shows that compared to overinvested acquirers that acquired overinvested firms, the productivity of underinvested acquirers that also acquired overinvested firms was higher by 0.104 units during 2000-2004, significant at the 1%. In addition, model (2) compares the difference in *TFP*s between underinvested acquirers of over and underinvested firms. We find that underinvested acquirers that chose overinvested firms became 0.091 units more productive by acquiring overinvested instead of underinvested target firms during the post-bubble period, significant at the 1%. This evidence suggests that acquirers that were relatively less invested during 1995-1999 gained the highest in productivity by acquiring overinvested target firms. We also compare the difference in *TFP*s between overinvested acquirers of over and underinvested firms. We find that overinvested acquirers of overinvested firms were 0.065 units more productive than overinvested acquirers of underinvested firms during the period 2000-2004, significant at the 5% (result is not reported in the table). The latter findings also suggest that compared to underinvested target firms, overinvested target firms significantly contributed to improving overall productivity of their acquiring firms during the period of economic slowdown.

[Insert Table 2.7 about Here]

2.6.4 Post-Acquisition Operating Performance of Acquiring Firms

Table 2.8 reports accounting-based measures of operating performances of two distinct groups of acquiring firms (acquirers of over versus underinvested target firms) during the pre- and post-acquisition period (1999 versus 2004).[35] Without controlling for other firm-specific factors, we find that acquirers of overinvested firms were, on average, small in terms of their sale revenues ($5,138 million versus $7,325 million). However, they were more profitable (0.122 versus 0.054) and more efficient in managing their operating costs (0.559 versus 0.633) compared to acquirers of underinvested firms in 1999. Furthermore, the former had marginally lower cash flows (0.104 versus 0.107) and higher investment incentives (0.150 versus 0.095) than the latter in 1999.

We also find that the operating performances of acquirers of overinvested firms improved significantly in 2004. This finding is also supported by the fact that 67% of total acquisitions of overinvested firms took place within the relevant

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[35] Accounting-based measures of performance evaluation are used by Healy, Palepu and Ruback (1992), Heron and Lie (2002), among others.

industries.[36] In contrast, there were insignificant changes in performance in the case of acquirers of underinvested firms in 2004, while 65% of their acquisitions also happened within the same industry. More precisely, we find that acquirers of overinvested firms achieved almost 100% sales growth (from $5,138 million to $10,253 million), significant at the 1%; improved their profitability (from 0.122 to 0.205), significant at the 5%; decreased their operating costs (from 0.559 to 0.507), significant at the 10%; reduced their capital expenditures (from 0.150 to 0.096), significant at the 10% and improved their operating cash flows (from 0.104 to 0.131), significant at the 10% in 2004. Finally, the changes in operating performances of both groups of acquirers between pre- and post-merger periods are also significantly different up to the 10% level. As an example, while operating margins of acquirers of overinvested firms increased by 8.3%, on average, the profitability of acquirers of underinvested firms declined by 0.30%, on average, between pre- and post-acquisition periods, which is significantly lower than the former at the 5% level. In summary, our results suggest that acquiring overinvested firms, following the speculative bubble in the late ′90s, significantly contributed to improving operating performances of their acquiring firms during the period of economic slowdown.

[Insert Table 2.8 about Here]

[36] Healy, Palepu and Ruback (1992) argue that business-overlaps in merger and acquisition enhance operating performances of acquiring firms.

2.7 ROBUSTNESS CHECK

2.7.1 Growth in total factor productivity

In addition to examining the difference in total factor productivity (*TFP*) between acquirers of over and underinvested target firms during the post-acquisition period, we also estimate the difference in productivity growth (*TFPGR*) between these two groups of firms for the period 2000-2004. The measure of *TFPGR* is also built on the following neoclassical production function of labor (*L*) and capital (*K*)

$$Y_i = AL_i^{\alpha}K_i^{\beta} \tag{10}$$

where *A* is a parameter. To solve for *TFPGR*, the function is converted to a per capita production function by dividing both sides by labor (*L*). By taking the log transformation and the time derivative, *TFPGR* is finally expressed as follows

$$TFPGR = GR - \alpha.CAPGR \tag{11}$$

where *GR* equals the rate of real per capita GDP growth, and *CAPGR* equals the growth rate of per capita physical capital stock.[37] Following King and Levine (1994), Beck, Levine and Loayza (2000) and Durnev, Li, Morck and Yeung (2004), we consider that α = 0.3.[38] We then use *TFPGR* as a dependent variable instead of *TFP* in model (7) to observe the cross-sectional differences in productivity growth between acquirers of over and underinvested target firms during the post-bubble period. By using an unbalanced panel dataset of sample acquiring firms for 2000-2004 and assuming α = 0.3 (0.4), we find that acquirers

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[37] The detail derivation of equation (11) is shown in Appendix 2A. See Romer (2001) for further details about growth accounting approach to measure *TFPGR*.

[38] For further verification, we also consider α equals to 0.2 and 0.4. The results are qualitatively similar.

of overinvested firms experienced a growth in *TFP* that was 12.4% (14.3%) higher than that among acquirers of underinvested firms during the period 2000-2004, significant at the 10% (10%). Consistent with our earlier evidence, this finding (reported in Panel A of Table 2.9) therefore suggests that acquirers of overinvested firms significantly gained in future growth in productivity by acquiring overinvested instead of underinvested firms of the late '90s.

2.7.2 Defining over versus underinvested firms following their methods of payment

According to Shleifer and Vishny (2003), the volume of stock acquisition increases with the dispersion of valuations between acquirers and target firms, and the fraction of such acquisitions increases when aggregate or industry valuations are high. Therefore, firms that acquired other firms by using stocks during the speculative bubble in the late ′90s were most likely overinvested in physical assets as they were then able to purchase a large volume of fixed assets at a relatively low price. We therefore distinguish all target firms during the period 2000-2004 as over and underinvested firms by examining whether they used stock or cash while acquiring other firms during the late ′90s. The sample target firms of 2000-2004 that in fact used stocks (cash) to acquire other firms during the period 1995-1999 are considered over (under)invested firms. We then re-calculate average *TFPGR*s of these new groups of over and underinvested firms for 1995-1999 by using equation (11).[39] We also re-estimate the average *TFPGR* of the respective

[39] In the table, we report the findings using $\alpha = 0.3$. However, the results are qualitatively similar when we consider $\alpha = 0.2$ and 0.4 (not reported in the table).

group of acquirers, in both pre- and post-acquisition periods, who in fact acquired the above group of target firms during the post-bubble period.

As is evident in Panel B of Table 2.9, the average *TFPGR* of sample target firms that used stock (cash) to acquire other firms during the late '90s was 2.7% (1.2%) during 1995-1999, significant at the 5%. The difference in *TFPGR* between these two types of target firms suggests that firms that overinvested during the bubble-period were in fact significantly more productive than other firms that underinvested in physical assets during the same period. Furthermore, the average *TFPGR*s of acquirers of overinvested target firms increased from 1.1% during the bubble period to 3.2% during the post-bubble period, significantly different at the 10%. In contrast, the average *TFPGR*s of acquirers of underinvested target firms insignificantly increased (by 1.1%) from 1.8% in 1995-1999 to 2.9% in 2000-2004. Most importantly, the average change in *TFPGR* among acquirers of overinvested firms was significantly higher by 1.0% than that among acquirers of underinvested firms. This finding supports our previous evidence that acquirers of overinvested firms significantly improved their overall productivity from pre- to post-acquisition period by acquiring overinvested, but highly productive, physical infrastructure of the latter group of firms relative to other acquirers of underinvested firms.

[Insert Table 2.9 about Here]

2.8 CONCLUSION

In this paper, we examine the real economic gain of acquiring overinvested plants and machinery of the late ′90s during the post-bubble period. Our evidence shows that a large number of firms invested excessively during the period of speculative bubble in the US stock market (i.e., 1995-1999). After the burst of stock price bubble in the middle of 2000, several of these overinvested firms were eventually acquired by other companies at a relatively low price during the period 2000-2004. More importantly, these overinvested target firms were indeed more productive than their acquirers during the bubble period.

Further analysis reveals that acquirers of overinvested firms significantly improved their own productivity by acquiring the highly productive physical infrastructures of their target firms. In addition, among all acquiring firms, underinvested acquirers of the late ′90s chose the most productive overinvested firms and thereby became able to significantly improve their productivity when the economy was poor. Finally, we find that acquirers of overinvested firms made significant gains in sales, profitability and cash flow margins, and also reduced their operating costs, compared to acquirers of underinvested firms during the post-acquisition period. Such an improvement in productivity and operating performances of acquirers of overinvested firms, even in the crisis period, exhibits a real economic gain of overinvestment following the speculative bubble of the late ′90s. This incidence leads us to conclude that overinvestment in highly productive infrastructures by several overvalued firms during the period 1995-1999 played a valuable role in the US economy even after the burst of stock price bubble.

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APPENDIX 2A

Derivation of Total Factor Productivity Growth (TFPGR)

The Cobb-Douglas production function of country *i* at year *t*

$$Y_{it} = A_{it}\ K_{it}^{\alpha}\ L_{it}^{1-\alpha}$$

$$\Rightarrow \frac{Y_{it}}{L_{it}} = A_{it}\ \frac{K_{it}^{\alpha}}{L_{it}}\ L_{it}^{1-\alpha}$$

$$\Rightarrow \frac{Y_{it}}{L_{it}} = A_{it}\ \frac{K_{it}^{\alpha}}{L_{it}^{\alpha}} = A_{it}\,.\,k_{it}^{\alpha}$$ (Here, k_{it} = Capital-labor ratio at year *t*)

$$\Rightarrow y_{it} = A_{it}\,.\,k_{it}^{\alpha}$$ (Here, y_{it} = Output per labor at year *t*)

By taking log transformation, I write

$$\Rightarrow \log y_{it} = \log A_{it} + \alpha.\log k_{it} \qquad (1)$$

Likewise, for year (*t + 1*)

$$\log y_{it+1} = \log A_{it+1} + \alpha.\log k_{it+1} \qquad (2)$$

Subtracting (1) from (2) yields

$$(\log y_{it+1} - \log y_{it}) = (\log A_{it+1} - \log A_{it}) + \alpha.(\log k_{it+1} - \log k_{it})$$

$$\Rightarrow \log \frac{y_{it+1}}{y_{it}} = \log \frac{A_{it+1}}{A_{it}} + \alpha.\log \frac{k_{it+1}}{k_{it}}$$

$$\Rightarrow \log \frac{A_{it+1}}{A_{it}} = \log \frac{y_{it+1}}{y_{it}} - \alpha.\log \frac{k_{it+1}}{k_{it}}$$

$$\Rightarrow TFPGR = GR - \alpha.CAPGR$$

Table 2.1: Boom-Bust valuation and investment cycles in the US economy during the period 1995-2004

The sample includes all publicly listed firms, except financials and utilities, listed in NYSE, AMEX and NASDAQ. Columns I and II report sample years and total number of sample observations in corresponding years, respectively. Firms that have the required financial data in CRSP/COMPUSTAT merged database are included in the sample. Column III includes annual value-weighted-average index returns of all stocks traded in the above US stock markets. Column IV reports median market-to-book (*MB*) ratio of all sample firms by year. Market value of a firm is defined as a fiscal year-end share price (Item 199) times the total number of year-end outstanding shares (Item 25). Following Baker and Wurgler (2002), the book-equity is calculated as total assets (Item 6) less total liabilities (Item 181) and preferred stocks (Item 10) plus deferred taxes (Item 35) and convertible debt (Item 79). When preferred stock is missing, it is replaced with the redemption value of preferred stock (Item 56). The total number of annual IPO issuances, reported in column V, is taken from the web site of Jay Ritter. Overvalued firms that were also overinvested during the period 1995-2004 are identified by calculating the ratio of total overvalued and overinvested firms to total number of overvalued firms. Firm-level investment (*CS*) is measured by the ratio of capital expenditure (Item 128) to sales (Item 12). By definition, if a firm's *MB* (*CS*) in a given year is higher than their respective industry-median *MB* (*CS*) in 2001, that firm is identified as overvalued (overinvested) firm. Column VI includes total percentage of all sample firms that were simultaneously overvalued and overinvested.

I	II	III	IV	V	VI
Year	Total sample firms	Average annual value-weighted index returns	Median market-to-book ratio	Number of new IPO issuances	Percentage of overvalued firms that were overinvested relative to industry-median investment of 2001
1995	5,653	0.325	2.067	524	58
1996	6,170	0.188	2.132	659	61
1997	6,251	0.282	2.216	473	60
1998	5,957	0.205	1.705	297	59
1999	5,741	0.236	1.892	486	61
2000	5,718	-0.120	1.500	379	63
2001	5,248	-0.124	1.531	85	55
2002	4,863	-0.221	1.280	72	47
2003	4,583	0.308	1.961	75	39
2004	4,540	0.108	2.103	187	43

Table 2.2: Average premium (discount) to shareholders of target firms

The 1999 sample target firms are defined as either over or underinvested firms based on four different specifications. In the first criterion, each firm's ratio of capital expenditure (*CAPEX*) to sales (*SALES*) in 1999 is compared with their respective industry-median *CAPEX*/*SALES* in 2001. If a firm's *CAPEX*/*SALES* in 1999 is higher (lower) than their industry-median *CAPEX*/*SALES* in 2001, that firm is chosen as an over (under)invested firm. In the second definition, all sample firms across industries are sorted in descending order (from the highest to the lowest) based on their *CAPEX*/*SALES* in 1999. We then consider firms in the top and the bottom quintiles as over and underinvested target firms, respectively. In the third (fourth) specification, firms are sorted in descending order based on their *CAPEX*/*ASSET* (*CAPEX*/*PPE*) in 1999. Finally, firms that belong to the top (bottom) quintile of each specification are identified as over (under)invested firms. Two different measures of premium (discount) are calculated based on *log[P(+1)/P(-1)]* and *log[P(+1)/P(peak)]*, where *P(-1)* is the stock price on the day-before-announcement of acquisition, *P(+1)* is the stock price on the day-after-announcement of acquisition, and *P(peak)* is the stock price on the last trading day of a peak year of a firm's respective industry. Columns II and III report the sample-size-weighted average premium (discount) of all over and underinvested target firms, respectively. Column IV includes the mean differences in premium (discount) between over and underinvested target firms, and column V reports corresponding *t*-statistics of the mean differences. ***, ** and * imply the significance of mean differences in premium/discount at the 1%, 5% and 10%, respectively.

I		II	III	IV	V
Definitions of		Premium/discount to overinvested target firms	Premium/discount to underinvested target firms	Mean difference in premium/discount (II – III)	Significance of mean difference
Over (Under)investment	Premium / Discount				
Firm level *CAPEX*/*SALES* in 1999 is greater (lower) than their respective industry-median *CAPEX*/*SALES* in 2001	P(-1, +1)	0.151	0.183	-0.032	-4.717***
	P(peak, +1)	-0.261	-0.069	-0.192	-6.985***
The top 25th percentile (bottom 25th percentile) of *CAPEX*/*SALES* in 1999	P(-1, +1)	0.136	0.181	-0.045	-2.134*
	P(peak, +1)	-0.355	-0.026	-0.329	-11.400***
The top 25th percentile (bottom 25th percentile) of *CAPEX*/*ASSET* in 1999	P(-1, +1)	0.229	0.294	-0.065	-4.689***
	P(peak, +1)	-0.162	-0.096	-0.066	-1.685*
The top 25th percentile (bottom 25th percentile) of *CAPEX*/*PPE* in 1999	P(-1, +1)	0.250	0.287	-0.037	-3.098**
	P(peak, +1)	-0.202	-0.118	-0.084	-1.957*

Table 2.3: Cross-sectional and time-series differences in total factor productivity

This table includes the median level of total factor productivity (*TFP*) of acquiring and target firms in each year during the period 1995-2004. Following Lichtenberg (1992), *TFP* is the residual of log transformation of the Cobb-Douglas production function of labor and capital. Since total number of sample firms varies in each year, we calculate sample-size-weighted average of *TFP* for each year. To examine the time-varying differences in *TFP*, we initially assume that the mean *TFP*s of acquirers of over and underinvested firms were insignificantly different between 1995-1999 and 2002-2004. For cross sectional differences in *TFP*, we assume that the mean differences between two distinct groups of firms (such as, acquirers of overinvested versus underinvested firms and overinvested target firms versus acquirers of these firms) were the same in a given period. ***, ** and * imply the significance of mean differences of *TFP* at the 1%, 5% and 10%, respectively.

Year	Acquiring firms		Target firms	
	Acquirers of overinvested target firms (OIA)	Acquirers of underinvested target firms (UIA)	Overinvested target firms (OIT)	Underinvested target firms (UIT)
	(I)	(II)	(III)	(IV)
1995	0.008	-0.001	0.006	-0.013
1996	-0.010	0.007	0.023	-0.015
1997	0.009	0.000	0.018	-0.009
1998	0.001	0.000	0.034	0.014
1999	0.000	0.004	0.054	0.000
2000	0.031	0.037	-	-
2001	0.006	0.025	-	-
2002	0.016	0.020	-	-
2003	0.008	0.010	-	-
2004	0.032	0.000	-	-
Sample-size-weighted average	$\mu^{OIA}_{TFP,95-99} = 0.005$ $\mu^{OIA}_{TFP,02-04} = 0.043$	$\mu^{UIA}_{TFP,95-99} = 0.007$ $\mu^{UIA}_{TFP,02-04} = 0.024$	$\mu^{OIT}_{TFP,95-99} = 0.109$ -	$\mu^{UIT}_{TFP,95-99} = -0.014$ -
Time-series comparison	$\mu^{OIA}_{TFP,95-99} = \mu^{OIA}_{TFP,02-04}$	$\mu^{UIA}_{TFP,95-99} = \mu^{UIA}_{TFP,02-04}$		
Mean differences in *TFP* (*t*-stat)	0.038*** (5.685)	0.017*** (3.692)	-	-
Difference-in-difference (*t*-stat)	0.021* (1.661)			
Cross-sectional comparison	$\mu^{OIA}_{TFP,95-99} = \mu^{UIA}_{TFP,95-99}$		$\mu^{OIA}_{TFP,95-99} = \mu^{OIT}_{TFP,95-99}$	$\mu^{UIA}_{TFP,95-99} = \mu^{UIT}_{TFP,95-99}$
Mean differences in *TFP* (*t*-stat)	-0.002 (-0.546)		-0.104*** (-11.895)	0.021*** (3.808)
Cross-sectional comparison	$\mu^{OIA}_{TFP,02-04} = \mu^{UIA}_{TFP,02-04}$			
Mean differences in *TFP* (*t*-stat)	0.019* (2.140)		-	-

Table 2.4: Different types of acquisition and productivity of target firms

The table reports average total factor productivity (*TFP*) of target firms during the period 1995-1999 under different types of acquisitions. For instance, cell (I) of the table includes average *TFP* of overinvested (OINV) target firms that were acquired by overinvested acquiring firms. Likewise, cell (III) includes average *TFP* of overinvested target firms that were acquired by underinvested (UINV) acquiring firms. All acquiring and target firms are therefore sorted into four individual groups of firms: (I) overinvested acquirers acquiring overinvested target firms, (II) overinvested acquirers acquiring underinvested target firms, (III) underinvested acquirers acquiring overinvested target firms, and (IV) underinvested acquirers acquiring underinvested target firms. To distinguish firms as overinvested and underinvested, a firm's ratio of capital expenditure (*CAPEX*) to sales (*SALES*) in 1999 is compared with the industry-median *CAPEX*/*SALES* in 2001. By definition, if a firm's *CAPEX*/*SALES* in 1999 is higher (lower) than its industry-median *CAPEX*/*SALES* in 2001, that firm is identified as over (under)invested firm. Following Lichtenberg (1992), *TFP* is the residual of log transformation of the Cobb-Douglas production function of labor and capital. *** and * imply the significance of the mean difference in *TFP*s between two groups of firms at the 1% and 10%, respectively.

Firm type		Target firms: OINV	Target firms: UINV	Difference in average *TFP* (*t*-stat)
Acquiring firms	OINV	(I) 0.002	(II) -0.001	(I) – (II) 0.003 (0.377)
Acquiring firms	UINV	(III) 0.017	(IV) -0.000	(III) – (IV) 0.017*** (3.031)
Difference in average *TFP* (*t*-stat)		(III) – (I) 0.015* (1.600)	(IV) – (II) 0.001 (0.379)	-

Table 2.5: Differences in total factor productivity (*TFP*) between acquirers of overinvested and underinvested target firms

The following estimated results are based on an unbalanced panel data set, clustered by firm, for the period 2000-2004. The dependent variable is the total factor productivity (*TFP*) of individual firms. Following Lichtenberg (1992), *TFP* is measured from the residuals of an ordinary least square regression of a log-transformed Cobb-Douglas production function of labor and capital. Among independent variables, *TYPE* is a dummy variable that is equal to 1 if a firm acquired an overinvested firm and 0 if a firm acquired an underinvested firm during the period 2000-2004; *QL* is the quality of labor, equal to a firm's net sales divided by total number of employees; *QK* is the output per capital, measured by a firm's total net sales divided by its plant, property and equipment; *SIZE* is the log value of a firm's total assets at the beginning of the year; *MKTSH* (a firm's market share) is equal to a firm's total sales divided by its industry's aggregate sales. The model also includes time- and industry-dummy variables to absorb the year and industry-specific fixed effects. The significance of each independent variable is calculated by using heteroskedasticity-consistent-standard error. *t*-statistics are given in the parentheses. *** and * imply the significance of the coefficients at the 1% and 10%, respectively.

Independent variables	Dependent variable: *TFP*
TYPE	0.055***
	(5.470)
QL	0.0001***
	(9.234)
QK	0.003***
	(6.176)
SIZE	0.047***
	(5.308)
MKTSH	-0.132*
	(-1.820)
CONSTANT	-0.283***
	(-6.324)
Sample size	2029
Time fixed effect	Yes
Industry fixed effect	Yes
R^2	0.268
Wald-Chi square statistic	193.707***

Table 2.6: Two-stage regression of total factor productivity (*TFP*)

Panel A includes the result of a Probit regression model of acquisition type. *TYPE* is a dummy variable that is equal to 1 if acquiring firms acquired overinvested firms or 0 if acquirers acquired underinvested firms during the period 2000-2004. The independent variables include operating cash flows (*OCF*), a ratio of operating income before depreciation less interest expense, taxes and dividend on common stocks to total assets; market-to-book ratio (*MB*), a ratio of market value (year-end stock price times year-end outstanding shares) to book value (total assets less total liabilities) of equity; leverage (*LEV*), a ratio of total long-term debt to book value of equity; firm size, measured by the logarithm of total assets at the beginning of the year and the magnitude of investment deviation, calculated by a firm's *CAPEX*/*SALES* less its industry-median *CAPEX*/*SALES* in a given year (*INVDEV*). Following Heckman (1979), we estimate the Inverse Mill Ratio (IMR) from the first-stage regression. We include IMR along with other explanatory variables in the second-stage regression to control for self-selection bias in acquisition type of an acquirer. The dependent variable in the second stage regression is total factor productivity (*TFP*) of individual acquiring firms. Following Lichtenberg (1992), *TFP* is measured from the residuals of an ordinary least square regression of a log-transformed Cobb-Douglas production function of labor and capital. In addition to IMR, the second stage regression model includes the ratio of sales to total number of employees (*QL*), the ratio of sales to plant, property and equipment (*QK*), firm's size (*SIZE*) and market share (*MKTSH*), a ratio of a firm's sales to aggregate sales of its respective industry in a given year. The model also includes industry-dummy variables to absorb industry-specific fixed effects. For the first (second) stage regression, sample data are taken from 1998-99 (2003-2004). The significance of each coefficient in the second-stage regression is chosen based on test statistic (*t*-stat) calculated following the equation of standard error in Greene (1981). *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively.

Panel A: First-stage regression
Dependent variable: TYPE

Independent variables	Coefficients (*t*-stat)
OCF	-0.088 (-0.200)
MB	0.010* (1.610)
LEV	-0.001 (-0.001)
SIZE	0.122* (1.636)
INVDEV	0.844* (1.822)
CONSTANT	-0.324 (-1.310)
Sample size	337
Likelihood ratio test statistic	9.389*
Pseudo R^2	0.157

Panel B: Second-stage regression
Dependent variable: TFP

Independent variables	Coefficients (*t*-stat)	
	Acquirers of overinvested target Firms	Acquirers of underinvested target firms
QL	0.0003*** (7.905)	0.0004*** (5.273)
QK	0.006*** (5.290)	0.002* (1.898)
SIZE	0.054** (2.404)	0.006 (0.168)
MS	0.292 (1.197)	0.126 (0.330)
λ_{ji}	0.194* (1.620)	-0.035 (-0.874)
CONSTANT	-0.660*** (-3.959)	-0.448*** (-2.751)
Sample size	155	121
Industry fixed effect	Yes	Yes
R^2	0.588	0.284
Mean (Actual TFP – Expected TFP | Alternative acquisition type)	0.004	-0.122
Mean difference	0.126***	
t-stat	4.103	

Table 2.7: Differences in total factor productivity between different types of acquirers of over and underinvested target firms

The following estimated results are based on an unbalanced panel data set, clustered by firm, for the period 2000-2004. The dependent variable is total factor productivity (*TFP*) of individual acquiring firms. Following Lichtenberg (1992), *TFP* is measured from the residuals of an ordinary least square regression of a log-transformed Cobb-Douglas production function of labor and capital. Among independent variables, *TYPE1* in model 1 is a dummy variable that is equal to 1 if an overinvested target firm was acquired by an underinvested acquiring firm or 0 if an overinvested target firm was acquired by an overinvested acquiring firm. Likewise, *TYPE2* in model 2 is another dummy variable that is equal to 1 if an underinvested acquiring firm acquired an overinvested target firm or 0 if the former acquired an underinvested target firm. Among independent variables, *QL* is the quality of labor, equal to a firm's net sales divided by total number of employees; *QK* is the output per capital, measured by a firm's total net sales divided by its plant, property and equipment; *SIZE* is the log value of a firm's total assets at the beginning of the year; *MKTSH* (a firm's market share) is equal to a firm's total sales divided by its industry's aggregate sales in a given year. The models also include time- and industry-dummy variables to absorb the year and industry-specific fixed effects. The significance of each independent variable is calculated by using heteroskedasticity-consistent-standard error. *t*-statistics are given in the parentheses. *** and ** imply the significance of the coefficients at the 1% and 5%, respectively.

Independent variables	Model 1	Model 2
TYPE1	0.104*** (10.480)	-
TYPE2	-	0.091*** (2.962)
QL	0.0001*** (9.985)	0.0002*** (12.310)
QK	0.004*** (5.868)	0.002*** (9.004)
SIZE	0.043*** (5.453)	0.001 (0.065)
MKTSH	0.104 (1.492)	-0.054 (-0.287)
CONSTANT	-0.217*** (-5.209)	-0.106** (-2.289)
Sample size	1029	511
Time fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
R^2	0.515	0.518
Wald-Chi Square statistic	1018.403***	292.884***

Table 2.8: Pre- and post-merger performance of acquiring firms

The table reports average financial performances of acquirers of overinvested and underinvested firms in 1999 (Panel A) and 2004 (Panel B). Panel C includes (i) the mean differences in operating performance of acquiring firms between pre- and post-acquisition period and (ii) the corresponding differences in performances between two types of acquirers in 2004. Firm performance is evaluated by total revenue (in million); operating margin, a ratio of operating income to sales; cost of production, a ratio of cost of goods sold to total sales revenue; fixed capital investment, a ratio of capital expenditure to sales and operating cash flows, a ratio of operating income before depreciation less interest expense, taxes and dividend on common stocks to total assets. Relatedness is measured by calculating the percentage of over (under)invested target firms acquired by acquiring firms within the same industry. ***, ** and * imply the significance of mean differences at the 1%, 5% and 10%, respectively.

Types of firms	**Panel A: Pre-merger performance (Year: 1999)**					
	Revenue	Operating margin	Operating cost	Fixed capital investment	Relatedness	Operating cash flows
Acquirers of overinvested firms	5137.80	0.122	0.559	0.150	67%	0.104
Acquirers of underinvested firms	7325.00	0.054	0.633	0.095	65%	0.107
	Panel B: Post-merger performance (Year: 2004)					
Acquirers of overinvested firms	10253.00	0.205	0.507	0.096	-	0.131
Acquirers of underinvested firms	12130.20	0.051	0.639	0.075	-	0.091
	Panel C: *t*-stats of mean differences					
Acquirers of overinvested firms						
Mean difference between 1999 and 2004	5115.20***	0.083**	-0.052*	-0.054*	-	0.027*
t-stat	2.703	2.788	-1.704	-1.874		1.778
Acquirers of underinvested firms						
Mean difference between 1999 and 2004	4805.20	-0.003	0.006	-0.020		-0.016
t-stat	1.534	-0.049	0.087	-1.128	-	-0.668
Difference-in-Difference	310*	0.086**	-0.058*	-0.034*		0.043*
t-stat	1.856	2.351	-1.602	-1.622		1.665

Table 2.9: Robustness check

Panel A: Difference in productivity growth between acquirers of over and underinvested firms

The following estimated results are based on an unbalanced panel data set, clustered by firm, for the period of 2000-2004. The dependent variable is the growth in total factor productivity (*TFPGR*) of individual acquiring firms. *TFPGR* is measured from a Cobb-Douglas production function of labor and capital, and calculated from a firm's growth in sales per employee less its share of capital in production (α) times its growth in capital per employee between *t* and *t-1*. Following King and Levine (1994), Beck, Levine and Loayza (2000) and Durnev, Li, Morck and Yeung (2004), we initially consider that $\alpha = 0.3$. For a robustness check, we also consider $\alpha = 0.4$. Among independent variables, *TYPE* is a dummy variable that is equal to 1 if a firm acquired an overinvested firm or 0 if a firm acquired an underinvested firm during the period 2000-2004; *QL* is the quality of labor, equal to a firm's net sales divided by total number of employees; *QK* is the output per capital, measured by a firm's total net sales divided by its plant, property and equipment; *SIZE* is the log value of a firm's total assets at the beginning of the year; *MKTSH* (a firm's market share) is equal to a firm's total sales divided by its industry's aggregate sales in a given year. The models also include time- and industry-dummy variables to absorb the year and industry-specific fixed effects. The significance of each independent variable is calculated by using heteroskedasticity-consistent-standard error. *t*-statistics are given in the parentheses. *** and * imply the significance of the coefficients at the 1% and 10%, respectively.

Independent variables	Dependent variable: *TFPGR*	
	α = 0.3	α = 0.4
TYPE	0.124*	0.143*
	(1.631)	(1.795)
QL	0.0001***	0.0001***
	(23.650)	(25.100)
QK	0.011***	0.013***
	(5.267)	(5.405)
SIZE	-0.184***	-0.194***
	(-3.572)	(-3.655)
MKTSH	-0.295	0.215
	(-0.457)	(0.332)
CONSTANT	0.042	0.751
	(0.088)	(1.513)
Sample size	2029	2029
Time fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
R^2	0.277	0.319
Wald-Chi square statistic	738.672***	847.706***

Panel B: Redefining over and underinvested target firms based on the medium of payment (either stock or cash) that they used to acquire other firms during the late ′90s

In this case, we define the original sample of target firms as over (under)invested firms if they used stock (cash) as a medium of payment to acquire other firms during the period 1995-1999. We then select their respective acquiring firms that eventually acquired the above group of target firms during the post-bubble period (i.e., 2000-2004). The table includes the average growth rate of total factor productivity (*TFPGR*) of both acquirers and target firms. *TFPGR* is measured from a Cobb-Douglas production function of labor and capital and calculated from a firm's growth in sales per employee less its share of capital in production (α) times its growth in capital per employee between *t* and *t-1*. Following King and Levine (1994), Beck, Levine and Loayza (2000) and Durnev, Li, Morck and Yeung (2004), we consider that $\alpha = 0.3$. ** and * imply the significance of mean differences in average *TFPGR* at the 5% and 10%, respectively.

Sample: Target Firms	Medium of payment used to acquire other firms in the late ′90s (1995-1999)	
Average growth in total factor productivity (*TFPGR*) during 1995-1999	STOCK (Overinvested target firms)	CASH (Underinvested target firms)
	2.7%	1.2%
Mean Difference in *TFPGR* *t*-stat	1.5%** 1.961	

Sample: Acquirers of the above group of target firms during 2000-2004	Average *TFPGR*	
	Acquirers purchased firms that used STOCK to acquire other firms in the late ′90s (Acquirers of overinvested firms)	Acquirers purchased firms that used CASH to acquire other firms in the late ′90s (Acquirers of underinvested firms)
During pre-acquisition period (1995-1999)	1.1%	1.8%
During post-acquisition period (2002-2004)	3.2%	2.9%
Mean difference in *TFPGR* *t*-stat	2.1%* 1.757	1.1% 0.828
Difference-in-difference *t*-stat	0.929* 1.610	

Figure 2.1: Value-Weighted index returns and overinvestment

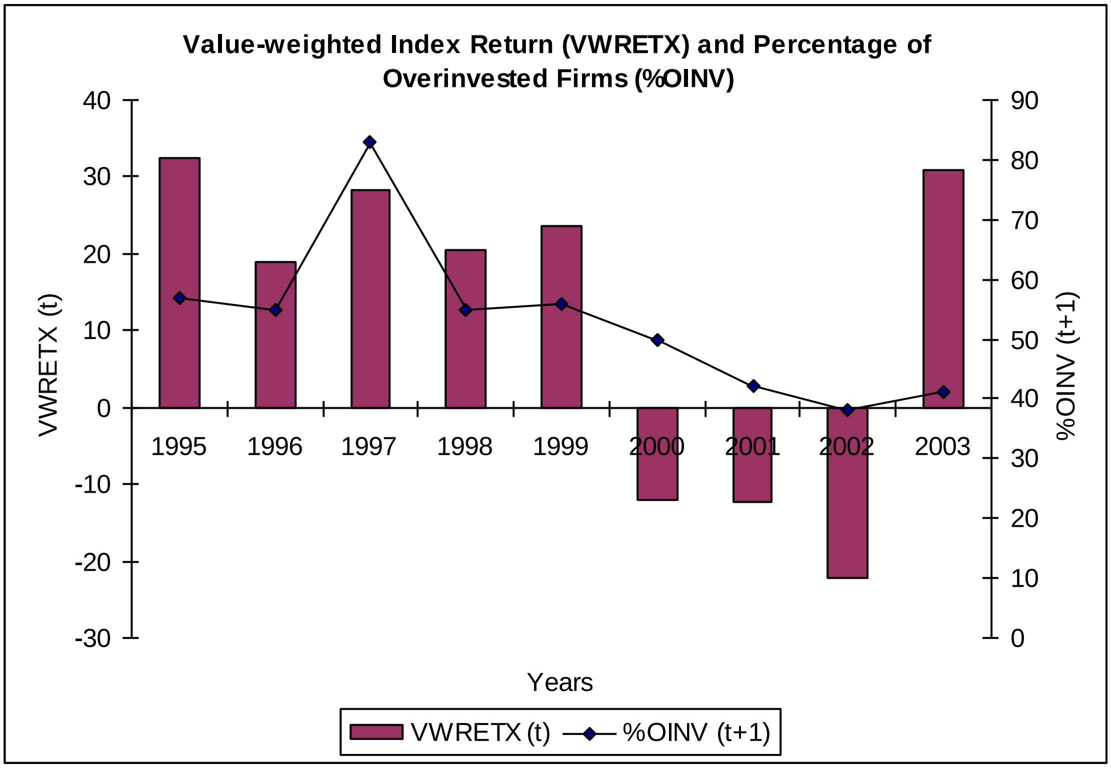


Figure 2.2: Time-varying changes in market values and capital expenditures of US firms

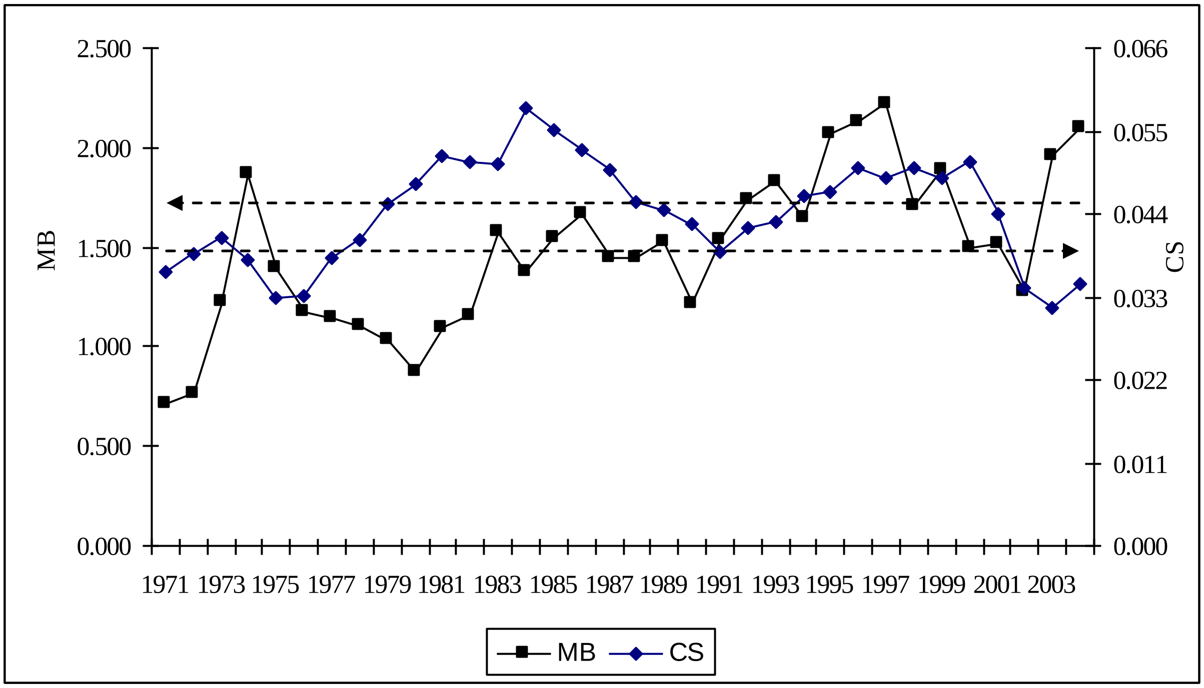
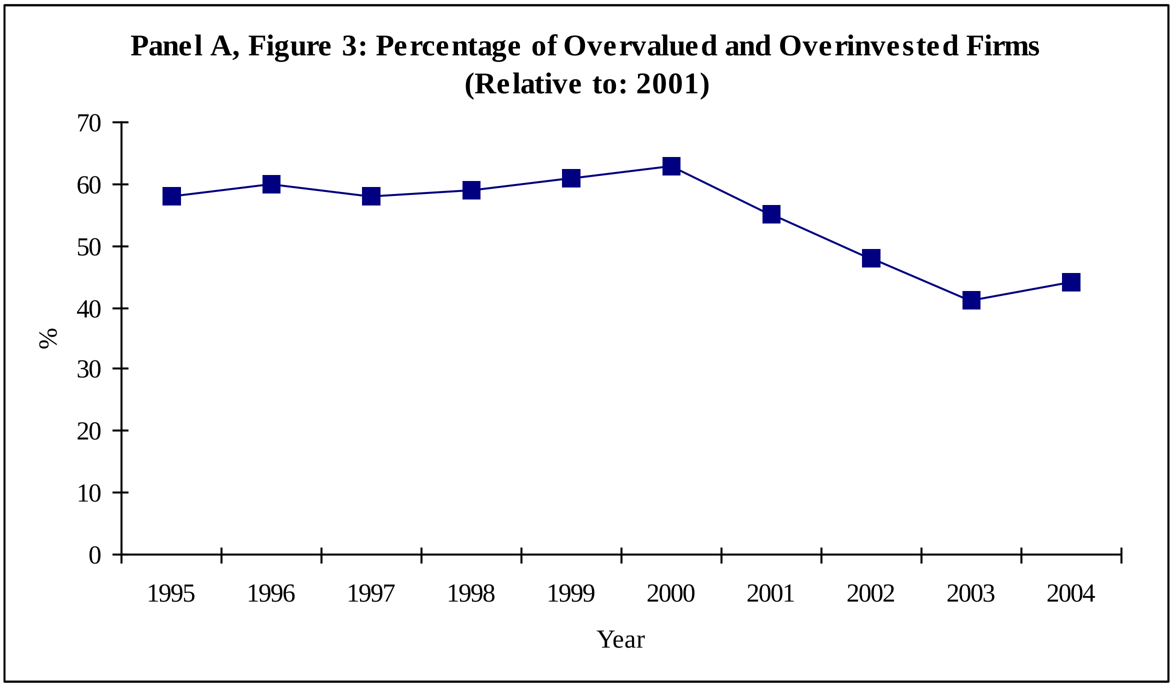
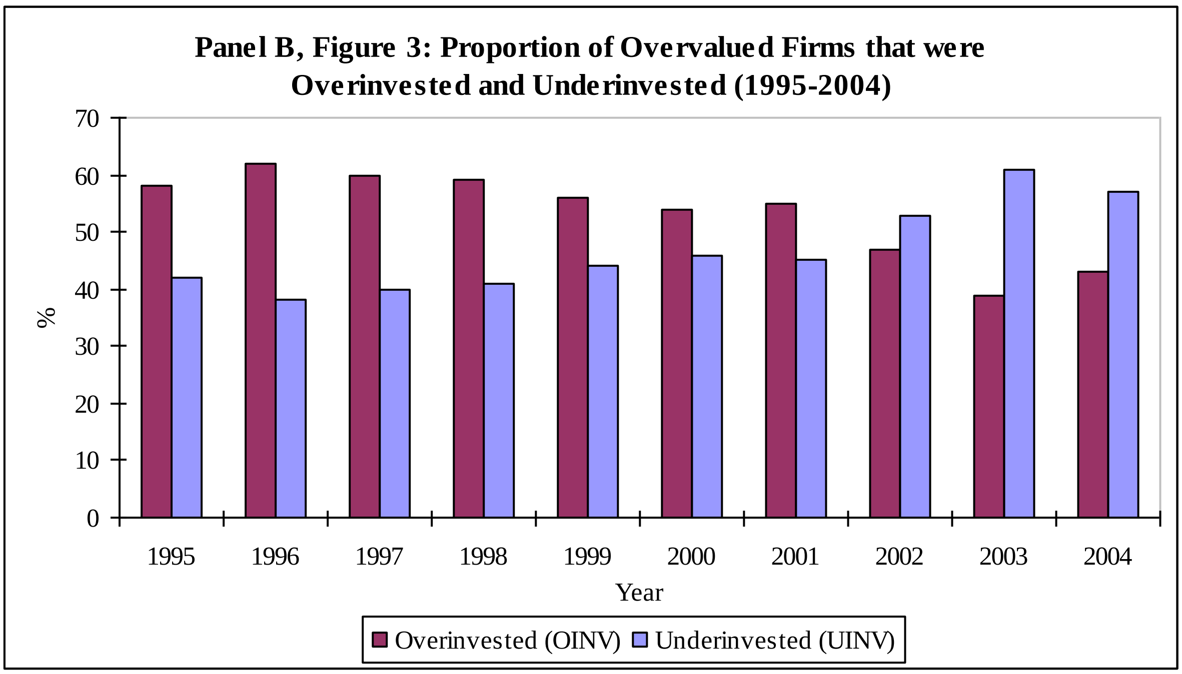


Figure 2.3: Overvalued and Overinvested versus Underinvested Firms





CHAPTER 3

COMBINED OR SEPARATE LEADERSHIP STRUCTURE? ROLES OF CEO AND COB IN DIFFERENT ECONOMIC AND BUSINESS CONDITIONS[1]

3.1 INTRODUCTION

Board effectiveness is believed to play a crucial role in corporate governance, particularly in monitoring top management.[2] Considerable debate among practitioners, regulators and researchers concerns whether the separation of decision management and decision control can better ensure the efficacy of the Board.[3] The business press claims that many of the problems in recent corporate scandals are partially attributable to corporate boards' rubber-stamping decisions made by individuals who assume the dual roles of Chief Executive Officer (CEO) and Chairman of the Board (COB) under a combined leadership structure.[4] As a corrective measure, regulators and shareholder activists advocate splitting the roles of CEO and COB in publicly-held corporations.[5] In May 1991, the Conservative Government of the United Kingdom appointed the Cadbury Committee to "… address the financial aspects of corporate governance" (see 1992 Report of the Committee on the Financial Aspects of Corporate Governance,

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[1] This chapter is co-authored with Jennifer Kao, Professor in Accounting, Department of Accounting and Management Information Systems, School of Business, University of Alberta.
[2] See Vance (1983).
[3] See Mallette and Fowler (1992), Weisbach (1988), Fama and Jensen (1983), Mintzberg and Waters (1982), Massie (1965) and Fayol (1949).
[4] See "Executive split" by Bill Roberts, Electronic Business, 30(8), 2004.
[5] See "Should the top roles be split?" by Ann Theresa Palmer, The Chief Executive, May 2005.

Section 1.8). The committee, headed by Sir A. Cadbury, submitted its recommendations in December 1992, calling for the separation of CEO and COB positions. Motivated by a concern for board independence, regulators in at least fifteen other countries issued similar guidelines between 1992 and 2004.[6] Many US executives, however, believe that no single model fits all companies. Cognizant of these sentiments, the US regulators have been reluctant to mandate separate leadership structure, resulting in the continued prevalence of combined leadership structure in corporate America today (see Table 1).[7]

Two opposing theories have been advanced in the extant literature regarding the effectiveness of combined leadership. On one hand, agency theorists argue that such leadership structure can firmly entrench a CEO at the top of the organization, thus challenging a board's ability to effectively monitor and discipline senior management. On the other hand, organization theorists point out that consolidation of the top-two positions within a company establishes a unity of command. A vigilant board therefore favors placing both decision-making and decision-control in the hand of the same person. Evidence to date, however, is mixed (see Kang and Zardkoohi 2005; Daily and Dalton 1997 for a list of references). Traditional tests to examine the effectiveness of combined leadership use univariate analysis and ordinary least square (OLS) regressions under the assumption that firms randomly choose combined or separate leadership structure. However, this assumption is unlikely to hold in practice, as the choice of

[6] They include Australia, Belgium, Brazil, Canada, Cyprus, Czech Republic, France, Greece, India, Japan, Kenya, Kyrgyz Republic, Malaysia, Singapore and South Africa.

[7] Separate leadership describes leadership structure used by firms where different persons hold the positions of CEO and COB. Combined leadership refers to firms where these two positions are held by the same person.

leadership structure depends on managerial rewards, industry complexity, board structure, social reciprocity practice and the power of CEO (see Faleye 2007; Coles and Hesterley 2000).

The first objective of this paper is to investigate the question of whether splitting the roles of CEO and COB would improve a firm's overall performance and if board of directors usually makes the right decision about leadership structure. Unlike prior studies, we employ a two-stage regression approach that explicitly takes into account potential endogeneity in the choice of leadership structure. In doing so, we contribute methodologically to the corporate governance literature and shed new light on the debate concerning the appropriateness of combined leadership in US firms. Since firms usually perform well when economic conditions are strong, shareholders may be reluctant to impose strict monitoring of their firms (Philippon 2006). Conversely, when times are tough firms need to be extra careful in making decisions, including their choice of leadership structure. Ting (2006) and Joh (2003), for examples, conclude that corporate governance can create value under poor economic conditions. Thus, we conduct separate analyses for the boom and the recessionary periods to see if a firm's choice of leadership structure is relatively more appropriate for its underlying circumstances in the latter period. To the best of our knowledge, none of the extant literature has studied the impact of leadership structure on firm performance conditional on the economic cycle. Insights from this line of enquiry would help shareholders and boards of directors better understand when a close monitoring of managerial actions may be worthwhile.

The second objective of this paper is to examine whether a given leadership structure, combined or separate, works well for all types of firms under different business conditions. Examples of factors that can mitigate or exacerbate potential conflicts-of-interest arising from combined leadership structure include, but are not limited to, firm size, capital structure, market share in the industry, equity type and exchange listing. Take debt financing for example. It entails a promise to pay interest and principle on time. Irrespective of the leadership structure, the CEOs of heavily debt-financed firms may be compelled to honor such promises in order to avoid future violations of debt covenants and bankruptcy. This in turn can limit their propensity to take action contrary to the best interest of shareholders. The proposed conditioning analysis extends prior leadership studies and offers insights to policy-makers in their deliberations concerning the merit of introducing new regulations or strengthening existing ones to counter any adverse effects that may arise from a firm's internal choice of leadership structure.

For our main analysis, the sample consists of 391 and 906 firms from 2000 and 2005, respectively, where the year 2000 represents the final year during a six-year (1995-2000) economic boom and 2005 is the final year of a five-year (2001-2005) economic downturn.[8] We measure firm performance in three ways: Tobin's *Q*, market-to-book ratio (*MB*) and return on assets (*ROA*). After controlling for a self-selection bias, we find that both combined and separate leadership firms employed an appropriate leadership structure for their own circumstances in the

[8] As discussed in Section 3.3, we choose 2000 (2005) as the representative of the boom (recessionary) period to ensure that data required for all the model variables come from the same economic cycle.

recessionary period (i.e., 2005), whereas they could enhance their firm value by choosing an alternative leadership structure during the boom time (i.e., 2000). Results are largely invariant to measures of firm performance and suggest that board of directors usually makes an appropriate decision about leadership structure when the economic condition is poor, but not so when the economy is strong. Further analysis indicates that combined leadership was a common practice over an 11-year (1995-2005) period for large and heavily debt-financed firms as well as for those with high market share, single-class stocks and listing in the New York Stock Exchange (NYSE). These patterns hold both overall and by year and lend support for our conjecture that the choice of leadership structure is not random. Focusing on the period of economic downturn (i.e., 2005), we also find that combined leadership firms could achieve a higher firm value by using separate leadership structure when they had high market share or if they were listed in a non-NYSE stock exchange. Moreover, small firms and firms with low leverage always chose the wrong leadership structure in 2005, whereas high-leveraged firms were able to consistently employ the appropriate (combined or separate) leadership structure in the same year.

Our findings that the value-maximizing leadership structure is not unique across different economic cycles and over varying business contexts for the same economic condition extend to other years (i.e., 1999 and 2004) within the 11-year sample period. Taken together, these results offer a plausible explanation as to why combined leadership structure remains popular in corporate America. Just as importantly, they point out that predictions made by agency theorists and organization theorists about the effectiveness of combined leadership are not mutually exclusive. Each of the arguments may be supported depending on the contexts.

The rest of the paper is organized as follows. Section 3.2 surveys the related literatures; Section 3.3 discusses our sample and data sources; Section 3.4 describes the research methodology and model variables; Section 3.5 presents our main results, followed by an analysis on the effectiveness of combined leadership under different business conditions in Section 3.6; Section 3.7 concludes the paper.

3.2 LITERATURE REVIEW

Agency theorists have identified the board of directors as a primary monitoring device for the protection of shareholders' interests (Fama and Jensen 1983). Weisbach (1988) describes a board as the shareholders' first line of defense against incompetent management. According to Harrison, Torres and Kukalis (1988) and Patton and Baker (1987), a combined leadership structure under which the same individual serves as CEO and COB promotes CEO's entrenchment and may lead to opportunistic behavior that reduces the value of shareholders' wealth (Jensen and Meckling 1976). Central to this view is the assertion that CEO who is also the Chairperson of the board has a concentrated power base, allowing that individual to undertake action in his/her own self-interests and at the expense of shareholders.

In contrast, organization theorists suggest that giving decision-making and decision-control to the same person has important implications for firm performance (Massie 1965; Fayol 1949). Specifically, a combined leadership confers legitimacy, responsibility and respect for authority and encourages managers to do a good job, which in turn signals to stakeholders that a firm has a clear sense of direction (Donaldson 1990; Salancik and Meindl 1984). Pfeffer and Salancik (1978) argue that leaders with considerable discretion are better able to implement strategic decisions and overcome organizational inertia. From this view, firms practicing a combined leadership structure are expected to have relatively superior performance.

To date, empirical evidence from finance and management literatures is mixed. Consistent with the agency-based arguments, several studies find that combined leadership adversely affects firm performance, as measured by return on assets, return on equity, return on investment or profit margin (Simpson and Gleason 1999; Pi and Timme 1993; and Rechner and Dalton 1991). By comparison, Coles, McWilliams and Sen (2001) and Baliga, Moyer and Rao (1996) show that a combined leadership structure has insignificant impact on these performance measures. Finally, Brickley, Coles and Jarrell (1997), Sridharan and Marsinko (1997) and Worrell, Nemec and Davidson (1997) report that firms with a separate leadership structure do not outperform those with a combined leadership structure.

The notion that marginal effect of a specific leadership structure on firm performance may depend on organizational and industrial complexity and dynamism was raised in Faleye (2007) and Boyd (1995). According to Faleye (2007), complex firms or firms whose highly reputable CEOs also serve as COBs tend to perform better. Faleye (2007) measures firm complexity by firm size (i.e., total assets), asset characteristic (i.e., the ratio of fixed assets to total assets) and growth opportunity (i.e., sales growth); and defines CEO reputation as the number of press articles in which CEOs' names appear. We extend Faleye (2007) to study the effectiveness of leadership structure chosen by firms under a wider range of conditions, such as economic cycles, capital structure, market share, equity type and exchange listing. Similarly, Boyd (1995) reports that performance of combined leadership firms is poorer (better) than those practicing separate leadership in growing (risky) industries. Boyd measures the two industry characteristics by reference to industry sales over the last five years. We differ from Boyd (1995) in that we include in the model factors, such as Rewards for Good Performance, Board Structure, Social Reciprocity and Enforcing Outcome of a Powerful CEO (discussed shortly), that also determine the choice of combined leadership. In short, questions about the effectiveness of combined leadership structure remain an unresolved empirical issue.

3.3. SAMPLE AND DATA SOURCES

Our initial sample is drawn from an 11-year period, from 1995 to 2005, which covers a complete cycle of upturn (1995-2000) and downturn (2001-2005) in the US economy and equity market (see Figure 1). Some of our model variables (defined in Section 3.4.2) require 5-year historical data. For these variables, the construction of historical data for the beginning of each economic cycle would require data from a different cycle (e.g., 1995 from 1990-1994 and 2001 from 1996-2000). The corresponding calculations for the final year of the boom and the recessionary periods, on the other hand, would draw historical data from years with largely similar economic conditions. For these reasons, our main analysis is based on 2000 and 2005.

We use the following three data sources for our study:

(i) *Executive Compensation* from Compustat to extract information about corporate leadership structure (combined versus separate), the exact dates when company executives become CEOs, CEO compensation[9] and CEOs' percentage of ownership in their own companies;

(ii) *RiskMetrics Governance and Directors Data* (formerly IRRC) from WRDS for information about a company's board size, directors' board affiliation (independent versus insider) and directors' current employment designation in their companies; and

(iii) *CRSP/Compustat Merged Database* for all other firm-specific financial information from 1995 to 2005.

There are 1,792 and 1,700 sample firms listed in the *Executive Compensation* database for 2000 and 2005, respectively. We further impose the constraints that data be available from *RiskMetrics Governance and Directors Data*, that firms belong to non-financial and non-utilities industries and that firms have complete financial data from *CRSP/Compustat Merged Database*. Applying

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[9] It includes salary, bonus, restricted stock grants, long-term protection plan and the value of options exercised, among others.

these constraints reduces the sample size for 2000 and 2005 to 635 and 906, respectively. For 2000, *Executive Compensation* includes 244 firms whose CEOs joined the firm after 2000 and hence were not in charge during the 1995-2000 period. Excluding these firms leaves us with 391 firms for the 2000 subsample. Since the 2005 subsample contains more firms than the 2000 subsample (i.e., 906 versus 391), most of our analyses are performed using the 2005 subsample. Both subsets of firms are sorted into 24 two-digit SIC industries.

As robustness checks, we also replicate the effectiveness of leadership structure analysis based on 562 and 860 firms that meet all the data requirements from 1999 and 2004, respectively. In both cases, we calculate variables of historical nature using four-year, as opposed to five-year, historical data so that data required for all the model variables are once again drawn from the same economic cycle.[10]

3.4 RESEARCH METHODOLOGY

3.4.1 Overview of Two-Stage Regression Procedure

Prior literature examining the impact of combined leadership on firm performance has used the following ordinary least square (OLS) regression approach:

$$Y_i = \alpha_0 + \alpha_1 LD_i + \alpha' X_i + \varepsilon_{i,} \qquad (1)$$

where Y_i is a measure of firm i's performance; LD_i is a dummy variable set equal to 1 if firm i's CEO also holds the position of COB in the same company

[10] The same data constraints prevent us from running a pooling regression for the entire 11-year (1995-2005) period with year dummies. Take the beginning of recessionary period (2001) for example. Lagged variables for this year would have to come from the boom period (1995-2000). As well, at least some of the firms may appear in multiple years. In that case, we do not have independent observations, making it difficult to pool across years.

(combined leadership) and 0 if (s)he does not take on the role of COB (separate leadership). The remaining explanatory variables (X_i) capture other firm characteristics that are known to affect firm performance. The coefficient on LD_i, α_1, identifies the effectiveness of combined leadership on firm performance relative to separate leadership.

Equation (1) implicitly assumes that corporate leadership structure is randomly allocated to firms. However, a wide range of governance mechanisms may be used simultaneously to align the interests of top management with shareholders. The relative importance of any mechanism may be influenced by a firm's choice of other governance and non-governance related factors.[11] For example, adopting a combined leadership structure may represent a response to organizational complexity, environmental uncertainty, board composition and social exchange reciprocity. Some firms may also use combined leadership to reward CEO for good performance, implying that *LD* is likely to be endogenously determined. Thus, we employ the following two-stage procedure of Heckman (1979), after controlling for bias associated with self-selection of leadership structure:

First-Stage Regression: $$LD_i = \alpha_0 + \alpha' Z_i + \varepsilon_i \quad (2)$$

where, $LD_i = 1$ if firm i uses the combined leadership, or

$LD_i = 0$ if firm i uses the separate leadership

As elaborated in the next section, we first obtain consistent estimates of coefficients from the first-stage probit regression of the dummy variable, *LD*, on factors (Z_i) expected to influence firm i's choice of leadership structure. We then

[11] See Faleye (2007) and Rediker and Seth (1995) for detailed discussion.

use Equation (2) estimates to compute the Inverse Mill Ratio (IMR). In the second-stage, we regress firm performance (Y_i) on IMR and other determinants (X_i) of firm performance by estimating the following model separately for firms with combined and separate leadership.

Combined leadership: $$Y_{ci} = \beta_{c0} + \beta_{ci}X_{ci} + \beta_{c\lambda}.\lambda_{ci} + u_c \quad (3a)$$

Separate leadership: $$Y_{si} = \beta_{s0} + \beta_{si}X_{si} + \beta_{s\lambda}.\lambda_{si} + u_s \quad (3b)$$

where λ_{ci} and λ_{si} denote IMR for firms practicing combined and separate leadership, respectively. The coefficient, $\beta_{c\lambda}$ (or $\beta_{s\lambda}$), is the covariance of residuals from Equation (3a) (or (3b)) for firms with combined (or separate) leadership and residuals from Equation (2). For each firm, we first calculate the difference between the observed firm value under combined (or separate) leadership, i.e., Y_{ci} (or Y_{si}), and the expected firm value had it selected an alternative separate (or combined) leadership structure, i.e., $E(Y_{si}|LD=c)$ (or $E(Y_{ci}|LD=s)$) using the following two equations:

Combined leadership: $$Y_{ci} - E(Y_{si}|LD=c) = Y_{ci} - \beta_{si}.X_{ci} - \beta_{s\lambda}.\lambda_{ci} \quad (4a)$$

Separate leadership: $$Y_{si} - E(Y_{ci}|LD=s) = Y_{si} - \beta_{ci}.X_{si} - \beta_{c\lambda}.\lambda_{si} \quad (4b)$$

In Equation (4a) (or (4b)), the expected firm value for Firm *i* under combined (or separate) leadership is obtained by multiplying its actual values of explanatory variables by parameters, β_{ji} and $\beta_{j\lambda}$, estimated from a pooled regression involving separate (or combined) leadership firms. We then take the average of differences across all combined (or separate) leadership firms in the sample and interpret it as the average marginal benefit/cost of practicing combined (or separate) leadership structure over the alternative of separate (or combined) leadership. From an econometric perspective, if either $\beta_{c\lambda} \neq 0$ or $\beta_{s\lambda} \neq 0$, then the dummy variable *LD* becomes correlated with the error term in Equation (3a) or (3b). In this case, the difference in firm performance between combined and separate leadership firms, estimated from standard OLS regression (i.e., Equation (1)), becomes biased.[12] On the other hand, if $\beta_{c\lambda} = 0$ and $\beta_{s\lambda} = 0$, then controlling for self-selection bias is no longer required and the effectiveness of a given leadership structure can once again be tested using Equation (1).

3.4.2 Research Design

First-Stage Regression Model:

To model the first-stage regression, we draw on the following theories and arguments presented in the extant finance and management literatures:[13]

(i) Rewards for Good Performance: According to Vancil (1987), CEOs may also be assigned the role of COBs due to their outstanding achievements in the past. To allow for this possibility, we initially consider two proxy variables, i.e., a firm's growth in sales (*FSLGR*; see Faleye 2007) and its growth in profits (*FPRGR*; see Finkelstein and D'Aveni 1994), measured over the last five years. We posit that growth in either dimension enhances the probability of adopting a combined leadership structure.

(ii) Industry Complexity: Boyd (1995) suggests that combined leadership is more likely to be practiced by firms operating in a complex, dynamic

[12] See Maddala (1983) for detailed discussion about endogeneity and self-selection bias in a latent variable model. Also see Chaney, Jeter and Shivakumar (2004) for its application.
[13] See Kang and Zardkoohi (2005) for a detailed review.

and resource-scarce environment. Following Boyd (1995), we initially consider three measures to capture industry complexity, i.e., industry sales growth over a five-year period (*INDSLGR*), volatility of industry sales growth over a five-year period (*INDVOL*) and industry concentration ratio (*INDCR*). We expect an increase in any of these proxy variables to raise the probability of introducing a combined leadership structure.

(iii) Board Structure: Harrison, Torres and Kukalis (1988, HTK thereafter) argue that assigning both CEO and COB positions to the same person are most likely for profitable firms, firms with many outside directors and those in highly concentrated industries. We use the number of insiders on the board[14] (*PRINS*; see Faleye 2007; HTK 1988) to proxy for board composition and predict that an increase in the proportion of inside directors reduces the probability of combined leadership.

(iv) Social Reciprocity: Westphal and Zajac (1997) theorize that social networks between a CEO and his/her company's board of directors who serve as a CEO or both CEO and COB of another company may yield less opposition to combined leadership. Following Westphal and Zajac (1997), we initially select two proxy variables to capture the impact of social reciprocity on the choice of combined leadership, i.e., the percentage of outside directors who are CEOs in their firms (*PRDIRCEO*) and the percentage of outside directors who are both CEO

[14] Growth in profits and industry concentration ratio are already included as proxy variables under rewards for good performance and industry complexity, respectively.

and COB in their firms (*PRDIRCOMB*). We predict that an increase in either *PRDIRCEO* or *PRDIRCOMB* raises the probability of a combined leadership structure.

(v) Enforcing Outcome of a Powerful CEO: Finkelstein and D'Aveni (1994, FD thereafter) argue that a powerful and entrenched CEO may exert pressure on the board to approve combined leadership structure. We initially consider three proxies to capture CEO's power, i.e., changes in CEO's total compensation (*CHCOMP*; see FD 1994; Finkelstein 1992), CEO's percentage of ownership in the firm (s)he manages (*CEOEQ*; see Faleye 2007; FD 1994) and his/her years of experience as a CEO in the same firm (*TENURE*; see Pfeffer and Salancik 1978). We expect that the probability of combined leadership to increase with the value of *CHTCOMP*, *CEOEQ* and *TENURE*.

The definitions and measurements of the aforementioned proxy variables for the first-stage regression are summarized in the Appendix.

As discussed in Section 3.5.2, most of the proxy variables within each leadership dimension are significantly correlated. To avoid potential multi-collinearity problems, we include only one variable that is most highly correlated with *LD* from each of the five dimensions in our first-stage regression model: [15]

$$LD_i = \alpha_0 + \alpha_1 FPRGR_i + \alpha_2 INDSLGR_i + \alpha_3 PRINS_i + \alpha_4 PRDIRCEO_i + \alpha_5 TENURE_i + \varepsilon_i \quad (5)$$

[15] Results using other combinations of proxy variables from each dimension of leadership structure are qualitatively similar and hence are not reported to conserve space. All the model variables are as defined previously.

Since leadership structure can also affect some of its determinants (e.g., *TENURE*; see Goyal and Park 2002), we lag all the right-hand variables in Equation (5) by at least one year.

Second-Stage Regression Model:

The second-stage regression model allows us to estimate the average benefit/cost associated with a specific leadership structure separately for subsets of firms with combined and separate leadership. In this case, we use the following model:

$$\text{Firm Performance}_{ji} = \beta_{j0} + \beta_{j1}PRINS_{ji} + \beta_{j2}CEOEQ_{ji} + \beta_{j3}LEV_{ji} + \beta_{j4}INVOPP_{ji} + \beta_{j5}SIZE_{ji} + \beta_{j6}FPRGR_{ji} + \beta_{j7}HISTFV_{ji} + \beta_{j\lambda}\lambda_{ji} + u_i \quad (6)$$

where j is either combined (c) or separate (s) leadership structure; firm performance is measured in three ways: Tobin's *Q*, market-to-book (*MB*) ratio and return on asset (*ROA*).[16] We include in Equation (6) the Inverse Mill Ratio (λ_{ji}) estimated from the first-stage regression along with seven well-known determinants of firm performance, such as board composition (*PRINS*; see Rosenstein and Wyatt 1990), CEO's equity ownership (*CEOEQ*; see Morck, Shleifer and Vishny 1988), leverage (*LEV*; see Faleye, Mehrotra and Morck 2006), investment opportunity (*INVOPP*; see Yermack 1996), firm size (*SIZE*; see Crongvist and Nilsson 2003), firm's growth in profitability over the last five years (*FPRGR*; see Mikkelson and Partch, 2003) and historical firm values (*HISTFV*; see Faleye et al. 2006). We also include industry dummy variables to control for

[16] These variables are commonly used as measures of firm performance in not just the finance and accounting literatures, but also recent papers on leadership structure (see Faleye 2006; Dahya 2004; Coles, McWilliams and Sen 2001)

industry-specific effects on firm performance (see Coles, McWilliam and Sen 2001).

Greene (1981) points out that the standard errors in OLS estimation based on Heckman's procedure can be either smaller or larger than the correct standard errors. We therefore calculate the correct variance-covariance matrix of the OLS estimates,[17] which allows us to adjust for standard errors in the OLS regression and find the correct level of significance for each of the second-stage regression variables.

Proxies for Conditioning Variables:

We consider five conditioning variables in this study. The first three are firm size, capital structure and market share, measured by the dollar value of total assets; the ratio of combined short- and long-term debt to net total assets; and the ratio of a firm's total sale revenue to its industry's aggregate sale revenue, respectively.[18] We first sort the entire sample firms from the recessionary period into terciles based on the Year *t-1* values of the conditioning variable in descending order (i.e., 2004 for our 2005 subsample). We then classify firms in the top-third distribution of firm size, capital structure or market share as large, heavily debt-financed or high market share; and those in the bottom-third as small, lightly debt-financed or low market share. For the remaining two conditioning variables, i.e., equity type and exchange listing, we partition sample firms into those with single versus dual-

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[17] The formula of variance-covariance matrix is given on pg. 785 in Greene's 5th edition of Econometric Analysis.

[18] These data are available from *COMPUSTAT*.

class stocks and NYSE versus non-NYSE listing, respectively.[19] For each of the above subsamples, we re-estimate Equation (3a) (or (3b)) for combined (or separate) leadership firms and re-calculate the mean marginal benefit/cost associated with combined (or separate) leadership over an alternative separate (or combined) leadership structure using Equations (4a) (or (4b)).

We do not repeat the above conditioning analysis for the boom period (i.e., 2000) due to a lack of data for some of the firms in each tercile, making the sample size too small for meaningful analysis. The omission is considered reasonable, as our overall analysis discussed in Section 3.5 indicates that the effectiveness of governance-related issues, such as leadership structure, is more important for the recessionary period than for the boom period.

3.5 MAIN RESULTS

3.5.1 Historical Trends in the US Corporate Leadership Structure

Table 3.1 reports the 11-year trend, starting from 1995, in leadership structure used by US firms.[20] On average, combined (separate) leadership was followed by 63% (37%) of all firms during the period of 1995-2005, significantly different from zero at the 1% level. Although combined leadership structure remained prominent throughout the period, the percentage of firms employing such

[19] These data are available from *RiskMetrics* and *CRSP*. Non-NYSE exchanges include National Association of Securities Dealers Automated Quotation System, American Stock Exchange and Over-the-Counter.

[20] The results are based on only those firms that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations in the table is higher than the actual sample size mentioned in Section 3.

leadership structure had gradually declined, ranging from a high of 68% in 1996 to a low of 54% in 2005.

[Insert Table 3.1 about Here]

Panels A-E of Table 3.2 reports both the number and the proportion of firms with combined leadership structure over an 11-year (1995-2005) period, when the sample is partitioned into two subsets annually according to firm size, capital structure, market share, equity type and exchange listing, respectively.

As is evident in Panel A, on average, about 74% of large firms chose to assign the dual roles of CEO and COB to the same person. The percentage is significantly higher than 52% for small firms at the 1% level. A relatively greater proportion of heavy debt-financed firms practiced combined leadership than light debt-financed firms, both overall and by year. For both groups of firms, the annual percentages went down from 70% (59%) in 1995 to 61% (44%) in 2005 (see Panel B). Combined leadership was also prominent among firms with high market share, more so than those with low market share (i.e., 72% versus 52%, on average, significant at the 1% level). This pattern applies to each of the 11 sample years (see Panel C). However, equity type does not appear to affect the choice of leadership structure. On average, combined leadership was only marginally more common among firms with single-class stock than those with dual-class stocks, i.e., 66% versus 60% at the 10% level (see Panel D).[21] Finally, a larger percentage of firms listed in NYSE used combined leadership during our 11-year sample period, compared to those listed in the other stock exchanges (i.e., 68% versus

[21] We have data on single- versus dual-class stocks of sample firms only for 5 years as shown in Panel D of Table 3.2.

53%, on average, significant at the 1% level). For both exchange types, the popularity of combined leadership has declined somewhat in recent years, ranging from 71% versus 58% in 1995 to 60% versus 43% in 2005 (see Panel E).

In short, evidence suggests that in corporate America combined leadership is more likely to be followed by large firms as well as firms with high debt-to-equity ratios, large market share, single-class stocks and NYSE listing. While firms appear to have gradually moved away from a combined leadership structure, such structure remained popular among the majority of our sample firms by the end of the sample period (i.e., 2005) for all sample partitions.

[Insert Table 3.2 about Here]

3.5.2 Descriptive Statistics of Sample Firms

Table 3.3 presents the pattern of leadership structure across 24 industries for the 2005 sample. As is evident in Column 4 (5), 504 (402) firms had a combined (separate) leadership. In 18 of 24 industries, the majority of firms used a combined leadership structure in 2005, where such structure was most prominent in the Food and Kindred Products (78%), followed by Petroleum Refining (75%) and Primary Metal industries (75%). By comparison, the separate leadership structure was favored by Agriculture (100%), Construction (60%) and Leather and Leather Product industries (60%).[22]

[Insert Table 3.3 about Here]

[22] In 2000 sample, combined leadership was prominent in 20 out of 22 industries. Among them, all sample firms in Tobacco, 90% firms in Paper and Printing, and 81% firms in Transportation Equipment industry practiced combined leadership. In contrast, the majority of firms in Construction (57%) and Manufacturing industries (56%) used separate leadership structure.

Univariate comparisons of mean and median first-stage regression variables presented in Panel A, Table 3.4, indicate that during the 2005 recessionary period firms practicing combined leadership on average experienced a profitability growth (*FPRGR*) of –15.5%, which is significantly different from the corresponding number of –54.6% under separate leadership. While industry complexity does not appear to influence a firm's choice of leadership structure, i.e., mean *INDSLGR* of 21% (19%) for combined (separate) leadership firms, these two groups of firms exhibit significant differences in the other three leadership dimensions (i.e. board structure, social reciprocity and enforcing outcome of a powerful CEO). Compared to firms with separate leadership, those with combined leadership tend to operate with relatively fewer inside directors (i.e., mean *PRINS* of 26.3% versus 31.3%, significant at the 1% level), a higher percentage of outside directors who also serve as the CEO of another company (i.e., mean *PRDIRCEO* of 16.9% versus 13.8%, significant at the 5% level), a higher proportion of outside directors who also serve as CEO and COB in another company (i.e., mean *PRDIRCOMB* of 8.7% versus 5.6%, significant at the 1% level), a larger equity ownership by CEOs in their own companies (i.e., mean *CEOEQ* of 2.5% versus 1.3%, significant at the 5% level) and longer CEO tenure (i.e., mean *TENURE* of 9.155 years versus 5.037 years, significant at the 1% level).

Contrasting the mean and median values of the second-stage regression variables reported in Panel B of Table 3.4 reveals that, in addition to *PRINS* and *CEOEQ*, firms with combined leadership structure also differ from those with separate leadership in the following three areas: the extent of leverage (i.e., mean *LEV* of 0.578 versus 0.499, significant at the 1% level), firm size (i.e., mean *SIZE* of USD 7,688 million versus USD 3,840 million, significant at the 1% level) and historic firm value (i.e., mean *HISTFV* of 1.794 versus 2.064, significant at the 1% level).[23] Of the three firm performance measures considered in the study, only Tobin's *Q* differs across firms with separate versus combined leadership (i.e., industry-adjusted average Tobin's *Q* of 1.715 versus 1.939, significant at the 1% level).

[Insert Table 3.4 about Here]

Turning next to Pearson correlations for the preliminary set of first-stage regression variables (see Panel A, Table 3.5). We find that the *LD* variable is significantly correlated with the following variables at the 1% level: the proportion of insiders in the Board (*PRINS*), the percentage of outside directors with either CEO designation (*PRDIRCEO*) or both CEO and COB designations (*PRDIRCOMB*) in another company, CEO ownership (*CEOEQ*) and CEO tenure (*TENURE*). The pair-wise Pearson correlations are –0.177, 0.089, 0.137, 0.084 and 0.272, respectively, suggesting that board structure, social reciprocity and CEO power are the strongest determinants for a combined leadership structure. Several of our proxy variables in each dimension are significantly correlated. To deal with potential problems due to multicollinearity, we only consider one

[23] Results hold when we compare median values of these variables between subsets of firms. For brevity, they are not discussed in the text. These univariate contrasts also extend to the 2000 sample and are consistent with results reported in Westphal and Zajac (1997), Finkelstein and D'Aveni (1994) and Harrison, Torres and Kukalis (1988).

variable from each dimension that is most significantly correlated with *LD* in our main analysis.[24]

Among the variables explaining firm performance in the second-stage regression (see Panel B, Table 3.5), CEO equity ownership (*CEOEQ*), firm's investment opportunity (*INVOPP*) and historic firm value (*HISTFV*) are positively correlated with Tobin's *Q*. The pair-wise Pearson correlations with Tobin's *Q* are 0.187, 0.082 and 0.758 respectively, significant at the 1% level. On the other hand, a firm's leverage and its size are both negatively correlated with Tobin's *Q* with pair-wise Pearson correlations of –0.222 and –0.176 respectively, significant at the 1% level. More importantly, corporate leadership dummy (*LD*) is negatively correlated with Tobin's *Q* (–0.087), significant at the 1% level.[25] Finally, all three firm performance measures, Tobin's *Q*, *MB* and *ROA*, are significantly and positively correlated with each other. The pair-wise Pearson correlation between Tobin's *Q* and *MB*, Tobin's *Q* and *ROA*, and *MB* and *ROA* are 0.428, 0.487 and 0.306 respectively, significant at the 1% level, suggesting that these are comparable measures of firm performance.

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[24] For example, within the dimension of industry complexity, the Pearson correlations between *INDSLGR* and *INDVOL*, *INDVOL* and *INDCR*, and *INDSLGR* and *INDCR* are –0.199, –0.065 and 0.089, significant at the 1%, 5% and 1% level, respectively. Proxies for social reciprocity, *PRDIRCEO* and *PRDIRCOMB*, are also strongly correlated (i.e., 0.605), significant at the 1% level. Finally, within the dimension of CEO power, the Pearson correlation between *CEOEQ* and *TENURE* is 0.336, significant at the 1% level. The only exception is in the social reciprocity dimension. The correlation between *PRDIRCEO* and *LD* (*PRDIRCOMB* and *LD*) is 0.089 (0.137), significant at the 1% level. We choose *PRDIRCEO* over *PRDIRCOMB* as our proxy for social reciprocity in the first-stage regression, because *PRDIRCEO* is relatively more common among our sample firms. On average 17% of outside directors are CEOs of other companies, whereas only 9% of outside directors hold both designations of CEO and COB in their own companies. Note that including *PRDIRCOMB* as well as all proxy variables in the first-stage regression model does not change our results qualitatively.

[25] We find that the variable *LD* is insignificantly correlated with *MB* and *ROA*. However, it is difficult to draw inferences about the effectiveness of combined leadership, as correlations are calculated without controlling for self-selection bias.

[Insert Table 3.5 about Here]

3.5.3 Results from the Two-Stage Regression Procedure

Columns 1 and 2 of Panel A (B and C), Table 3.6 report results from the first-stage (second-stage) regressions for 2005 and 2000, respectively. As is evident in Panel A, with the exception of the first dimension (i.e., reward for a CEO's good performance) all other proxy variables chosen to explain the leadership structure are significantly different from zero at the conventional levels in at least one of the sample years. Take 2005 for example. The coefficient estimate on the proxy for Industry Complexity (*INDSLGR*) is 0.555, significant at the 10% level. The corresponding estimates for Board Structure (*PRINS*), Social Reciprocity (*PRDIRCEO*) and CEO Power (*TENURE*) are –2.337, 1.055 and 0.066, all significant at the 1% level. Results are largely similar in the boom period of 2000 for the Board Structure and the CEO Power dimensions. These results suggest that irrespective of economic conditions, a greater representation of inside directors in the board decreases the probability of selecting combined leadership. Likewise, the CEO tenure has a significant effect on the choice of combined leadership structure in both the recessionary and the boom period. However, the importance of Social Reciprocity or Industry Complexity would appear to depend on the economic climate. In particular, as the proportion of outside directors with the CEO designation increases or industry sales growth rises, firms are more likely to choose a combined leadership structure only during recessionary period (i.e., 2005). The findings that firms favor combined leadership when there is limited number of insiders sitting in the board, more social networking between CEO and outside directors holding similar positions in another company and greater CEO power earned through his long services with the firm as a CEO suggest that the choice of a firm's leadership structure is not random.[26]

Moving to the second-stage regression of firm performance on leadership structure next. Equation (6) is estimated separately for firms with combined and separate leadership in each sample period to allow the slope coefficients to vary across these two groups of firms. When Tobin's Q is used as a proxy for firm performance, we find that for combined leadership firms the coefficients on Inverse Mill Ratio in 2005 and 2000 are significant at the 1% and 5% level, respectively, implying that it is appropriate to control for self-selection bias (see Panel B). Among firms with combined leadership in the recessionary period (i.e., 2005), Tobin's *Q*, is inversely related to *PRINS* (i.e., coefficient estimate = –0.509, significant at the 10% level) and *SIZE* (i.e., coefficient estimate = –0.134, significant at the 1% level), but positively related to *CEOEQ* and *HISTFV* (i.e., coefficient estimates = 3.954 and 0.703, significant at the 1% level). During the boom period (i.e., 2000), *CEOEQ* and *SIZE* adversely affect combined leadership firms' value (i.e., coefficient estimates = –4.924 and –0.541, significant at the 5% level); and the converse is true with *FPRGR* and *HISTFV* (i.e., coefficient estimates = 0.064 and 1.330, significant at the 1% level).

Turning next to the question of whether firms have chosen the appropriate leadership structure. We find that combined (separate) leadership firms

[26] As a robustness check, we run the first-stage regression by including a different proxy variable from each dimension. The regression results (not reported in a table) are qualitatively similar.

consistently attained a higher firm value during the economic downturn (i.e., 2005), compared to the case had they adopted separate (combined) leadership. The average marginal benefits, measured by Tobin's *Q*, were 1.325 and 1.400 to firms with combined and separate leadership, respectively, both significant at the 1% level (see Columns 1a-1b, Panel B). The corresponding figures when *MB* is used as a measure of firm performance are 0.478 and 0.985, significant at the 10% and 1% levels, respectively (see Columns 1a-1b, Panel C). Results are qualitatively similar, though weaker, when we employ *ROA* as a proxy for firm performance. While the average marginal benefit was insignificantly different from zero for combined leadership firms, it is positive and significant (0.035) at the 10% level for separate leadership firms (see Columns 1a-1b, Panel D). Taken together, these results suggest that after taking into account the self-selection bias both groups of firms made the appropriate choice about their leadership structure when the economic condition is poor. By comparison, during boom times (i.e., 2000) firms consistently employed the inappropriate leadership structure, irrespective of how firm performance is measured. Take Tobin's *Q* for example. The average marginal cost to combined (separate) leadership firms was 2.114 (1.963), significant at the 1% (1%) level (see Columns 2a-2b, Panel B). Costs were even higher when *MB* is used as a proxy for firm performance (i.e., 3.596 and 4.396, both significant at the 1% level). These results imply that both groups of firms could improve their firm value by choosing an alternative separate (combined) leadership structure. It would appear that when the economy is strong firms tend to make decisions, including their choice of leadership structure, that are contrary to the best interest of shareholders.

[Insert Table 3.6 about Here]

The above results are robust to alternative choices of sample years from the boom and recessionary periods. For this analysis, we draw 562 and 860 firms from 1999 and 2004, respectively. Take the 2004 sample for example, the average marginal benefits, measured by *MB*, for combined and separate leadership firms were 1.424 and 4.514, both significant at the 1% level. The average marginal costs for combined and separate leadership firms in 1999 were 0.099 and 2.413, significant at the 10% and 1% levels, respectively.

To rule out the possibility that the sensitivity of our findings to economic conditions may be driven by differences in sample size, i.e., 906 versus 391 in 2005 and 2000, respectively, we also re-run 2005 regressions based on a reduced sample of firms that overlap with our 2000 sample. Results (not reported in a table) remain qualitatively unchanged.

Finally, we replicate the Table 6 analysis based on a subset of 488 firms that stayed with the same leadership structure from 1995 to 1999 to ensure that our results are not confounded by factors that contribute to switches in leadership structure. Among them, 358 and 130 are classified as combined and separate leadership firms, respectively. The average marginal cost, measured by *MB*, to combined (separate) leadership firms in 2000 was 0.086 (11.439), significant at the 1% (1%) level. This result is once again consistent with our main finding for the boom period.[27]

3.6 FURTHER ANALYSIS OF THE EFFECTIVE OF COMBINED LEADERSHIP

Panels A-E of Table 3.7 present results from estimating the two-stage regression model, Equations (3a) and (3b), on our 2005 sample firms when the sample is partitioned into small versus large firms, high versus low debt-to-equity ratios and high versus low market share, dual- versus single-class stocks and NYSE versus non-NYSE exchange listings.

As is evident in Panel A, large combined leadership firms performed significantly better than the case had they used an alternative separate leadership structure. Conversely, large separate leadership firms could have increased their firm value, measured by *ROA*, by using combined leadership structure instead. The average marginal benefit (cost) of combined (separate) leadership structure is 0.029 (–0.042), significant at the 1% (1%) level (see Columns 2a-2b, Panel A).[28] It would appear that the complexity of large organizations has made combined leadership structure more appealing notwithstanding the potential conflicts of interests that may arise from such a leadership structure. By comparison, small firms consistently chose the wrong leadership structure during the recessionary period (i.e., 2005). Small combined (separate) leadership firms attained a lower

[27] Unfortunately, we cannot apply an analogous methodology to the recessionary period (2001-2005) because there is no self-selection bias.
[28] Results (not reported in a table) are qualitatively similar when *MB* is used as a proxy for firm performance.

firm value than the case had they employed separate (combined) leadership structure (see Columns 1a-1b, Panel A). The mean marginal cost to small combined (separate) leadership firms is –0.052 (–0.016), significant at the 1% (5%) level.

Using debt-to-equity ratios as the conditioning variable, we find that high-leveraged firms were able to select the appropriate leadership structure in 2005. For this group of firms, their chosen combined (or separate) leadership structure generates higher firm value, measured by *MB*, than the alternative of separate (or combined) leadership structure. The improvement to performance is especially pronounced for high-leveraged combined leadership firms with average marginal benefit of 2.408, significant at the 1% level. The corresponding mean marginal benefit for high-leveraged separate leadership firms is 1.295, significant at the 1% level (see Columns 2a-2b, Panel B). In contrast, low-leveraged firms could have achieved higher firm value, measured by *ROA*, had they adopted an alternative leadership structure. The average marginal costs for those practicing combined and separate leadership are –0.075 and –0.036, respectively, both significant at the 1% level (see Columns 1a-1b, Panel B).

When firms have low market share in the industry, combined leadership structure would consistently yield better firm performance, measured by *ROA*, than separate leadership. For this group of firms, the average marginal benefit (cost) is 0.038 (–0.043) if their chosen leadership structure is combined (separate), significant at the 1% (1%) level (see Columns 1a-1b, Panel C). Thus, competitive pressure from rival firms in the product market would appear to have helped constrain a combined leader's ability to act in a manner contrary to the best interest of shareholders. Conversely, firms with high market share are generally better off with separate leadership structure, irrespective of their chosen leadership structure. The mean marginal cost (benefit) is –0.053 (0.097) for firms practicing combined (separate) leadership, significant at the 1% (1%) level (see Columns 2a-2b, Panel C).

Both single-class and dual-class stock firms are able to choose the "appropriate" leadership structure in 2005. For example, single-class combined (separate) leadership firms enjoyed better firm performance, measured by *MB*, than the case had they opted for separate (combined) leadership. The average marginal benefits are 0.124 and 0.232, respectively, both significant at the 10% level (see Columns 1a-1b, Panel D). The corresponding average benefits facing dual-class combined and separate leadership firms are 1.229 and 4.146, respectively, both significant at the 1% level (see Columns 2a-2b, Panel D). These results suggest that no single equity type would consistently limit or exacerbate agency problems such as to make one of the leadership structures an overwhelming favorite all the time.

Finally, results indicate that non-NYSE listed firms could attain higher firm value, measured by *ROA*, by using a separate leadership structure in 2005 (see Columns 1a-1b, Panel E). For non-NYSE combined (separate) leadership firms, the average marginal cost (benefit) over the alternative separate (combined) leadership structure are –0.033 (0.035), significant at the 1% (1%) level. The relatively poor performance experienced by non-NYSE listed combined leadership firms may be explained by less stringent regulatory requirement in these exchanges, thus allowing any agency problem arising from combined leadership to remain unchecked.

Taken together, results from the above conditional analyses suggest that when the economy is bad (i.e., in 2005) the effectiveness of combined leadership varies across firms. In particular, combined leadership structure works well for large firms and firms with low market share. On the other hand, separate leadership structure yields higher firm value for firms with high market share and those listed in a non-NYSE stock exchange. By identifying conditions under which combined leadership is the value-maximizing leadership structure, we shed light on why the combined leadership structure remains popular in corporate America today. As reported in Table 2, about 67% of large firms in our sample were still led by the same person with dual CEO and COB responsibilities by the end of our sample period (i.e., 2005), yet most (57%) of the non-NYSE listed sample firms practiced separate leadership structure that same year.[29]

Evidence on whether firms employ the appropriate leadership structure in practice is also mixed. The answer is affirmative when equity type is used as the conditioning variable to partition the sample, but less so when capital structure, firm size, market share or exchange listing is used. The findings that firms are able to select a leadership structure that enhances their firm value under at least some business conditions lend support for our conjecture that the choice of

[29] Admittedly, our conditional analysis cannot explain the trends exhibited by high versus low market share firms, reported in Panel C of Table 3.2. Greater insight may be gained by further partitioning the sample along multiple dimensions. It is nonetheless beyond the scope of current study.

leadership structure is non-random. Thus, studies of the association between firm performance and leadership structure would need to employ a research design that explicitly takes into account the potential self-selection bias.

[Insert Table 3.7 about Here]

3.7 CONCLUSION

Following recent high-profiled corporate scandals, many researchers, practitioners and regulators have questioned the effectiveness of combined leadership. Notwithstanding the on-going debates, such practice remains prominent in corporate America. In this study, we have addressed the question of whether restructuring corporate leadership structure is really necessary using a two-stage regression model after controlling for the interdependence of leadership structure with other governance and non-governance related factors in different economic cycles and under varying business conditions.

Results indicate that, regardless of how firm performance is measured, both combined and separate leadership firms consistently chose a leadership structure appropriate for their circumstances during the recessionary period (i.e., 2005). The converse, however, is true in the boom period (i.e., 2000). It would appear that firms are generally less careful about their choice of leadership structure when the economy is strong. A closer monitoring by board of directors during boom time therefore may be worthwhile.

Partitioning 2005 sample according to several firm-specific and industry-level attributes, we find that the overall observation that firms used the "right" leadership structure during economic downturn does not extend to all firms. In particular, small and low-leveraged firms often chose the “wrong” leadership structure, whereas high-leveraged firms were able to use the appropriate leadership structure. Further analysis indicates that under some business conditions one of the leadership structures always produces relatively higher firm value. For example, combined leadership is the value-maximizing leadership structure for large firms and those with low market share. By comparison, separate leadership structure is associated with better firm performance for non-NYSE listed or high market-share firms. These results offer a plausible explanation for the observed popularity of combined or separate leadership structure among these firms in 2005. Just as importantly, they identify conditions that support the opposing views proposed by the agency and organization theorists about the effectiveness of combined leadership structure.

There are several avenues to extend the current study: (1). Checking to see whether our results about the effectiveness of leadership structure would continue to hold for firms that made at least one change to their leadership structure during the 11-year (1995-2005) sample period. Presumably, an independent board may implement changes to leadership structure when an existing combined (separate) leadership structure produces lower firm value than the alternative of separate (combined) leadership structure. Tracking the patterns of leadership structure and the associated marginal benefits/costs for the same firm over time would allow the researcher to address this issue. (2). Looking into the characteristics of firms that made no versus multiple changes to their leadership structure. For example, does each successive change improve firm value or represent a response to changes to the underlying business conditions? Does an absence leadership structure changes turn out to be rational *ex post*? Insight obtained from both lines of enquiry, which we are pursuing in a separate research project, will enhance our understanding of the relationship between leadership structure and firm performance.

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Appendix 3A: Definition and Measurement of Two-Stage Regression Variables

Panel A: First-Stage Regression Variables	Definition	Measurement
(1) Reward for a CEO's Good Performance		
FSLGR	Firm *i*'s sales growth over 5 years	$(Sales_{i,t-1} - Sales_{i,t-5})/Sales_{i,t-5}$
FPRGR	Firm *i*'s growth in profitability over 5 years	$(ROA_{i,t-1} - ROA_{i,t-5})/ROA_{i,t-5}$
(2) Industry Complexity		
INDSLGR	Industry *j*'s sales growth over 5 years	$(Sales_{j,t-1} - Sales_{j,t-5})/Sales_{j,t-5}$
INDVOL	Industry volatility	Standard deviation of aggregate industry sales growth over 5 years
INDCR	Industry concentration ratio	$\Sigma(Market\ Share)_i$ where *i* is the top four firms with the highest market shares within the industry
(3) Board Structure		
PRINS	Proportion of insiders in the board	Ratio of number of directors who are either employees or individuals connected with the firm to total number of directors in the board as of (*t-1*)
(4) Social Reciprocity		
PRDIRCEO	Proportion of directors with CEO (Chief Executive Officer) designation in other companies	Ratio of number of directors who are also CEOs in their companies to total number of independent directors
PRDIRCOMB	Proportion of directors with both CEO and COB (Chairman of the Board) designations in other companies	Ratio of number of directors who hold both positions of CEO and Chairman in their companies to total number of independent directors
(5) Enforcing Outcome of a Powerful CEO		
CHGCOMP	Change of total compensation (*TC*) of a CEO	$(TC_{CEO,i,t} - TC_{CEO,i,t-1})/TC_{CEO,i,t-1}$
CEOEQ	CEO's equity ownership	Number of shares of the company owned by CEO divided by total number of year-end outstanding shares of the company
TENURE	CEO's tenure	Number of years as a CEO in the firm as of (*t-1*)

Panel B: Second-Stage Regression Variables	Definition	Measurement
MB	Market-to-Book ratio	Ratio of market value of common equity to book value of common equity. Market value is the product of year-end stock price and year-end number of outstanding shares. Book value is defined as a firm's total assets less total liabilities
ROA	Return on asset	$Net\ income_{i,t}/Total\ assets_{i,t-t}$
TQ	Tobin's *Q*	Defined as market value of common equity plus book values of preferred equity and long-term debt divided by the book value of assets less short-term debt
LD	Leadership dummy	A dummy variable that is equal to 1 if a CEO holds the position of Chairman of the board in his/her company, 0 otherwise
PRINS	Proportion of insiders in the board	Ratio of number of directors who are either employees or individuals connected with the firm to total number of directors in the board as of (*t-1*)
CEOEQ	CEO ownership	Number of shares of the company owned by CEO at *t* divided by total number of outstanding shares of the company at (*t-1*)
LEV	Leverage	$Total\ liabilities_{i,t}/Total\ assets_{i,t-1}$
INVOPP	Investment opportunity	$Capital\ expenditure_{i,t}/Total\ assets_{i,t-1}$
SIZE	Firm size	Log($Total\ Assets_{i,t-1}$)
HISTFV	Historical firm value	Median of Tobin's *Q* over the last five years

Table 3.1: Corporate Leadership Structure

The following results are based on only those firms of the *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations in this table is higher than the actual sample size mentioned in the paper. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) in the same company. In contrast, separate leadership implies that two individual persons hold the responsibilities of the CEO and the COB of a firm. Percentage of firms with combined (separate) leadership is estimated by calculating the ratio of the number of firms with combined (separate) leadership to total number of observations. *** implies the significance of the difference in average between total number (the percentage) of combined and separate leadership firms at the 1% level.

Year	Total Number of Observations	# (%) of Firms with Combined Leadership	# (%) of Firms with Separate Leadership
1995	1600	1067 (67%)	533 (33%)
1996	1651	1115 (68%)	536 (32%)
1997	1674	1126 (67%)	548 (33%)
1998	1731	1131 (65%)	600 (35%)
1999	1811	1144 (63%)	665 (37%)
2000	1792	1144 (64%)	648 (36%)
2001	1671	1033 (62%)	638 (38%)
2002	1675	1037 (62%)	638 (38%)
2003	1692	1006 (59%)	686 (41%)
2004	1699	993 (58%)	706 (42%)
2005	1700	911 (54%)	789 (46%)
Average	1700	1064 (63%)	635 (37%)
Difference in Average # (%)			429*** (26%)***
t-stat of Difference in Average # (%)			13.05 (13.89)

Table 3.2: Distribution of Firms with Combined Leadership under Conditional Factors

Panel A: Firm Size

The table includes only those firms of *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations differs from the sample size mentioned in the paper. Furthermore, total number of sample firms varies each year depending on the availability of data in *CRSP/Compustat*. We sort all firms of the entire sample in ascending order based on firm size (total assets in USD $$) in each year and consider firms in the top (the first 33% of observations) and bottom (the last 33% of observations) terciles as small and large firms, respectively. Therefore, total number of small and large firms is the same in each year. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer and the Chairman of the Board in the same company. Percentage of large (small) firms with combined leadership is estimated by calculating the ratio of the number of large (small) firms with combined leadership to total number of large (small) firms. *** implies the significance of difference in the average at the 1% level.

Year	Total # of Large/Small Firms	Total # of Firms with Combined Leadership		% of Firms with Combined Leadership	
		Large Firms	Small Firms	Large Firms	Small Firms
1995	519	410	290	79%	56%
1996	534	419	304	78%	57%
1997	542	436	300	80%	55%
1998	560	435	312	78%	56%
1999	585	451	296	77%	51%
2000	577	433	304	75%	53%
2001	557	400	289	72%	52%
2002	543	391	279	72%	51%
2003	551	384	276	70%	50%
2004	551	383	266	70%	48%
2005	551	368	228	67%	41%
Average	552	410	286	74%	52%
Difference in Average	-	124***		22%***	
t-stat of Difference in Average	-	11.52		11.70	

Table 3.2 (Continued)

Panel B: Firm's Capital Structure

The table includes only those firms of *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations differs from the sample size mentioned in the paper. Furthermore, total number of sample firms varies each year depending on the availability of data in *CRSP/Compustat*. We initially sort all firms of the entire sample in ascending order based on the ratio of total short- and long-term debt to net total assets in each year and then consider firms in the top (the first 33% of observations) and the bottom (the last 33% of observations) tercile as firms with the lowest and the highest debt-equity (DE) ratio, respectively. Therefore, total number of firms with the lowest and the highest DE are the same in each year. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer and the Chairman of the Board in the same company. Percentage of firms with the lowest (the highest) DE and combined leadership is estimated by calculating the ratio of the number of the lowest (the highest) DE firms with combined leadership to total number of the lowest (the highest) DE firms. *** implies the significance of difference in the average at the 1% level.

Year	Total # of Firms with High/Low DE	Total # of Firms with Combined Leadership		% of Firms with Combined Leadership	
		High DE	Low DE	High DE	Low DE
1995	528	370	310	70%	59%
1996	546	394	333	72%	61%
1997	553	409	322	74%	58%
1998	572	401	330	70%	58%
1999	604	408	310	68%	51%
2000	597	422	320	71%	54%
2001	553	388	282	70%	51%
2002	552	375	297	68%	54%
2003	560	372	285	66%	51%
2004	559	358	279	64%	50%
2005	557	342	247	61%	44%
Average	562	385	301	69%	54%
Difference in Average	-	84***		15%***	
t-stat of Difference in Average	-	7.80		8.14	

Table 3.2 (Continued)

Panel C: Firm's Market Share

The table includes only those firms of *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations differs from the sample size mentioned in the paper. Furthermore, total number of sample firms varies each year depending on the availability of data in *CRSP/Compustat*. We initially sort all firms of the entire sample in ascending order based on the ratio of a firm's total sale revenues to its industry's aggregate sale revenues in each year and then consider firms in the top (the first 33% of observations) and the bottom (the last 33% of observations) tercile as firms with the lowest (highest) market share (MS), respectively. Therefore, total number of firms with the lowest and the highest MS are the same in each year. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer and the Chairman of the Board in the same company. Percentage of firms with the lowest (the highest) MS and combined leadership is estimated by calculating the ratio of the number of the lowest (the highest) MS firms with combined leadership to total number of the lowest (the highest) MS firms. *** implies the significance of difference in the average at the 1% level.

Year	Total # of Firms with High/Low MS	Total # of Firms with Combined Leadership		% of Firms with Combined Leadership	
		High MS	Low MS	High MS	Low MS
1995	407	317	227	78%	56%
1996	422	327	241	77%	57%
1997	433	341	236	79%	55%
1998	448	333	247	74%	55%
1999	475	334	234	70%	49%
2000	467	343	248	73%	53%
2001	438	303	233	69%	53%
2002	434	302	224	70%	52%
2003	329	223	159	68%	48%
2004	440	305	208	69%	47%
2005	430	292	189	68%	44%
Average	429	311	222	72%	52%
Difference in Average	-	89***		20%***	
t-stat of Difference in Average	-	6.75		11.70	

Table 3.2 (Continued)

Panel D: Equity Type

The table includes only those firms of the *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations in this table is different from the sample size mentioned in the paper. Out of our sample years from 1995 to 2005, *RiskMetric* has data on equity-type for the following five years and therefore the table contains the results corresponding to these years only. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer and the Chairman of the Board in the same company. Percentage of firms with dual-class (single-class) stocks and combined leadership is estimated by calculating the ratio of the number of dual-class (single-class) stock firms with combined leadership to total number of dual-class (single-class) stock firms. *** and * implies the significance of difference in the average at the 1% and 10%, respectively.

Year	Total Number of Observations	# of Observations by Equity Type		# (%) of Firms with Combined Leadership	
		Firms with Dual-class Stocks	Firms with Single-class Stocks	Firms with Dual-class Stocks	Firms with Single-class Stocks
1995	697	50	647	34 (68%)	461 (71%)
1998	995	80	915	50 (63%)	604 (66%)
2000	1035	93	942	53 (57%)	638 (68%)
2002	1273	115	1158	65 (57%)	739 (64%)
2004	1392	131	1261	74 (56%)	770 (61%)
Average	1079	94	985	55 (60%)	642 (66%)
Difference in Average # (%)				587*** (6%*)	
t-stat of Difference in Average # (%)				10.64 (2.02)	

Table 3.2 (Continued)

Panel E: US Stock Exchanges

The table includes the proportion of firms with combined leadership that are listed in the New York Stock Exchange (NYSE) and non-NYSE (i.e., National Association of Securities Dealers Automated Quotation System, American Stock Exchange and Over-the-Counter) during the period of 1995-2005. The following results are based on only those firms of the *Executive Compensation* that have data about a CEO's complete designation in a company. As we do not apply other filters to select sample firms, the total number of observations in this table is higher than the actual sample size mentioned in the paper. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) of a company. Percentage of firms with combined leadership that are listed in a specific stock exchange (NYSE versus non-NYSE) is estimated by calculating the ratio of the number of firms with combined leadership in a stock exchange to total number of sample firms listed in the same stock exchange. *** implies the significance of the difference in average at the 1% level.

Year	Total Number of Observations	# of Observations by Stock Exchanges		# (%) of Firms with Combined Leadership in Respective Exchanges	
		NYSE	Non-NYSE	NYSE	Non-NYSE
1995	1600	1080	520	763 (71%)	304 (58%)
1996	1651	1111	540	789 (71%)	326 (60%)
1997	1674	1107	567	802 (72%)	324 (57%)
1998	1731	1119	612	790 (71%)	341 (56%)
1999	1811	1123	688	781 (70%)	363 (53%)
2000	1792	1110	682	777 (70%)	367 (54%)
2001	1671	1064	607	719 (68%)	314 (52%)
2002	1675	1075	600	726 (68%)	311 (52%)
2003	1692	1086	606	714 (66%)	292 (48%)
2004	1699	1083	616	696 (64%)	297 (48%)
2005	1700	1073	627	642 (60%)	269 (43%)
Average	1700	1094	606	745 (68%)	319 (53%)
Difference in Average # (%)				426*** (15%***)	
t-stat of Difference in Average # (%)				24.37 (8.06)	

Table 3.3: Corporate Leadership Structure By Industry (Sample Year: 2005)

The table includes 24 individual US industries except energy and financials as classified by 2-digit SIC. These industries include all sample firms in 2005, which are categorized into firms with combined and separate leadership. Combined leadership implies a unique position that includes the roles of both the CEO (Chief Executive Officer) and the COB (Chairman of the Board) of a firm. Under separate leadership, the CEO and the COB are two individual executives who lead the management and the board of a firm, respectively. Firm distribution based on the type of leadership is calculated by dividing the number of firms under each category within an industry by total number of sample firms of the same industry.

1. Industry	2. Two-digit SIC	3. # of sample firms	4. # of sample firms *with* combined leadership	5. # of sample firms *with* separate leadership	6. Distribution by Leadership	
					6a. % of sample firms with combined leadership *within* industry	6b. % of sample firms with separate leadership *within* industry
Agriculture	01, 02, 07, 08, 09	1	0	1	0	100
Mining	10, 12, 13, 14	40	21	19	53	48
Construction	15, 16, 17	15	6	9	40	60
Food and Kindred Products	20	27	21	6	78	22
Tobacco	21	3	2	1	67	33
Textiles and Apparels	22, 23	12	7	5	58	42
Lumber, Wood Products and Furniture	24, 25	16	7	9	44	56
Paper and Publishing	26, 27	42	29	13	69	31
Chemicals	28	76	46	30	61	39
Petroleum Refining	29	12	9	3	75	25
Rubber and Plastic	30	9	5	4	56	44
Leather and Leather Products	31	5	2	3	40	60
Stone, Clay, Glass and Concrete Products	32	6	4	2	67	33
Primary Metal	33	24	18	6	75	25
Fabricated Metal	34	16	10	6	63	38
Machinery and Computers	35	62	35	27	56	44
Electronics and Electrical Products	36	96	40	56	42	58
Transportation Equipments	37	32	22	10	69	31
Other Manufacturing	38, 39	80	43	37	54	46
Transportation and Communications	40 - 48	49	26	23	53	47
Wholesale Trade	50, 51	35	21	14	60	40
Retail Trade	52 - 59	92	50	42	54	46
Services (Excluding Financials and Energy)	70 - 79, 80 - 87	154	79	75	51	49
Unclassified	99	2	1	1	50	50
	Total	906	504	402	56	44

Table 3.4: Cross-sectional Differences between Sample Firms With- and Without Combined Leadership

The following calculations are based on all 2005 sample firms. It distinguishes the characteristics of individual firms with combined and separate leadership along the five dimensions. Combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) of a company. In contrast, separate leadership implies that two individual persons hold the responsibilities of the CEO and the COB of a firm. The definition of each dimension of leadership structure in Panel A is given in the text. As two separate proxy variables of Reward for a CEO's Good Performance, we consider a firm's industry-adjusted growth in sales (*FSLGR*) and industry-adjusted profitability growth (*FPRGR*) over the last five years. Sales and profitability growth of a firm, *i*, is calculated from ($Sales_{i,t-1} - Sales_{i,t-5}$)/$Sales_{i,t-5}$ and ($ROA_{i,t-1} - ROA_{i,t-5}$)/$ROA_{i,t-5}$, respectively. We then subtract the industry-median growth of sales and profitability from their corresponding firm level measures to estimate industry-adjusted values of sales and profitability growth of each sample firm. In the formula, profitability is measured by *ROA* (return on asset) that is a ratio of a firm's net income to total assets in a given year. Among three measures of Industry Complexity, *INDSLGR* is industry (*j*) sales growth over the last five years, *INDVOL* is the volatility in industry sales over the last five years and *INDCR* is the industry concentration ratio. *INDSLGR* is calculated from ($Sales_{j,t-1} - Sales_{j,t-5}$)/$Sales_{j,t-5}$ and industry concentration is measured by taking the summation of the highest market shares (the ratio of a firm's sales to its respective industry's total sales in a given year) of top four firms within an industry. We consider *PRINS* as a proxy measure of Board Structure, which is the proportion of insiders (either employees or individuals connected with the firms) on the board of directors. As two different indicators of Social Reciprocity, we consider *PRDIRCEO* and *PRDIRCOMB*, and they are estimated by calculating the ratio of number of directors who are either CEOs or both CEOs and COBs of their own companies to total number of directors, respectively. Among three proxy variables of Powerful CEO, *CHTCOMP* is the change in total compensations of CEOs between period *t* and *t-1*, *CEOEQ* is the CEO's equity ownership, and *TENURE* is CEO's total number of years of experience as a CEO in the same company as of *t-1*. Total compensation includes cash salary, bonus, restricted stock grants, LTIP payments and value of option exercised in a given year, and equity ownership is the ratio of the number of company-shares held by the CEO to total number of outstanding shares of his/her company. Panel B includes all variables of the second-stage regression. Among them, *MB* (market-to-book) is the ratio of market value of common equity to its book value. Market value of equity is calculated by multiplying year-end share price with year-end outstanding shares and book value is a firm's total assets less total liabilities. *ROA* is the ratio of a firm's net income at period *t* to total assets in period *t-1* and Tobin's *Q* is the market value of common equity plus book values of preferred equity and long-term debt divided by the book value of assets less short term debts. Among control variables, *LEV* is a firm's leverage (a ratio of a firm's total liabilities at *t* to total assets at *t-1*), *INVOPP* is the firm's investment opportunity (a ratio of a firm's capital expenditure at *t* to its total assets at *t-1*), *SIZE* is the firm's total asset in USD $$ at the beginning of the year (we use logarithm of a firm's total assets at *t-1* in the regression) and *HISTFV* is the firm's historical firm value (median of a firm's Tobin's *Q* over the last five years). The table includes mean and median of all variables from the first- and second-stage regressions and their corresponding *t*-statistics of mean differences between two categories of firms. ***, ** and * imply the level of significance in mean difference at the 1%, 5% and 10% level, respectively.

Panel A: First-Stage Regression Model

Variables	Average Numbers		Median Numbers		Significance Test of Mean Difference (*t*-stat)
	Firms *with* Combined Leadership	Firms *with* Separate Leadership	Firms *with* Combined Leadership	Firms *with* Separate Leadership	
<u>Reward for a CEO's Good Performance</u>					
FSLGR	-0.113	-0.176	-0.242	-0.353	1.074
FPRGR	-0.155	-0.546	-0.574	-0.623	1.701*
<u>Industry Complexity</u>					
INDSLGR	0.209	0.193	0.198	0.160	1.549
INDVOL	0.085	0.086	0.054	0.054	-0.315
INDCR	0.306	0.301	0.299	0.278	0.709
<u>Board Structure</u>					
PRINS	0.263	0.313	0.222	0.300	-5.421***
<u>Social Reciprocity</u>					
PRDIRCEO	0.169	0.138	0.143	0.125	2.712**
PRDIRCOMB	0.087	0.056	0.000	0.000	4.144***
<u>Enforcing Outcome of a Powerful CEO</u>					
CHTCOMP	0.783	0.969	0.167	0.219	-1.150
CEOEQ	0.025	0.013	0.004	0.002	2.536**
TENURE	9.155	5.037	6.000	3.000	8.511***

Panel B: Second-Stage Regression Model

<u>Dependent Variables</u>					
MB	3.160	3.252	2.527	2.527	-0.544
ROA	0.068	0.063	0.065	0.065	0.908
TOBIN'S Q	1.715	1.939	1.369	1.565	-2.965***
<u>Independent Variables</u>					
PRINS	0.263	0.313	0.222	0.300	-5.421***
CEOEQ	0.025	0.013	0.004	0.002	2.536**
LEV	0.578	0.499	0.559	0.478	4.784***
INVOPP	0.057	0.058	0.040	0.037	-0.109
SIZE	7688.080	3839.568	1893.498	1097.198	4.222***
FPRGR	-0.155	-0.546	-0.574	-0.623	1.701*
HISTFV	1.794	2.064	1.381	1.646	-3.157***

Table 3.5: Pearson Correlation between Regression Variables

The following correlation matrices are based on all 2005 sample firms. The table includes all variables of the first- and the second-stage regression models. *LD* is a leadership dummy that is either equal to 1 if a firm experiences combined leadership or 0 if a firm practices separate leadership structure. By definition, combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) of a company. In contrast, separate leadership implies that two individual persons hold the responsibilities of the CEO and the COB of a firm. As two separate proxy variables of Reward for a CEO's Good Performance, we consider a firm's industry-adjusted growth in sales (*FSLGR*) and industry-adjusted profitability growth (*FPRGR*) over the last five years. Sales and profitability growth of a firm, *i*, is calculated from $(Sales_{i,t-1} – Sales_{i,t-5})/Sales_{i,t-5}$ and $(ROA_{i,t-1} – ROA_{i,t-5})/ROA_{i,t-5}$, respectively. We then subtract the industry-median growth of sales and profitability from their corresponding firm level measures to estimate industry-adjusted values of sales and profitability growth of each sample firm. In the formula, profitability is measured by *ROA* (return on asset) that is a ratio of a firm's net income to total assets in a given year. Among three measures of Industry Complexity, *INDSLGR* is industry (*j*) sales growth over the last five years, *INDVOL* is the volatility in industry sales over the last five years and *INDCR* is the industry concentration ratio. *INDSLGR* is calculated from $(Sales_{j,t-1} – Sales_{j,t-5})/Sales_{j,t-5}$ and industry concentration is measured by taking the summation of the highest market shares (the ratio of a firm's sales to its respective industry's total sales in a given year) of top four firms within an industry. We consider *PRINS* as a proxy measure of Board Structure, which is the proportion of insiders (either employees or individuals connected with the firms) on the board of directors. As two different indicators of Social Reciprocity, we consider *PRDIRCEO* and *PRDIRCOMB*, and they are estimated by calculating the ratio of number of directors who are either CEOs or both CEOs and COBs of their own companies to total number of directors, respectively. Among three proxy variables of Powerful CEO, *CHTCOMP* is the change in total compensations of CEOs between period *t* and *t-1*, *CEOEQ* is the CEO's equity ownership, and *TENURE* is CEO's total number of years of experience as a CEO in the same company as of *t-1*. Total compensation includes cash salary, bonus, restricted stock grants, LTIP payments and value of option exercised in a given year, and equity ownership is the ratio of the number of company-shares held by the CEO to total number of outstanding shares of his/her company. Panel B includes all variables of the second-stage regression. Among them, *MB* (market-to-book) is the ratio of market value of common equity to its book value. Market value of equity is calculated by multiplying year-end share price with year-end outstanding shares and book value is a firm's total assets less total liabilities. *ROA* is the ratio of a firm's net income at period *t* to total assets in period *t-1* and Tobin's *Q* is the market value of common equity plus book values of preferred equity and long-term debt divided by the book value of assets less short term debts. Among control variables, *LEV* is a firm's leverage (a ratio of a firm's total liabilities at *t* to total assets at *t-1*), *INVOPP* is the firm's investment opportunity (a ratio of a firm's capital expenditure at *t* to its total assets at *t-1*), *SIZE* is the logarithm of a firm's total assets at *t-1* in the regression, and *HISTFV* is the firm's historical firm value (median of a firm's Tobin's *Q* over the last five years). *p*-values are given in parentheses. ***, ** and * imply the significance of correlation between two variables at the 1%, 5% and 10% level, respectively.

Panel A: First-Stage Regression Variables

	LD	*FSLGR*	*FPRGR*	*INDSLGR*	*INDVOL*	*INDCR*	*PRINS*	*PRDIRCEO*	*PRDIRCOMB*	*CHTCOMP*	*CEOEQ*	*TENURE*
LD	1.000											
	-											
Reward for a CEO's Good Performance												
FSLGR	0.001	1.000										
	(0.977)	-										
FPRGR	0.041	-0.017	1									
	(0.219)	(0.614)	-									
Industry Complexity												
INDSLGR	0.051	0.059*	0.002	1								
	(0.122)	(0.074)	(0.954)	-								
INDVOL	-0.010	0.067**	-0.003	-0.199***	1							
	(0.753)	(0.041)	(0.929)	(0.000)	-							
INDCR	0.023	0.049	-0.002	0.089***	-0.065**	1						
	(0.478)	(0.145)	(0.948)	(0.007)	(0.052)	-						
Board Structure												
PRINS	-0.177***	0.014	-0.032	-0.016	-0.031	-0.076**	1					
	(0.000)	(0.680)	(0.334)	(0.639)	(0.354)	(0.022)	-					
Social Reciprocity												
PRDIRCEO	0.089***	-0.045	0.056*	0.006	-0.046	0.002	0.083***	1				
	(0.007)	(0.172)	(0.092)	(0.852)	(0.166)	(0.952)	(0.012)	-				
PRDIRCOMB	0.137***	-0.034	0.042	0.014	0.000	0.061*	-0.142***	0.605***	1			
	(0.000)	(0.305)	(0.206)	(0.685)	(0.996)	(0.065)	(0.000)	(0.000)	-			
Enforcing Outcome of a Powerful CEO												
CHTCOMP	0.017	0.001	-0.008	0.033	0.032	-0.023	-0.038	-0.010	0.017	1		
	(0.599)	(0.980)	(0.798)	(0.318)	(0.341)	(0.491)	(0.247)	(0.756)	(0.607)	-		
CEOEQ	0.084***	0.039	0.028	0.004	-0.014	-0.026	0.178***	-0.041	-0.072**	-0.016	1	
	(0.011)	(0.239)	(0.399)	(0.908)	(0.667)	(0.439)	(0.000)	(0.217)	(0.031)	(0.631)	-	
TENURE	0.272***	0.053	0.028	-0.030	0.023	-0.041	0.156***	-0.048	-0.048	-0.033	0.336***	1
	(0.000)	(0.111)	(0.407)	(0.369)	(0.495)	(0.215)	(0.000)	(0.147)	(0.152)	(0.328)	(0.000)	-

Table 3.5 (Continued)

Panel B: Second-Stage Regression Variables

	Tobin's *Q*	*MB*	*ROA*	*LD*	*PRINS*	*CEOEQ*	*LEV*	*INVOPP*	*SIZE*	*FPRGR*	*HISTFV*
Dependent Variables											
Tobin's *Q*	1.000										
	-										
MB	0.428***	1.000									
	(0.000)	-									
ROA	0.487***	0.306***	1.000								
	(0.000)	(0.000)	-								
Independent Variables											
LD	-0.087***	0.039	0.030	1.000							
	(0.009)	(0.237)	(0.374)	-							
PRINS	0.047	-0.031	0.023	-0.177***	1.000						
	(0.160)	(0.352)	(0.488)	(0.000)	-						
CEOEQ	0.187***	0.069**	0.086***	0.084***	0.178***	1.000					
	(0.000)	(0.038)	(0.010)	(0.011)	(0.000)	-					
LEV	-0.222***	0.047	-0.161***	0.155***	-0.063*	-0.044	1.000				
	(0.000)	(0.158)	(0.000)	(0.000)	(0.057)	(0.187)	-				
INVOPP	0.082***	0.023	0.164***	-0.006	0.108***	0.039	0.108***	1.000			
	(0.014)	(0.486)	(0.000)	(0.850)	(0.001)	(0.246)	(0.001)	-			
SIZE	-0.176***	-0.003	0.050	0.187***	-0.137***	-0.166***	0.289***	-0.020	1.000		
	(0.000)	(0.930)	(0.133)	(0.000)	(0.000)	(0.000)	(0.000)	(0.550)	-		
FPRGR	-0.022	-0.005	0.029	0.041	-0.032	0.028	-0.025	-0.004	0.031	1.000	
	(0.516)	(0.889)	(0.388)	(0.220)	(0.334)	(0.399)	(0.450)	(0.915)	(0.358)	-	
HISTFV	0.758***	0.318***	0.326***	-0.101***	0.025	-0.002	-0.231***	0.014	-0.096***	-0.026	1.000
	(0.000)	(0.000)	(0.000)	(0.002)	(0.449)	(0.943)	(0.000)	(0.666)	(0.004)	(0.436)	-

Table 3.6: Two-Stage Regression of Firm Performance

Panel A of the table reports results of the first-stage regression model. In the estimated model, the dependent variable is the leadership structure dummy variable that is either equal to 1 if a firm experiences combined leadership or 0 if the firm follows separate leadership structure. By definition, combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) of a company. In contrast, separate leadership implies that two individual persons hold the responsibilities of the CEO and the COB of a firm. *FPRGR* is the firm's industry-adjusted growth in profitability calculated from $(ROA_{i,t-1} - ROA_{i,t-5})/ROA_{i,t-5}$, where *ROA* is the return on asset. *ROA* is the ratio of net income to a firm's total assets. *INDSLGR* is the respective industry's sales growth over the last five years (from *t-5* to *t-1*), *PRINS* is the proportion of insiders (either employees or individuals connected with the firms) on the board of directors, *PRDIRCEO* is the fraction of outside directors who are also CEOs (Chief Executive Officers) in their respective companies, and *TENURE* is the CEO's years of experience as a CEO in the same company. Following Heckman (1979), we estimate the Inverse Mill Ratio (IMR) from the first-stage regression in Panel A. We include IMR along with other explanatory variables in the second-stage regression to control for self-selection bias in leadership structure of a firm. In addition to *IMR*, *PRINS* and *FPRGR*, the second-stage regression in Panel B includes firm's leverage (*LEV*), investment opportunity (*INVOPP*), firm's size (*SIZE*) and historical firm value (*HISTFV*). Among them, *LEV* is a ratio of a firm's total liabilities at *t* to total assets at *t-1*, *INVOPP* is the firm's investment opportunity (a ratio of a firm's capital expenditure at *t* to its total assets at *t-1*), *SIZE* is the logarithm of a firm's total assets at *t-1* and *HISTFV* is the firm's historical firm value that is the median of a firm's Tobin's *Q* over the last five years. Tobin's *Q* is the market value of common equity plus book values of preferred equity and long-term debt divided by the book value of assets less short term debts. Among other dependent variables, *MB* (market-to-book) is the ratio of market value of common equity to its book value. Market value of equity is calculated by multiplying year-end share price with year-end outstanding shares and book value is a firm's total assets less total liabilities. In addition, *ROA* is the ratio of a firm's net income at period *t* to total assets in period *t-1*. Panel B (C) of the table addresses the impact of different leadership structure on Tobin's *Q* (*MB*) during the recessionary and boom period. Panel D reports the effectiveness of combined and separate leadership structure on return on asset (*ROA*) in the recessionary period. *t*-statistics are given in the parentheses. The significance of each coefficient in the second-stage regression is chosen based on test statistic (*t*-stat) calculated following the equation of standard error in Greene (1981). ***, ** and * imply the significance of a coefficient and average benefit/cost at the 1%, 5% and 10% level, respectively.

Panel A: First-Stage Regression

Dependent Variable: Leadership Structure Dummy Variable

Independent Variables	Coefficients (*t*-stat)	
	1. Recessionary Period (Sample Year: 2005)	2. Boom Period (Sample Year: 2000)
Reward for a CEO's Good Performance		
FPRGR	0.005 (0.699)	-0.011 (-1.120)
Industry Complexity		
INDSLGR	0.555* (1.898)	-0.346 (-1.451)
Board Structure		
PRINS	-2.337*** (-7.173)	-1.071*** (-2.919)
Social Reciprocity		
PRDIRCEO	1.055*** (3.926)	-0.226 (-0.815)
Enforcing Outcome of a Powerful CEO		
TENURE	0.066*** (9.322)	0.038*** (3.664)
CONSTANT	0.081 (0.649)	0.872*** (4.656)
Sample Size	906	391
Chi-Square	144.027***	29.603***
Pseudo R^2	0.147	0.073

Table 3.6 (Continued)

Panel B: Second-Stage Regression

Dependent Variable: Tobin's Q

Independent Variables	Coefficients (*t*-stat)			
	1. Recessionary Period (Sample Year: 2005)		2. Boom Period (Sample Year: 2000)	
	1a. Firms *with* Combined Leadership	1b. Firms *with* Separate Leadership	2a. Firms *with* Combined Leadership	2b. Firms *with* Separate Leadership
PRINS	-0.509* (-1.746)	-0.239 (-0.741)	-0.060 (-0.074)	-1.070 (-0.792)
CEOEQ	3.954*** (9.742)	1.133 (1.518)	-4.924** (-2.560)	0.708 (0.164)
LEV	-0.089 (-0.766)	-0.322* (-1.790)	0.519 (1.579)	0.629 (1.303)
INVOPP	0.419 (0.595)	1.167 (1.494)	0.487 (0.260)	-0.162 (-0.071)
SIZE	-0.134*** (-24.298)	-0.188** (-2.598)	-0.541** (-2.396)	0.727* (2.089)
FPRGR	0.003 (0.051)	-0.006 (-0.989)	0.064*** (3.195)	0.002 (0.342)
HISTFV	0.703*** (26.891)	0.683*** (22.212)	1.330*** (13.851)	0.864*** (10.259)
λ_{ji}	0.465*** (3.354)	-0.056 (-0.379)	-2.113** (-2.438)	0.649 (0.617)
CONSTANT	1.049*** (3.496)	1.492* (1.874)	1.964* (1.839)	-0.692 (-0.345)
Sample Size Industry Fixed Effect R^2	504 Yes 0.668	402 Yes 0.620	269 Yes 0.568	122 Yes 0.620
Average Marginal Benefit/Cost	1.325*** (39.172)	1.400*** (35.081)	-2.114*** (-17.699)	-1.963*** (-6.839)

Table 3.6 (Continued)

Panel C: Second-Stage Regression

Dependent Variable: MB

Independent Variables	Coefficients (*t*-stat)			
	1. Recessionary Period (Sample Year: 2005)		2. Boom Period (Sample Year: 2000)	
	1a. Firms *with* Combined Leadership	1b. Firms *with* Separate Leadership	2a. Firms *with* Combined Leadership	2b. Firms *with* Separate Leadership
PRINS	-1.710 (-1.283)	-0.799 (-0.914)	-7.450 (-1.258)	-2.695 (-0.809)
CEOEQ	5.467*** (2.856)	2.776 (1.358)	-12.348 (-0.836)	2.652 (0.263)
LEV	1.147* (2.043)	2.510*** (5.025)	4.706* (1.600)	-4.359*** (-3.840)
INVOPP	-1.268 (-0.383)	0.338 (0.162)	-4.910 (-0.301)	4.296 (0.801)
SIZE	0.269*** (10.795)	-0.188 (-0.973)	0.388 (0.215)	2.481** (3.007)
FPRGR	-0.012 (-0.044)	0.001 (0.069)	0.069 (0.449)	-0.011 (-0.751)
HISTFV	1.061*** (7.884)	1.109*** (13.136)	3.321*** (3.978)	0.731*** (3.669)
λ_{ji}	1.325* (2.088)	0.587 (1.467)	1.041 (0.158)	3.716* (1.761)
CONSTANT	-0.326 (-0.232)	2.809 (1.316)	-3.799 (-0.457)	1.707 (0.350)
Sample Size	504	402	269	122
Industry Fixed Effect	Yes	Yes	Yes	Yes
R^2	0.156	0.373	0.189	0.167
Average Marginal Benefit/Cost	0.478* (1.670)	0.985*** (3.189)	-3.596*** (-3.966)	-4.396*** (-5.629)

Table 3.6 (Continued)

Panel D: Second-Stage Regression

Dependent Variable: ROA[30]

Independent Variables	Coefficients (*t*-stat) 1. Recessionary Period (Sample Year: 2005) 1a. Firms *with* Combined Leadership	1b. Firms *with* Separate Leadership
PRINS	-0.050* (-1.779)	0.021 (0.644)
CEOEQ	0.166*** (4.118)	0.029 (0.375)
LEV	-0.057*** (-4.859)	-0.032* (-1.705)
INVOPP	0.077 (1.100)	0.277*** (3.458)
SIZE	0.011* (1.896)	0.019** (2.533)
FPRGR	0.000 (0.187)	0.001 (1.174)
HISTFV	0.026*** (9.924)	0.022*** (7.043)
λ_{ji}	0.030** (2.275)	0.002 (0.129)
CONSTANT	0.055* (1.851)	0.006 (0.078)
Sample Size	504	402
Industry Fixed Effect	Yes	Yes
R^2	0.289	0.267
Average Marginal Benefit/Cost	-0.041 (1.343)	0.035* (1.877)

[30] Since IMR is found insignificant in the second-stage regression while using *ROA* as a measure of firm performance in the boom period (i.e., 2000), we do not report the corresponding results in the table.

Table 3.7: Leadership Structure and Conditional Factors

Two-stage regression model is estimated under different business conditions (e.g., firm size, capital structure, market share, equity type and affiliated stock exchange). The results are based on all 2005 sample firms. By definition, combined leadership implies that the same person holds the positions of both the Chief Executive Officer (CEO) and the Chairman of the Board (COB) of a company. Firm size is based on total assets in USD million. Debt-to-equity is the ratio of total short- and long-term debt to total assets less total liabilities. Market share is defined by a firm's total sale revenues with respect to its industry's aggregate sale revenues. In equity type, firms are sorted based on single-class and dual-class stocks. Affiliated stock exchange implies a stock exchange where a firm's stock is traded including New York Stock Exchange (NYSE), National Association of Securities Dealers Automated Quotation System (NASDAQ), American Stock Exchange (AMEX) and Over-the-Counter (OTC). The latter three exchanges are defined as non-NYSE for the analysis. Firms with the lowest (the highest) size, debt-to-equity and market share are from the bottom-third (top-third) tercile of the variables, respectively. Furthermore, sample firms with combined leadership are also sorted between single-class versus dual-class and NYSE versus non-NYSE. In the model, *PRINS* is the proportion of insiders (either employees or individuals connected with the firms) on a firm's Board of Directors, *CEOEQ* is the CEO's equity ownership (a ratio of the number of company shares held by its CEO to total number of outstanding shares of the company), *LEV* is a firm's leverage (a ratio of a firm's total liabilities at *t* to total assets at *t-1*), *INVOPP* is the firm's investment opportunity (a ratio of a firm's capital expenditure at *t* to its total assets at *t-1*), *SIZE* is the firm's size (a logarithm of a firm's total assets at *t-1*) and *HISTFV* is the firm's historical firm value (median of a firm's Tobin's *Q* over the last five years). The model is estimated only for the recessionary period (i.e., 2005). Three different proxy variables of firm performance include Tobin's *Q*, market-to-book (*MB*) ratio and return on asset (*ROA*). Tobin's *Q* is the market value of common equity plus book values of preferred equity and long-term debt divided by the book value of assets less short term debts, *MB* is the ratio of market value of common equity (calculated by multiplying year-end share price with year-end outstanding shares) to its book value (a firm's total assets less total liabilities), and *ROA* is the ratio of a firm's net income at period *t* to total assets in period *t-1*. *t*-statistics are given in the parentheses. The significance of each coefficient in the second-stage regression is chosen based on test statistic (*t*-stat) calculated following the equation of standard error in Greene (1981). ***, ** and * imply the significance of a coefficient and average benefit/cost at the 1%, 5% and 10% level, respectively.

Table 3.7 (Continued)

Panel A[31]: Firm size

Independent Variables	Coefficients (*t*-stat)			
	Dependent Variable: *ROA*			
	1. Small Firms		2. Large Firms	
	1a. Firms with Combined Leadership	1b. Firms with Separate Leadership	2a. Firms with Combined Leadership	2b. Firms with Separate Leadership
PRINS	0.037 (0.738)	-0.001 (-0.013)	0.051 (1.051)	-2.058 (-0.402)
CEOEQ	0.140** (2.580)	0.036 (0.454)	-0.089 (-0.521)	-38.213* (-1.695)
LEV	-0.018 (-0.672)	-0.022 (-0.840)	-0.004 (-0.218)	9.517*** (3.544)
INVOPP	0.300** (2.270)	0.240* (2.090)	0.106 (1.334)	-6.412 (-0.515)
SIZE	0.015*** (9.464)	0.024*** (32.941)	0.003*** (4.849)	-2.782*** (-30.201)
FPRGR	-0.001 (-0.043)	0.001 (0.023)	0.000 (0.001)	0.055 (0.044)
HISTFV	0.017*** (3.623)	0.026*** (5.263)	0.023*** (6.658)	2.116*** (4.349)
λ_{ji}	0.041** (2.316)	-0.002 (-0.080)	-0.048* (-1.917)	-0.906 (-0.373)
CONSTANT	-0.079 (-0.916)	-0.012 (-0.125)	0.067* (1.634)	8.044 (1.371)
Sample Size	165	137	197	105
Industry Fixed Effect	Yes	Yes	Yes	Yes
R^2	0.429	0.312	0.299	0.410
Average Marginal Benefit/Cost	-0.052*** (-8.523)	-0.016** (-2.345)	0.029*** (7.603)	-0.042*** (-7.191)

[31] Since IMR is found insignificant in the second-stage regression while using *Q* and *MB* as two distinct measures of firm performance for small firms as well as in the case of *Q* for large firms, we do not report the corresponding results in the table. For large firms, we however find a significant IMR while using *MB* as a dependent variable and the corresponding result is qualitatively same as found in the case of *ROA*. We therefore do not report the result to conserve the space.

Table 3.7 (Continued)

Panel B[32]*: Capital Structure*

Independent Variables	Coefficients (*t*-stat)			
	Dependent Variable: *ROA*		Dependent Variable: *MB*	
	1. Low Debt-to-Equity		2. High Debt-to-Equity	
	1a. Firms with Combined Leadership	1b. Firms with Separate Leadership	2a. Firms with Combined Leadership	2b. Firms with Separate Leadership
PRINS	0.002 (0.028)	0.041 (0.933)	1.037 (0.470)	-4.588 (-1.401)
CEOEQ	0.175* (1.594)	-0.040 (-0.289)	-3.185 (-0.485)	3.112 (0.949)
LEV	0.040 (0.566)	0.037 (0.570)	-1.404* (-2.105)	-2.592* (-1.963)
INVOPP	0.177 (1.380)	0.354** (2.621)	-2.297 (-0.548)	-2.545 (-0.530)
SIZE	0.017*** (8.481)	0.025*** (26.977)	0.397*** (14.133)	-0.281*** (-5.411)
FPRGR	0.003 (0.221)	-0.001 (-0.040)	-0.041 (-0.117)	0.024 (0.050)
HISTFV	0.027*** (6.379)	0.025*** (5.674)	1.571*** (9.726)	2.018*** (8.869)
λ_{ji}	0.051** (2.462)	-0.017 (-0.760)	0.626 (0.457)	4.481** (2.645)
CONSTANT	-0.075 (-1.168)	-0.091* (-1.697)	0.673 (0.343)	10.358*** (3.155)
Sample Size Industry Fixed Effect R^2	127 Yes 0.310	175 Yes 0.346	187 Yes 0.311	115 Yes 0.412
Average Marginal Benefit/Cost	-0.075*** (-12.660)	-0.036*** (-5.870)	2.408*** (11.207)	1.295*** (4.563)

[32] Since IMR is found insignificant in the second-stage regression while using *Q* and *MB* as two distinct measures of firm performance for low debt-to-equity firms and in the cases of *Q* and *ROA* for high debt-to-equity firms, we do not report the corresponding OLS results in the table.

Table 3.7 (Continued)

Panel C[33]*: Market Share*

Independent Variables	Coefficients (*t*-stat)			
	Dependent Variable: *ROA*			
	1. Low Marker Share		2. High Market Share	
	1a. Firms with Combined Leadership	1b. Firms with Separate Leadership	2a. Firms with Combined Leadership	2b. Firms with Separate Leadership
PRINS	0.041 (0.799)	0.039 (0.837)	-0.025 (-0.696)	0.040 (0.779)
CEOEQ	0.108* (1.732)	0.027 (0.305)	-0.120 (-0.971)	0.412* (1.901)
LEV	-0.070*** (-4.285)	-0.035 (-1.227)	-0.031* (-1.694)	0.037 (1.106)
INVOPP	0.189* (1.624)	0.365*** (3.091)	0.114 (1.314)	-0.243 (-1.501)
SIZE	0.024*** (13.769)	-0.012*** (-14.893)	-0.017*** (-29.489)	0.014*** (11.337)
FPRGR	-0.004 (-0.220)	0.001 (0.029)	0.000 (0.001)	-0.001 (-0.054)
HISTFV	0.023*** (4.559)	0.020*** (3.975)	0.021*** (6.229)	0.032*** (6.220)
λ_{ji}	0.044*** (2.612)	-0.010 (-0.453)	-0.030* (-1.600)	-0.007 (-0.342)
CONSTANT	-0.017 (-0.174)	-0.005 (-0.057)	0.179*** (4.371)	-0.049 (-0.640)
Sample Size Industry Fixed Effect R^2	138 Yes 0.397	164 Yes 0.312	202 Yes 0.299	100 Yes 0.418
Average Marginal Benefit/Cost	0.038*** (4.409)	-0.043*** (-5.389)	-0.053*** (-11.798)	0.097*** (15.804)

[33] Since IMR is found insignificant in the second-stage regression while using *Q* and *MB* as two distinct measures of firm performance for firms with high market share, we do not report the corresponding results in the table. For firms with low market share, we however find a significant IMR while using *Q* and *MB* as two separate dependent variables and the corresponding results are qualitatively same as found in the case of *ROA*. We therefore do not report these results to conserve the space.

Table 3.7 (Continued)

Panel D[34]*: Equity Type*

Independent Variables	Coefficients (*t*-stat) Dependent Variable: *MB*			
	1. Single-class Stock		2. Dual-class Stock	
	1a. Firms with Combined Leadership	1b. Firms with Separate Leadership	2a. Firms with Combined Leadership	2b. Firms with Separate Leadership
PRINS	-1.243 (-1.275)	0.039 (0.837)	-3.294 (-1.327)	4.936* (1.717)
CEOEQ	1.237 (0.569)	0.027 (0.305)	-0.965 (-0.124)	-2.515 (-0.839)
LEV	1.316*** (3.410)	-0.035 (-1.227)	0.907* (0.829)	6.426*** (4.542)
INVOPP	-0.965 (-0.416)	0.365*** (3.091)	3.882 (0.499)	-13.307* (-2.068)
SIZE	0.273*** (15.566)	-0.012*** (-14.893)	-0.605*** (-12.711)	-1.381*** (-9.570)
FPRGR	-0.019 (-0.101)	0.001 (0.029)	0.019 (0.040)	-0.121 (-0.273)
HISTFV	1.161*** (13.785)	0.020*** (3.975)	0.752*** (2.966)	1.529*** (7.698)
λ_{ji}	0.660* (1.600)	-0.010 (-0.453)	-0.333 (-0.307)	-2.125** (-2.268)
CONSTANT	-0.224 (-0.236)	-0.005 (-0.057)	3.252 (1.295)	-2.865 (-1.125)
Sample Size Industry Fixed Effect R^2	437 Yes 0.372	334 Yes 0.323	46 Yes 0.315	42 Yes 0.422
Average Marginal Benefit/Cost	0.124* (1.601)	0.232* (2.051)	1.229*** (3.249)	4.146*** (14.445)

[34] Since IMR is found insignificant in the second-stage regression while using *Q* and *ROA* as two distinct measures of firm performance for firms with single-class stocks and in case of *ROA* for firms with dual-class stocks, we do not report the corresponding results in the table. For firms with dual-class stocks, we however find a significant IMR while using *Q* as a dependent variable and the corresponding result is qualitatively same as found in the case of *MB*. We therefore do not report that result to conserve the space.

Table 3.7 (Continued)

Panel E[35]*: Stock Exchange*

Independent Variables	Coefficients (*t*-stat)	
	Dependent Variable: *ROA*	
	Non-NYSE	
	1a. Firms with Combined Leadership	1b. Firms with Separate Leadership
PRINS	0.053 (0.904)	0.089* (1.952)
CEOEQ	0.093* (1.600)	-0.131 (-1.065)
LEV	-0.061** (-2.497)	-0.030 (-1.104)
INVOPP	0.072 (0.542)	0.353*** (2.972)
SIZE	-0.003*** (-3.085)	0.010*** (12.502)
FPRGR	-0.001 (-0.044)	0.001 (0.119)
HISTFV	0.024*** (4.852)	0.022*** (5.380)
λ_{ji}	0.036* (1.800)	-0.014 (-0.606)
CONSTANT	0.045 (0.590)	-0.036 (-0.379)
Sample Size Industry Fixed Effect R^2	131 Yes 0.397	176 Yes 0.311
Average Marginal Benefit/Cost	-0.033*** (-4.255)	0.035*** (5.124)

[35] Since IMR is found insignificant in the second-stage regression while using *Q*, *MB* and *ROA* as three distinct measures of firm performance for firms that are listed in NYSE and in the case of *Q* for firms that are listed in non-NYSE, we do not report the corresponding results in the table. For firms that are listed in non-NYSE, we however find a significant IMR while using *MB* as a dependent variable and the corresponding result is qualitatively same as found in the case of *ROA*. We therefore do not report that result to conserve the space.

Figure 3.1: The US stock market and the US economy during 1985-2005

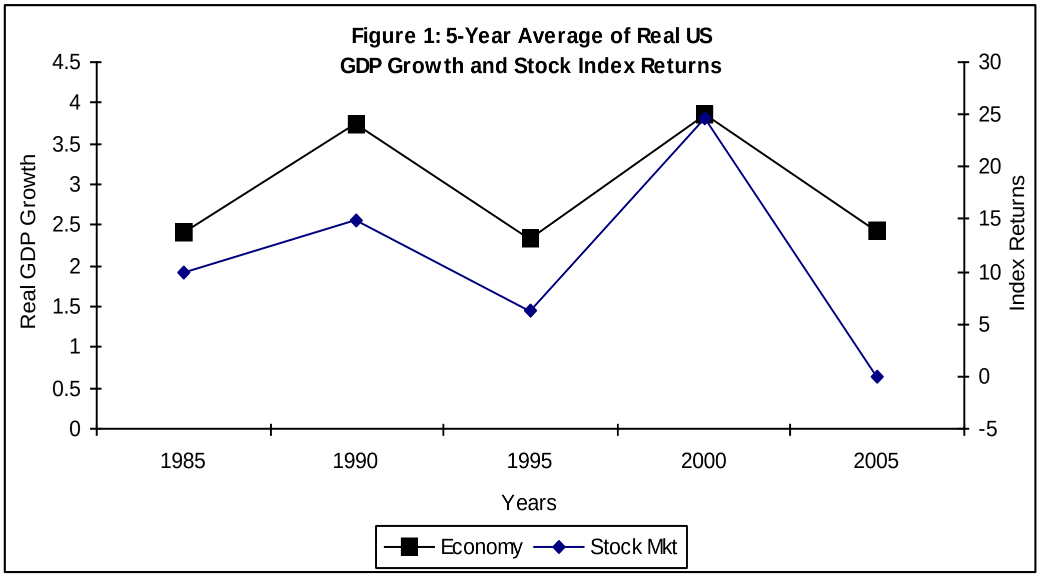
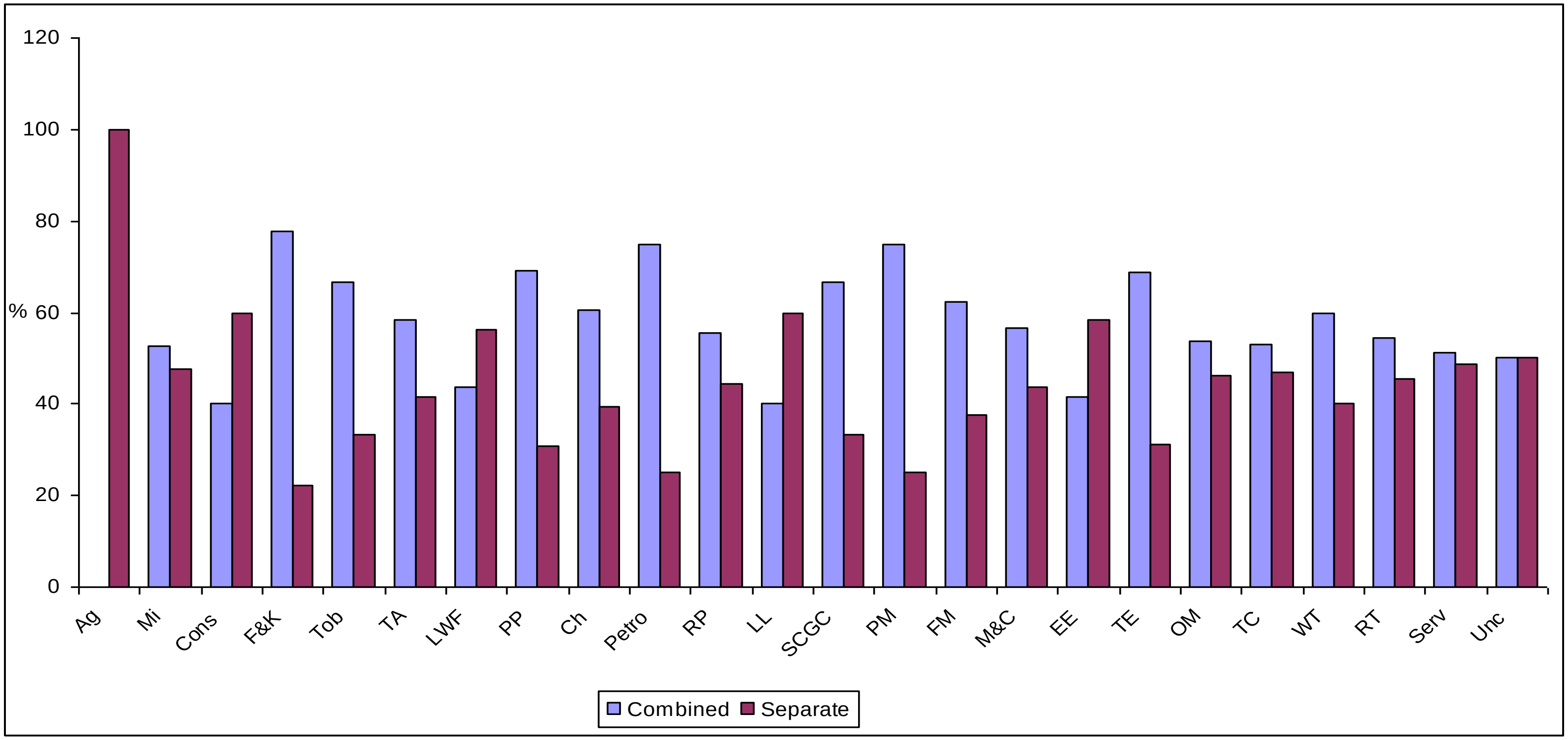


Figure 3.2: Percentage of Firms with Combined and Separate Leadership Structure by Industry in 2005



CHAPTER 4

RETURN ON R&D INVESTMENT, FINANCE AND LAW: EVIDENCE FROM INTERNATIONAL DATA

4.1 INTRODUCTION

Researchers in Economics and Finance have argued that investment in research and development (R&D) results in better production technology and also raises the productivity at the firm, industry and country level.[1] Extant literature also suggests that the level of financial and legal development is a leading indicator of economic growth.[2] However, neither of these studies explicitly discusses how financial and legal development might influence the overall productivity growth of a country through R&D investments by government and firms.[3] I therefore investigate this issue by examining whether the rate of return on R&D is fundamentally related to individual social infrastructures, such as financial and legal environments, across emerging and developed countries. My contribution is to show how importantly and to what extent both stock and credit markets, as well as the legal rights of their respective stakeholders, improved the effectiveness of

[1] See Griliches (1986, 1990), Mansfield (1988), Goto and Suzuki (1989), Lichtenberg (1993), Meliciani (2000), Timmer (2003) and Gonzalez and Gascon (2004), among several others.

[2] See Levine (1993), Levine and Zervos (1998), Rajan and Zingales (1998) and Beck and Levine (2002).

[3] Beck, Levine and Loayza (2000) examine the relationship between financial intermediary development and the sources of growth, such as private savings rate, physical capital accumulation and total factor productivity; however, I extend this relationship one step further by taking interaction terms of financial and legal development indicators with aggregate and firm level R&D (one at a time) to determine the channel through which financial intermediary and legal rights might increase total factor productivity and thus result in higher economic growth.

R&D activities initiated by the government and business sectors across sample countries during the period 1997-2006.

I argue that investment in R&D usually differs from other sorts of capital investment in fixed assets, inventory or project financing along several important dimensions related to information asymmetry. First, investors can sometimes derive little or no information about the productivity and value underlying a particular R&D project. This asymmetry in information is stronger in emerging economies because of inadequate coverage by analysts, low reporting requirements and the emerging quality of auditing in these countries. Second, there is no organized market of R&D capital. Therefore, there are no prices on R&D capital available from which information about the quality of R&D efforts can be derived.[4] Third, the quality of R&D efforts becomes challenging in an environment where the laws related to copyrights or patents are weak and their enforcement is lax. Therefore, information asymmetry between R&D investors (i.e., firms, government) and their stakeholders (i.e., lenders, equity-holders, taxpayers), as well as weak provision of legal action in an economy, might allow the former to either expropriate or misallocate resources, which in turn may reduce the rate of return on R&D investment. Furthermore, reducing information asymmetry through higher disclosure about R&D might not be an effective solution, particularly for emerging economies, due to the ease of imitation of inventive ideas in those markets. However, an active financial market can produce

[4] This point is also argued by Aboody and Lev (2000). In a firm-level study, they find that insider gains in R&D-intensive firms are substantially larger than insider gains in firms without R&D. According to them, this is possible, because R&D activities usually enhance information asymmetry.

information *ex ante* about possible investments, as well as monitor investments and exert corporate governance after providing finance. Furthermore, a well-structured legal system in an economy can ensure more accountability of R&D investors and thereby convince them to invest in value-enhancing R&D projects. Thus, the rate of return on R&D investment might be higher for economies with efficient financial markets and more well-developed legal environments.

I initially analyze the effectiveness of R&D investments by the government, business and education sectors for both emerging and developed economies throughout the period 1997-2006. Among them, R&D activities by business entities, in general, significantly contributed to growth in total factor productivity (*TFP*) of sample countries during that period. However, while examining the differences in rate of return on sector-specific R&D between emerging and developed countries, I find that the business sector contributed significantly to improving the return on their R&D investments in the former economies, whereas R&D initiatives by the education sector had the most significant impact on *TFP* of the latter countries during the sample period. Furthermore, though the R&D activities grew more significantly in the government sector of emerging than developed economies from 1997 to 2006, such investments resulted in an insignificant impact on *TFP* of individual countries during this period.

Further analyses reveal that finance and law can matter for productivity growth in an economy by significantly increasing the rate of return on business-sector R&D. In particular, the return on R&D investment by the business sector in developed economies can be much higher in the presence of a high-functioning stock market and effective legal rights to minority shareholders. In the case of emerging economies, an active financial market, including equity and credit markets, as well as higher legal rights to shareholder and lenders are equally important to increase the return of their business-sector R&D. In contrast, the marginal contribution of government-sector R&D on *TFP* is always insignificant for both developed and emerging countries, regardless of the level of development of their financial markets and legal environments. Likewise, the financial and legal statuses of an economy are less crucial in improving the effectiveness of education-sector R&D. Therefore, the differences in finance and law across countries account for many of the differences, particularly in overall performance of business-sector R&D throughout individual economies. However, the collaboration in R&D activities between the government and business sectors improves the quality of R&D projects in the respective sectors and thereby should increase the rate of return on both government- and business-sector R&D. The above evidence therefore suggests that the extent to which finance and law influence economic growth of a country depends on R&D intensity in the government versus the business sector, their collective efforts in R&D, as well as the degree of financial activity and the legal rights of stakeholders of business entities in that country.

I organize the rest of the article as follows: In section 4.2, I briefly discuss relevant literature. I describe sample data in section 4.3, followed by my research methodology in section 4.4. I present the main empirical findings in section 4.5. I finally conclude the paper in section 4.6.

4.2 THEORETICAL BACKGROUND

Economic theory argues that R&D investment is one of the major sources of productivity growth over the long term.[5] For instance, Lichtenberg (1993) finds that the return on private-sector R&D is seven times larger than that on fixed investment. Furthermore, Caselli, Esquivel and Lefort (1996) and Barro (1991) suggest that emerging economies tend to grow faster towards their steady-state level of income, which in turn is determined by a series of policy-related factors, such as financial development, education and trade liberalization.

Extending this discussion further, Beck, Levine, and Loayza (2000) argue that financial development can accelerate economic growth if a financier can exercise some control over investment decisions of an entrepreneur; therefore, a well-developed financial market allows capital to flow toward the more productive uses, which improves the efficiency of resource allocation. In a firm-level study across countries, Demirgüç-Kunt and Maksimovic (1998) show that an active stock market and a well-implemented legal system are associated with firm growth financed by external funding. Finally, Beck and Levine (2002) suggest that overall financial development and the legal environment are equally important for industry growth and the efficiency of capital allocation.

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[5] See Solow (1957), Mansfield (1988), Griliches (1990), Romer (1990), Meliciani (2000) and Timmer (2003).

Thus, the transparency of the financial market as well as the adaptability and the flexibility of legal systems influence efficient uses of external capital for productive purposes. In this paper, I therefore examine the effectiveness of finance and law in improving the rate of return on individual sector-specific R&D in emerging and developed economies, both at aggregate and firm level. To examine this proposition, a cross-country analysis on R&D investment is therefore suitable, since a large variation in financial and legal environments is most feasible across countries.

4.3 DATA DESCRIPTION

I collected raw data on R&D investments by the government, business and education sectors of 70 different countries for the period 1997-2006 from the *UNESCO Institute of Statistics*. Furthermore, I collected firm-level R&D data of sample countries for the 10-year sample period from the *OSIRIS database* of the Bureau van Dijk Electronic Publishing.[6] Among individual countries, the OECD economies are considered as developed economies.[7] In contrast, the non-OECD countries are identified as emerging economies.[8, 9]

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[6] Sample firms include all non-financial and non-utility businesses of sample countries.

[7] Countries include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

[8] Emerging countries include Argentina, Armenia, Azerbaijan, Belarus, Bolivia, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Ecuador, Guatemala, Hong Kong, India, Indonesia, Islamic Republic of Iran, Israel, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia FYR, Malaysia, Mongolia, Panama, Peru, Philippines, Romania, Russian Federation, Serbia and Montenegro, Singapore, Slovenia, South Africa, Sri Lanka, Thailand, Tunisia, Uganda, Ukraine, Uruguay and Vietnam.

[9] Djankov, McLeish and Shleifer (2007) define a country as an emerging (developed) economy if the per capita *GDP* of that country lies below (above) the sample median per capita *GDP* in 2003.

According to the *UNESCO Institute for Statistics*, the government sector includes central (federal), state and local government authorities. The business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services. Finally, higher education institutions include all private and public universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, higher education establishments.

I use either annual level of R&D investment (*RD*) or annual change in R&D (*RDGR*) at each sector, whenever they are appropriate to estimate unbiased estimators in multivariate analyses. I consider the following three different proxy variables to understand how active the stock and credit markets of an individual economy are:

(i) Ratio of stock market capitalization to *GDP* (*SMCAP*; i.e., Beck, Levine and Loayza, 2000);

(ii) Ratio of total value traded in a stock market to *GDP* (*SMTURN*; i.e., Beck, Levine and Loayza, 2000);

(iii) Ratio of private credit by banks and other financial institutions to *GDP* (*PCREDIT*; i.e., Beck, Levine and Loayza, 2000);

I also consider three separate variables to measure the extent of legal rights that stakeholders might exercise as a result of any misuse of resources in R&D investment by either the public or private sector of sample countries:

Based on this criterion, the OECD (Non-OECD) countries also belong to developed (emerging) economies. Therefore, results remain qualitatively similar.

(i) Shareholder rights (*SR*; i.e., La Porta, Lopez-de-Silanes, Shleifer and Vishny, 1998);

(ii) Creditor rights (*CR*; i.e., Djankov, McLeish and Shleifer, 2007);

(iii) Law Enforcement Index (*ENF*; i.e., World Bank, 2007).

To control for the productivity growth at country level, I consider physical capital intensity (*CAPINT*; i.e., Barro, 1990), human capital (*HC*; Barro and Lee, 2001); trade liberalization (*OPEN*; i.e., Caselli, Esquivel and Lefort, 1996) and government consumption expenditure (*GOVT*; i.e., Barro, 1990). I collect relevant data from the *World Development Indicators* of the World Bank. The measurements of individual variables are discussed in Appendix A. Furthermore, I use an unbalanced panel data set of labor (*L*), physical capital (*K*), R&D capital (R) and sales (*Y*) of a large number of firms in 70 countries for the period 1997-2006 to estimate the return on firm-level R&D investment.

4.4 RESEARCH METHODOLOGY

To determine the importance of financial and legal development, I initially examine the cross-sectional differences in R&D intensity among the government, business and education sectors of individual countries with different levels of financial and legal development. To do this analysis, I conduct a univariate analysis and calculate a Pearson correlation matrix by using country-level data. I also calculate summary statistics of individual variables to observe the average level of sector-specific R&D as well as the financial and legal statuses of sample countries.

I construct two separate models to estimate the effectiveness of finance and law in returns on total R&D initiated by the government (*GRD*) and business (*BRD*) sectors. To estimate the return on sector-specific R&D at country level, I use growth in total factor productivity (*TFPGR*) of each economy at year t as a measure of R&D outcome.[10] The measure of *TFPGR* is built on a neoclassical production function, which includes physical capital (K), labor (L), the level of total factor productivity (A) and the capital share (α) of a country. It is assumed that the aggregate production function is homogenous across countries (i) and time, so that aggregate output (Y) is expressed by the following Cobb-Douglas production function:

$$Y_i = A_i K_i^{\alpha} L_i^{1-\alpha} \tag{1}$$

To solve for *TFPGR*, the above function is converted to per capita production function by dividing both sides by L. By taking log transformation and the time derivative, *TFPGR* is finally expressed as follows: $TFPGR = GR - \alpha.CAPGR$, where *GR* equals the rate of real per capita GDP growth, and *CAPGR* equals the growth rate of per capita physical capital stock.[11] Following King and Levine (1994), Beck, Levine and Loayza (2000) and Durnev, Li, Morck and Yeung (2004), I consider that $\alpha = 0.3$.[12] To determine the return on R&D investment at the firm-level, I finally estimate the sensitivity of knowledge or R&D capital in firm's total output following the empirical model of Hall and Mairesse, 1995 (discussed shortly).

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[10] For additional references, see Jones and Williams (1998), Goto and Suzuki (1989) and Mansfield (1988).

[11] The derivation is shown in Appendix 4B.

[12] For a robustness check, I also consider $\alpha = 0.25$ and 0.40. Results, not reported in the table, are qualitatively similar.

4.4.1 *Rate of Return on R&D Investment at Country Level*

I use three different equations to estimate the rate of return on sector-specific R&D under different scenarios. Among them, equation (2-1) estimates the rate of return on individual sector-specific R&D across all countries, in general. The specification of the model is as follows

$$TFPGR_{it+1} = \text{Constant} + \beta_1.\text{Sector-specific R\&D}_{it} + \beta_2.CAPINT_{it} + \beta_3.HC_{it} + \beta_4.OPEN_{it} + \beta_5.GOVT_{it} + \beta_6.PCGDP_{it} + \varepsilon_{it} \quad (2\text{-}1)$$

where *CAPINT* is the capital intensity of an economy, measured by a ratio of physical capital accumulation to gross domestic product (GDP); *HC* is the human capital, which was estimated by Barro and Lee (2001) for 142 countries[13]; *OPEN* is the openness of an economy, measured by a ratio of total export and import to GDP; *GOVT* is the government's consumption expenditure in a country, estimated by a ratio of the government's annual consumption to GDP, and *PCGDP* is the per capita GDP, estimated by a ratio of GDP to total population in a country. All determinants of *TFPGR* are calculated from lagged data to avoid the problem of endogeneity between the left- and right-hand side variables of equation 2-1.[14]

Second, I estimate equation (2-2) to distinguish the differences in return on sector-specific R&D between emerging and developed economies by re-defining the model as follows

$$TFPGR_{it+1} = \text{Constant} + \beta_1.\text{Sector-specific R\&D}_{it} + \beta_2.(\text{Sector-specific R\&D}_{it} \times OECDD_{it}) + \beta_3.CAPINT_{it} + \beta_4.HC_{it} + \beta_5.OPEN_{it} + \beta_6.GOVT_{it} + \beta_7.OECDD_{it} + \varepsilon_{it} \quad (2\text{-}2)$$

[13] Barro and Lee (2001) provide a data set of educational attainment at five-year intervals from 1960 to 2000. I calculate the average of the time-series data and use the measure as a proxy of *HC*. The data set includes two separate estimates of attainment for the population aged 15 and over as well as for the population aged 25 and over. According to Barro and Lee, the age group of 15 and over corresponds better to the labor force for many emerging countries. I therefore consider the data for the population aged 15 and over to estimate the mean level of *HC*.

[14] Details about the measurement of individual variables have been discussed in Appendix 4A.

where *OECDD* is a dummy variable that is equal to 1 if the sample economy belongs to the OECD countries or 0 if the country is a member of non-OECD countries.[15] Finally, I examine whether the rate of return on sector-specific R&D can be influenced by any spillover effect of R&D activities from one sector to another. I therefore re-estimate equation (2-1) by including an interaction term between R&D investments of two specific sectors one at a time, such as follows

$$TFPGR_{it+1} = \text{Constant} + \beta_1.GRD_{it} + \beta_2.BRD_{it} + \beta_3.(GRD_{it} \times BRD_{it}) + \beta_4.CAPINT_{it} + \beta_5.HC_{it} + \beta_6.OPEN_{it} + \beta_7.GOVT_{it} + \beta_8.OECDD_{it} + \varepsilon_{it} \quad (2\text{-}3)$$

where *GRD* and *BRD* are government- and business-sector R&D investments, measured by aggregate R&D activities performed by government and business entities as a percentage of GDP, respectively. Two other specifications include interaction terms between *ERD* (education-sector R&D investment as a percentage of GDP) and *BRD* as well as *GRD* and *ERD*. The above equations are estimated by using an unbalanced panel data set at aggregate level. To absorb year-specific effects, the equations also include year dummy variables.

4.4.2 Importance of Finance and Law in Government-Sector R&D

To examine whether financial and legal development of an economy improves the return on government-sector R&D, I initially consider the following model:

$$TFPGR_i = \text{Constant} + \beta_1.GRDGR_i + \beta_2.CAPINT_i + \beta_3.HC_i + \beta_4.OPEN_i + \beta_5.GOVT_i + \beta_6.OECDD_i + \varepsilon_i \quad (3\text{-}1)$$

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[15] Results remain robust even if *PCGDP*, instead of *OECDD*, is included in the equation. However, I use *OECDD* in the equation to absorb the main effect of the dummy variable.

Here, I assume that the magnitude of β_1 at which *GRDGR* influences *TFPGR* of an economy depends on the level of financial activity and legal status of that country. Therefore,

$$\beta_{1i} = \gamma_{0i} + \gamma_{1i}.(\text{Financial Activity})_i + \gamma_{2i}.(\text{Legal Status})_i + e_i$$

After substituting β_1 in equation (3-1), the final linear regression model becomes:

$$TFPGR_i = \text{Constant} + \beta_1.GRDGR_i + \beta_2.(GRDGR_i \times \text{Financial Activity}_i) + \beta_3.(GRDGR_i \times \text{Legal Status}_i) + \beta_4.CAPINT_i + \beta_5.HC_i + \beta_6.OPEN_i + \beta_7.GOVT_i + \beta_8.OECDD_i + \varepsilon_i \quad (3\text{-}2)$$

In each model specification, I consider both financial and legal development indicators in combination to understand the importance of finance and law in improving the effect of government-initiated R&D on productivity growth. Furthermore, I include different proxy measures of financial and legal indicators one at a time. Importantly, I include the average change in R&D investment at the government sector (*GRDGR*) during the period 1997-2006 instead of yearly R&D investments by government organizations (*GRD*) in both models (3-1) and (3-2). Between the two alternative measures of government-sector R&D (*GRD* versus *GRDGR*), I find that *GRDGR* is insignificantly correlated with *TFPGR* and all other proxy variables of financial and legal development. Therefore, the problem of multi-collinearity can easily be precluded by using *GRDGR*, instead of *GRD*, while estimating the coefficients of the model.[16] I finally estimate the results by

[16] Pearson correlations between *GRDGR* and *TFPGR*, *SMCAP*, *PCREDIT*, *SR* and *CR* are 0.047 (*p*-value of 0.242), 0.006 (*p*-value of 0.879), 0.003 (*p*-value of 0.934), -0.054 (*p*-value of 0.178) and -0.010 (*p*-value of 0.798), respectively. Correlations between *GRD* and other variables can be found in Table 3.

applying the ordinary least square (OLS) method and test the significance of individual coefficients by using heteroskedasticity-consistent-standard-error.[17]

4.4.3 Importance of Finance and Law in Business-Sector R&D

Due to the problem of information asymmetry between managers and other stakeholders, new debt or equity financing is relatively more expensive for R&D investment. Furthermore, the lack of collateral in R&D reduces the possibility of external financing. Therefore, positive cash flows may be more important for R&D investments by firms.[18] However, this possibility is most likely in the case of emerging economies where both the financial market and legal enforcement are relatively weak. But, in the case of developed economies where industry-level information is widely available and managers are relatively more accountable for their decisions to stakeholders, R&D financing by external sources might be possible.[19] To understand whether both stock and credit markets are equally important for R&D financing in the business sectors across emerging and developed economies, I initially estimate a model of R&D financing at firm-level following the discussion in Hall (2002). The specification of the model[20] is as follows

$$(BRD_{it}/ASSET_{it-1}) = \text{Constant} + \beta_1.(CASH_{it}/ASSET_{it-1}) + \beta_2.(DEBT_{it}/ASSET_{it-1}) + \beta_3.(EQUITY_{it}/ASSET_{it-1}) + \beta_4.SIZE_{it-1} + \varepsilon_i \quad (4)$$

[17] There are several countries that have missing data on *GRD* for each year. Therefore, measuring *GRDGR* with a one-year lag (or with same interval across sample economies) is not possible for several countries. In this case, estimating the coefficients by using panel regression method might be biased as a result of measurement error in *GRDGR* across individual countries.
[18] For details, see Hall (1992) and Himmelberg and Petersen (1994).
[19] Brown, Fazzari and Peterson (2009) find that the US stock market generated sufficient funds for R&D boom in the U.S. during the late ′90s.
[20] Similar sort of model is also used by Himmelberg and Peterson (1994).

where *CASH* is total cash holdings; *DEBT* is total long-term debt; *EQUITY* is total shareholders equity and *ASSET* is total assets of firm *i*. In the estimated model, β_1 measures the sensitivity of internal cash flows in financing R&D; β_2 and β_3 imply whether issuance of additional debt or equity financing encourages R&D investment by firms. To estimate the coefficients of the model, I cluster an unbalanced panel data set by firm and include both country and year dummy variables to absorb country- and year-specific effects, respectively.

Hall and Mairesse (1995) estimate the productivity of R&D with and without imposing constant returns to scale in a Cobb-Douglas production function (*Y*) of labor (*L*), capital (*K*) and R&D or knowledge capital (*R*). Following their approach, the log transformation of production functions in the case of constant and non-constant returns to scale are expressed as follows:[21]

Constant returns to scale: $\log(Y/L)_{it+1} = \text{Constant} + \beta_1.\log(K/L)_{it} + \beta_2.\log(R/L)_{it} + \varepsilon_{it}$

Non-constant returns to scale: $\log(Y/L)_{it+1} = \text{Constant} + \beta_1.\log L_{it} + \beta_2.\log(K/L)_{it} + \beta_3.\log(R/L)_{it} + \varepsilon_{it}$

Here, I assume that the magnitude at which R&D capital influences firm-level productivity depends on the level of financial markets' activities and stakeholders' legal rights in an economy. By using an unbalanced panel data set of a large number of sample firms from both emerging and developed countries, I therefore estimate the following models:

$$\log(Y/L)_{it+1} = \text{Constant} + \beta_1.\log(K/L)_{it} + \beta_2.\log(R/L)_{it} + \beta_3.[\log(R/L)_{it} \times \text{Financial Activity}_{it}] + \beta_4.[\log(R/L)_{it} \times \text{Legal Status}_{it}] + \varepsilon_{it} \quad (5\text{-}1)$$

$$\log(Y/L)_{it+1} = \text{Constant} + \beta_1.\log L_{it} + \beta_2.\log(K/L)_{it} + \beta_3.\log(R/L)_{it} + \beta_4.[\log(R/L)_{it} \times \text{Financial Activity}_{it}] + \beta_5.[\log(R/L)_{it} \times \text{Legal Status}_{it}] + \varepsilon_{it} \quad (5\text{-}2)$$

[21] Detailed derivation of the model can be found in Appendix C.

Equations (5-1) and (5-2) are two separate specifications with and without imposing the condition of constant returns to scale in the production function, respectively. Finally, I estimate the results of both equations after clustering all observations by firm. To absorb country- and year-specific effects, I also include both country and year dummies in the estimated equations. I finally estimate the results of both equations by including sample firms operating in emerging economies only to observe whether the underlying findings differ in the case of the business sector of these countries.

4.5 RESULTS

4.5.1 Summary Statistics

Table 4.1 reports summary statistics of productivity growth and its determinants, sector-specific R&D investments, financial activity and legal status of sample countries. Among them, the average growth in total factor productivity in these economies was 4.3% during the period 1997-2006. Furthermore, average R&D investments by the government, business and education sectors across emerging and developed economies were 0.28%, 0.46% and 0.25% of GDP, respectively. Therefore, the business sector, in general, was very active in research activities during the sample period. Compared to 1997, R&D investment in the government-sector declined by 0.80% of GDP, whereas R&D in the business and education sectors grew respectively, by 4.8% and 5.6%, on average, in 2006. Among individual financial and legal indicators, the average size of stock market and private lending were 54% and 63% of GDP, respectively, and both shareholder and creditor rights were moderate at 3.5 in a scale of 1-5 and 2.0 in a scale of 1-4, respectively across sample economies. In addition, the average levels of capital intensity and government consumption were minimal (22% and 16% of GDP, on average, respectively), whereas the volume of commodity trading was very high (86% of GDP, on average) during the period 1997-2006. Finally, the data reveals that only 6% of total population aged 15 and above completed their education successfully in the sample countries during that period, on average.

[Insert Table 4.1 about Here]

4.5.2 Emerging versus Developed Economies

Table 4.2 includes the cross-sectional differences in sector-specific R&D investments as well as financial, legal and economic indicators between emerging and developed economies during the period 1997-2006, on average. Over these ten years, developed economies invested much more higher in R&D than emerging countries. The mean difference of R&D investments between developed and emerging economies was 1.060% of total GDP, significant at the 1% level. At a disaggregated level, the average R&D investments by the government, business and education sectors were 0.188% (0.214%), 0.271% (1.048%) and 0.141% (0.387%) of GDP, respectively, across all emerging (developed) countries during the period 1997-2006. Among them, R&D investments by the business and education sectors in developed economies were significantly higher (at the 1% level) than those in emerging countries throughout the sample years. Nevertheless, emerging economies experienced a significant growth in R&D

investment than developed countries from 1997 to 2006 (28.4% versus 10.2%, on average, significant at the 5% level). Most notably, R&D investments were increased by 2.6%, on average, in the government sectors of emerging countries, whereas government-initiated R&D in developed countries was decreased by 1.8%, on average, significantly different from the former at the 10% level. In contrast, R&D flows in the business and education sectors remained insignificantly different between emerging and developed countries during those years.

The level of financial activity in the emerging economies with real per capita GDP of $2,734 was significantly lower than that of developed economies with real per capita GDP of $14,072 during the period 1997-2006 (per capita GDP is constant at 2000 US$). More precisely, the stock market capitalization and market turnover were on average 38.2% and 18.9% of GDP, respectively across emerging countries. In contrast, the market capitalization and turnover in developed countries were on average 68.7% and 58.6% of their GDPs, respectively, which is significantly higher than the former at the 5% level. Likewise, the magnitude of private credit in emerging economies was 44.1% less than that in developed countries during the sample period, significant at the 1% level. In terms of legal practices, there were no significant differences in shareholder rights and creditor rights between emerging and developed countries during the same period. However, law was much more strongly enforced in developed than emerging economies during the sample period (9.058 versus 5.505 in an index from 1 to 10, significantly different at the 1% level).

[Insert Table 4.2 about Here]

4.5.3 Pearson Correlation Matrix

Table 4.3 reports the Pearson correlations among individual sector-specific R&D, productivity growth, its determinants and financial as well as legal status of sample countries. The correlation between *BRD* and *TFPGR* is 0.186, significant at the 1% level. In contrast, the correlation between *GRD* (*ERD*) and *TFPGR* is -0.193 (-0.102), significant at the 1% level (10% level). This implies that while R&D investment by the business sector had a significant positive impact on productivity growth, R&D initiatives by both the government and education sectors adversely affected total factor productivity of an economy during the period 1997-2006. Furthermore, I find that an increase in business-sector R&D resulted in an increase in government-sector R&D (the Pearson correlation between *GRD* and *BRD* is 0.801, significant at the 1% level) and reduced R&D investment in the education sector (the Pearson correlation between *ERD* and *BRD* is -0.501, significant at the 1% level) across countries during the sample period. Such an interaction among *GRD*, *BRD* and *ERD* suggests that R&D investment by one sector might have a spillover effect on R&D in another sector, and thereby might increase (reduce) the return on R&D of a less (more) efficient sector. For instance, the business sector might hire scientists away from the education sector. Therefore, it might reduce the effectiveness of R&D activities in education institutions, and thus minimize the rate of return on R&D investment in the education sector. Hence, understanding the interactive effect of sector-specific R&D on *TFPGR* in a multivariate set-up is crucial.

While individual proxy measures of finance and law are insignificantly correlated with *TFPGR* of sample countries, they are in fact significantly correlated with individual sector-specific R&D. Therefore, the return on sector-specific R&D might be indirectly influenced by the magnitude of financial activity and the legal status of an economy. For example, an increase in total lending (measured by *PCREDIT*) to the private sector by 1% increased R&D activities among business firms by 0.54% of total *GDP* in an economy during the period 1997-2006. Since the correlation between *BRD* and *TFPGR* is 0.186, significant at the 1% level, it is possible that the total factor productivity of an economy improved due to an increase in business-sector R&D as a result of a significant amount of credit financing in that country during the same period. In contrast, an increase in private lending by 1% significantly decreased R&D investments in the government and education sectors by 0.52% and 0.19% of total *GDP*, respectively. Since both *GRD* and *ERD* are negatively correlated with *TFPGR* (-0.193 and -0.102, respectively), it is likely that a higher private lending accelerated productivity growth during the period 1997-2006 by reducing R&D activities in the government and education sectors of sample economies, as well. Likewise, all other indicators of financial and legal development in an economy also significantly increase (decrease) *BRD* (*GRD* and *ERD*), and therefore might influence the rate of return on sector-specific R&D.[22]

[Insert Table 4.3 about Here]

4.5.4 Rate of Return on R&D Investment

Table 4.4 reports marginal contributions of R&D investments by the government, business and education sectors to productivity growth of an economy. I initially find that R&D initiatives by the government and education sectors had an insignificant impact on *TFPGR* across individual economies during the period 1998-2006. In contrast, the business sector significantly increased productivity growth of an economy throughout the sample period. More precisely, the rate of return on business-sector R&D was 0.037, significant at the 10% level. This evidence remains consistent under different specifications of the model. For instance, I consider both *GRD* and *BRD* together in model (V). It shows that while the sensitivity of business-sector R&D to *TFPGR* was 0.046, significant at the 10% level, government-sector R&D insignificantly influenced productivity growth in an economy during the period 1998-2006.[23] However, further analysis reveals that business enterprises have a positive spillover effect into government-sector R&D, which indeed helps the government sector to improve their

[22] At this stage, it is still difficult to draw inferences about the effectiveness of finance and law in productivity growth through sector-specific R&D investments, as correlations are calculated without controlling for other relevant determinants of *TFPGR*.

[23] Since *GRD*, *BRD* and *ERD* are significantly correlated, a model including these three sources of R&D together might not reflect the true impact of sector-specific R&D on an economy. I therefore consider the average growth in R&D at individual sectors during 1998-2006, which are insignificantly correlated with each another. Results, not reported in the table, reveal that a 1% increase in R&D growth by the business sector significantly contributed on *TFPGR* during the sample period, whereas an increase in R&D growth at the government and education sectors could not exhibit any significant return during the sample period.

performance in R&D. For example, in the presence of an industry-government relationship, an increase in *GRD* by 1% increased overall growth in *TFP* of an economy by 0.13% with an average *BRD* of 0.462% of *GDP*, significant at the 1% level (refer to model I of Table 4.5). In contrast, an increase of 1% in *BRD* improved *TFPGR* of a country by 0.06% with an average *GRD* of 0.281% of *GDP*, significant at the 1% level. Therefore, a strong relationship between industry and government is advantageous to enhance the effectiveness of R&D investments in both the business and government sectors. In contrast, I find that there exists a negative spillover effect in R&D activities between the business and education sectors (refer to model III in Table 4.5). This is possible when industry attracts good researchers from academic institutions and thereby reduces the quality of R&D activities in the education sector. However, further evidence suggests that if there are interconnections among all three sectors within an economy, the negative spillover effect between the business and education sectors becomes insignificant (refer to model IV in Table 4.5). In summary, the rate of return on R&D investment can be augmented by combined efforts in R&D activities among individual sectors of an economy.

[Insert Table 4.4 and 4.5 about Here]

Table 4.6 distinguishes the differences in rate of return on sector-specific R&D between emerging and developed economies. As is evident in model I, while government-sector R&D significantly increased in emerging economies during 1997-2006 (an average increase of 2.6%), such a change in *GRD* insignificantly contributed to *TFPGR* of respective countries in the following years. Furthermore, the government sectors of developed countries concentrated less on increasing their R&D activities during the sample period (an average decrease of 1.8%) and therefore had an insignificant effect on their *TFPGR*, as well. Between the business and education sectors in emerging economies, I find that R&D investments by business enterprises significantly increased their total factor productivity by 4.80%, whereas R&D activities in the education sector adversely affected their overall productivity by 7.20%, significant at the 10% and 5% level, respectively. In contrast, R&D investments by education institutions in developed countries significantly improved their *TFP*s by 12.9% relative to emerging economies; however, R&D activities by business entities resulted in a decline of *TFP* by 12.1% in developed compared to emerging economies during 1998-2006, significant at the 5% and 1% level, respectively.

[Insert Table 4.6 about Here]

In summary, the results suggest that countries in which R&D investments were mostly conducted by their government institutions did not experience a higher growth in productivity during the period 1998-2006. In contrast, an increase in *TFP* among emerging economies mainly resulted from R&D initiatives by business enterprises, whereas research activities in the education sectors contributed significantly in developed countries during that period. Therefore, the question remains whether the financial and legal development in individual countries might increase the rate of return on government-, business- and education-sector R&D in both developed and emerging economies. I address this issue in the remaining sections of the paper.

4.5.5 Importance of Finance and Law in Return on Government-Sector R&D

Table 4.7 reports the estimated coefficients of model (3-2). While considering *SMCAP* and *SR* as two separate proxy measures of stock market activity and legal right of shareholders, I find that an increase in *GRDGR* by 1% resulted in an insignificant change in *TFP* by 0.005% during the period 1999-2006, with an average *SMCAP* and *SR* of 0.538 and 3.473, respectively. In contrast, as is evident in model (III) of Table 4.7, an increase in *GRDGR* by 1% marginally reduced overall productivity by 0.009% during the same period, with an average *PCREDIT* and *CR* of 0.628 and 1.957, respectively. While such an effect is significant at the 1% level, this is however economically negligible.[24] Other models in Table 4.7 also reveal similar findings.

In summary, the results related to government-sector R&D suggest that an increase in R&D activities by the government sector does not result in any significant increase in productivity. Even ensuring a higher level of financial development and well-protected rights to stakeholders in both emerging and developed countries cannot alter this impact on economic growth. R&D activities are mainly conducted by the government sectors in emerging countries, and financial markets and legal environments are heavily controlled by their governments as well (see, Dinç, 2005; La Porta, Lopez-de-Silanes and Shleifer, 2008, 2002). Given this fact, the higher return on government-initiated R&D in emerging economies is less likely. However, based on the previous evidence in Table 4.5, it appears that the collaborative activities between the business and

[24] Average values of financial and legal statuses are given in Table 4.1.

government sectors should enhance the effectiveness of government-initiated R&D in emerging markets.

[Insert Table 4.7 about Here]

4.5.6 Importance of Finance versus Law in Return on Business-Sector R&D

Financing of Business-Sector R&D in Emerging and Developed Economies:

Table 4.8 includes the estimated results of R&D financing across firms in emerging versus developed economies. I find that R&D investment in the business sector and their sources of external financing are negatively correlated in emerging countries. More precisely, an increase in new debt and equity issuances by 1% decreased firm-level investment in R&D by 0.10% and 0.12% of their total assets during 1998-2006, significant at the 1% level. In contrast, an increase in internal cash holdings by 1% of total assets raised *BRD* by 0.14% of total assets across firms in emerging economies, significant at the 1% level. Therefore, the growth in R&D activities by business firms in emerging countries is highly responsive to internal financing. In the case of developed countries, firms were able to increase R&D investments by raising new debts and internal cash flows. However, I find that *BRD* was usually less financed by new equity issuances in developed economies. For instance, while excluding US firms in model (III), I find that an increase in leverage and cash holding by 1% increased R&D investments across firms by 0.02% and 0.10% of total assets, respectively, significant at the 1% level. In contrast, an increase in shareholders equity of these firms by 1% reduced firm-level investment in R&D by 0.02%, significant at the

1% level. I find similar evidence in the case of US firms. However, cash flow impacts are much larger in the U.S. than other developed and emerging countries (2.039 versus 0.095 and 0.137, respectively, significant at the 1% level). This result is consistent with the evidence in extant literature that also finds a large positive change in R&D due to an increase in cash flows of US manufacturing firms relative to firms in France, Germany, Ireland, Japan and UK (see, Harhoff, 1998; Mulkay, Hall and Mairesse, 2001; Bougheas, Goerg and Strobl, 2001).[25] Therefore, both internal cash flows and active credit markets play a crucial role in financing R&D of the business sector in developed economies.

[Insert Table 4.8 about Here]

Effectiveness of Business-Sector R&D:

Table 4.9 reports the importance of finance and law in increasing the marginal contribution of business-sector R&D on firm-level productivity. I initially consider the restriction of constant returns to scale in the production function. By using different proxy variables of financial and legal status of an economy in individual model specifications, I find that the return on R&D capital across firms was higher in countries with active stock markets than credit markets during the period 1998-2006. Furthermore, the responsiveness of R&D investments by the business sector to their total factor productivity was higher in economies where

[25] Emerging countries experienced a significant increase in business-sector R&D during the period 1997-2006 because of a large cash inflow by foreign companies of developed countries. For instance, more than 300 multinational corporations set up R&D and technical centers in India during the period 2006-2007, of which 125 firms are Fortune 500 companies. In contrast, local firms in emerging countries are usually more financially constrained than foreign firms in developed countries, and therefore the change in R&D due to an increase in their internal cash flows is significantly less in emerging than in developed economies.

shareholder rights were relatively strong and legal enforcement was efficient during the sample period. For example, as shown in model (I) of Table 4.9, a rise in firms' R&D capital by 1% during 1997-2005 increased their productivity by 0.20% during 1998-2006 across individual countries, with an average *SMCAP* and *SR* of 0.538 and 3.473, respectively, significant at the 1% level. In contrast, a 1% increase in R&D capital decreased firm-level productivity by 0.01% across individual economies, with an average *PCREDIT* and *CR* of 0.628 and 1.957, respectively, significant at the 1% level (see model II). Table 4.10 includes the results of same-model specifications after imposing the restriction of non-constant returns to scale in the production function (equation 5-2). The results remain robust even after applying the latter condition in the model.

Therefore, the above findings suggest that between two types of capital markets and two forms of stakeholder rights, an active stock market and strong right of minority shareholders can significantly improve the quality of R&D activities by the business sector. This evidence is consistent with the idea that the problem of information asymmetry between managers and shareholders might be reduced through a large volume of trading in stock market (see Kyle, 1985) and by involving shareholders in decision-making about individual R&D projects. In contrast, a highly functioning credit market and high standards of creditor rights do not guarantee sufficient involvement of lenders in retrieving inside information *ex ante* and thereby might not be sufficient to ensure that firms are investing in the most efficient R&D projects. However, unlike developed economies, the results finally exhibit that the overall development of both equity and credit markets, as well as strong legal rights to both shareholders and lenders, are equally important to increase the return on business-sector R&D in emerging countries (refer to Table 4.11).

[Insert Table 4.9, 4.10 and 4.11 about Here]

4.5.7 Importance of Finance and Law in Education-Sector R&D

While examining the combined effect of *ERD* and finance and law on *TFPGR*, I find that the degree of financial activity and legal rights of stakeholders insignificantly influenced the rate of return on education-sector R&D during the period 1998-2006 (results not reported in the table). Given the fact that R&D activities in the education sector are mainly financed by the public sector of a country, the financial market and legal structures, in general, are expected to be less critical in improving the overall effectiveness of education-sector R&D. However, I observe that there are some institutional differences at the level of higher education between emerging and developed countries. Since the education sector in developed economies significantly contributed to their overall productivity from 1998 to 2006, whereas R&D activities in education institutions of emerging countries had an insignificant effect on *TFP*, I imagine that further development within the higher education sector might enhance the effectiveness of *ERD* in the latter countries. For instance, as is evident in Table 4.12, (I) the quality of mathematics and science education (*QMSE*); II) the quality of management studies (*QMS*); III) internet accessibility in education (*IAS*); IV) research and professional training (*RTS*); V) the quality of scientific research institutions (*QSRI*); and VI) the university-industry collaboration in R&D (*UIC*) in emerging economies are still significantly weaker than those in developed countries. Therefore, further development in these areas might be beneficial to improve the return on *ERD* in emerging economies; however, more extensive research is required in this direction. Therefore, a separate research study ought to be conducted in future after completing a detailed survey of different academic institutions (e.g., colleges and universities) in several emerging and developed countries.

[Insert Table 4.12 about Here]

4.6 CONCLUSION

This study determines the importance of an active financial market and a strong legal environment in improving the return on R&D investments by the government and business sectors across emerging and developed countries. By addressing this issue, the paper finally exhibits a new channel through which both finance and law in an economy can matter for overall productivity growth of a country. This experiment also contributes to extant literature by doing an extensive analysis, both at the aggregate and firm level, of several countries.

I find that R&D investments by the business sector in emerging economies significantly contributed to total factor productivity of these countries during the period 1998-2006. In contrast, the education sectors played a vital role in improving overall productivity of developed economies through their effective research activities. Further analyses reveal that an active stock market and strong legal rights of minority shareholders are most important to increasing the rate of return on business-sector R&D. This evidence is reasonable, given the fact that a large volume of trading of stocks and involvement of minority shareholders in corporate decision-making can minimize information asymmetry between managers and shareholders. However, a well-developed financial market and a strict legal environment are not sufficient for increasing the return on government-sector R&D. In contrast, the results suggest that marginal contribution of government-sector R&D can be improved by engaging the business sector in government-initiated R&D projects. Finally, the financial and legal structure of an economy insignificantly influences the return on education-sector R&D. Therefore, the extent to which finance and law matter for productivity growth of a country depends on R&D intensity in the government versus the business sector, their joint efforts in R&D activities, as well as the level of stock market development and shareholder rights in that particular economy.

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Appendix 4A: Variables – Descriptions and Data Sources

Variable name (Symbol)	Description and Source	Number of countries
Research and Development (*RD*)	A ratio of R&D expenditure to Gross Domestic Product (GDP). Numbers are given in percentage. Sector-wise R&D by performance includes R&D investments by the government (*GRD*), business (*BRD*) and education (*ERD*) sectors. The sample data is available from 1997 to 2006. Source: UNESCO Institute for Statistics.	70
Financial Activity		
Stock market capitalization (*SMCAP*)	A measure that indicates the size of a stock market relative to the size of an economy (measured by GDP). The variable is a ratio of the value of listed shares to GDP. Data is available from 1976 to 2006. Source: Beck, Demicguc-Kunt and Levine, 2000	68
Stock market total value traded (*SMTURN*)	A ratio of total value traded to GDP. It also reflects the degree of liquidity that a stock market provides to an economy. Total value traded equals the value of total shares traded on a stock exchange. Data is available from 1975 to 2006. Source: Beck, Demicguc-Kunt and Levine, 2000	67
Private credit by deposit money banks and other financial institutions (*PCREDIT*)	A ratio of total domestic credit to private sector to GDP. It measures the magnitude of channeling savings to local investors. Data is available from 1960 to 2006. Source: Beck, Demicguc-Kunt and Levine, 2000	65
Legal Status		
Shareholder rights (*SR*)	An index that measures how strongly the legal system favors minority shareholders against managers or dominant shareholders in the corporate decision-making process including the voting process. The index is calculated out of 5, with higher number implying high level of shareholder rights. Source: La Porta, Lopez-de-Silanes, Shleifer and Vishny, 1998	56
Creditor rights (*CR*)	An index that measures whether secured creditors (1) are able to seize the collateral, (2) are paid first out of the proceeds of liquidating a bankrupt firm, (3) whether there are restrictions, such as creditor consent, when a debtor files for reorganization, and (4) whether an administrator, but not management, is able for running the business during the reorganization. The score lies between 0 (poor creditor rights) and 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Source: Djankov, McLiesh and Shleifer, 2007	70
Legal enforcement (*ENF*)	An indicator of the effectiveness of the legal system in enforcing contracts. It ranges from 1 (weak law and order tradition) to 10 (strong law and order tradition). Source: World Bank Development Indicators, World Bank, 2007	70

Variable name (Symbol)	Description and Source	Number of countries
Other Variables		
Capital intensity (*CAPINT*)	A ratio of physical capital accumulation to GDP. Data is available from 1960 to 2006. Source: World Bank	70
Human capital (*HC*)	The average percentage of population aged 15 and over who have successfully completed a given level of schooling – say secondary, tertiary or post-primary schooling. Data are collected at five-year intervals from 1960 to 2000. Source: Barro and Lee (2001)	70
Trade liberalization (*OPEN*)	A ratio of total value of export and import to GDP. Data is available from 1960 to 2006. Source: World Bank	70
Government consumption (*GOVT*)	A ratio of government consumption expenditure to GDP. Data is available from 1960 to 2006. Source: World Bank	70
Per capita GDP (*PCGDP*)	A ratio of GDP to total number of population. Data is available from 1960 to 2006. Source: World Bank	70
OECD dummy variable (*OECDD*)	A dummy variable that is equal to 1 if the sample country is a member of OECD countries, 0 otherwise	70
Quality of mathematics and science education (*QMSE*)	This is based on the statistical score in a 1-7 scale, where 1 = lag far behind from most of the countries and 7 = among the best in the world. Source: WEF Global Competitive Report	70
Quality of management studies (*QMS*)	It is constructed in a scale of 1-7, where 1 = limited or of poor quality and 7 = among the world's best. Source: WEF Global Competitive Report	70
Internet access in school (*IAS*)	The scores are based on a scale of 1-7, where 1 = very limited and 7 = pervasive – most children have frequent access. Source: WEF Competitiveness Report	70
Research and professional services (*RTS*)	The scores measure the availability of specialized research and training services in a scale of 1-7, where 1 = not available and 7 = available from world-class local institutions. Source: WEF Competitiveness Report	70
Quality of scientific research institutions (*QSRI*)	The scores imply the quality of university laboratories in a scale of 1-7, where 1 = nonexistent and 7 = the best in their fields internationally. Source: WEF Competitive Report	70
University-Industry collaboration (*UIC*)	The scores are given in a scale of 1-7, where 1 = minimal or non-existent and 7 = intensive and ongoing. Source: WEF Global Competitiveness Report	70

Appendix 4B: Derivation of Total Factor Productivity Growth (*TFPGR*)

The Cobb-Douglas production function of country *i* at year *t*

$$Y_{it} = A_{it}\ K_{it}^{\alpha}\ L_{it}^{1-\alpha}$$

$$\Rightarrow \frac{Y_{it}}{L_{it}} = A_{it}\ \frac{K_{it}^{\alpha}}{L_{it}}\ L_{it}^{1-\alpha}$$

$$\Rightarrow \frac{Y_{it}}{L_{it}} = A_{it}\ \frac{K_{it}^{\alpha}}{L_{it}^{\alpha}} = A_{it}\ .\ k_{it}^{\alpha}$$ (Here, k_{it} = Capital-labor ratio at year *t*)

$$\Rightarrow y_{it} = A_{it}\ .\ k_{it}^{\alpha}$$ (Here, y_{it} = Output per labor at year *t*)

By taking log transformation, I write

$$\Rightarrow \log y_{it} = \log A_{it} + \alpha.\log k_{it} \qquad (1)$$

Likewise, for year (*t + 1*)

$$\log y_{it+1} = \log A_{it+1} + \alpha.\log k_{it+1} \qquad (2)$$

Subtracting (1) from (2) yields

$$(\log y_{it+1} - \log y_{it}) = (\log A_{it+1} - \log A_{it}) + \alpha.(\log k_{it+1} - \log k_{it})$$

$$\Rightarrow \log \frac{y_{it+1}}{y_{it}} = \log \frac{A_{it+1}}{A_{it}} + \alpha.\log \frac{k_{it+1}}{k_{it}}$$

$$\Rightarrow \log \frac{A_{it+1}}{A_{it}} = \log \frac{y_{it+1}}{y_{it}} - \alpha.\log \frac{k_{it+1}}{k_{it}}$$

$$\Rightarrow TFPGR = GR - \alpha.CAPGR$$

Appendix 4C: Measuring the Impact of R&D Capital on Firm-Level Productivity

The following model is taken from Hall and Mairesse (1995). Assume that the production function of manufacturing firms is a Cobb-Douglas function of three inputs: Labor (L), physical capital (K) and R&D or knowledge capital (R). Therefore, the production function is:

$$Y_{it} = A \cdot e^{\lambda t} \cdot L_{it}^{\alpha} \cdot K_{it}^{\beta} \cdot R_{it}^{\gamma} \cdot e^{\varepsilon_{it}} \qquad \text{(C-1)}$$

Here, Y is value added, ε is a multiplicative disturbance, i denotes firms, and t implies years. λ is the rate of disembodied technical change; however, the time trend λt is replaced by time dummies in the regression. Finally, the knowledge capital is defined by the following equation

$$R_{it} = RD_{it}/(g + \delta)$$

where RD is R&D investment by a firm, g is the growth rate of R&D and δ is the rate of depreciation of knowledge capital. Following Hall and Mairesse (1995), I assume that $\delta = 0.15$, which is also assumed constant both across firms and over time.

By taking logarithm in both sides of (C-1), the following equation can be written

$$y_{it} = a + \lambda t + \alpha l_{it} + \beta k_{it} + \gamma r_{it} + \varepsilon_{it} \qquad \text{(C-2)}$$

where, the lower case letters denote the logarithms of variables.

Finally, assume that under constant returns to scale, $\alpha + \beta + \gamma = 1$, otherwise, $\alpha + \beta + \gamma = \mu$.

By subtracting labor from both sides in (C-2) and imposing the above conditions, I construct two separate equations:

First, $(y_{it} - l_{it}) = a + \lambda t + \alpha l_{it} + \beta k_{it} + \gamma r_{it} + \varepsilon_{it} - l_{it}$

$$= a + \lambda t + (\alpha + \beta + \gamma).l_{it} + \beta.(k_{it} - l_{it}) + \gamma.(r_{it} - l_{it}) + \varepsilon_{it} - l_{it} \qquad \text{(C-3)}$$

Now, if $\alpha + \beta + \gamma = 1$, then equation (C-3) can be written as:

$$(y_{it} - l_{it}) = a + \lambda t + \beta.(k_{it} - l_{it}) + \gamma.(r_{it} - l_{it}) + \varepsilon_{it}$$

$$\Rightarrow log(Y/L)_{it} = a + \lambda t + \beta log(K/L)_{it} + \gamma log(R/L)_{it} \qquad \text{(C-4)}$$

Otherwise, if $\alpha + \beta + \gamma = \mu$, then equation (C-3) can be written as:

$$(y_{it} - l_{it}) = a + \lambda t + \beta.(k_{it} - l_{it}) + \gamma.(r_{it} - l_{it}) + (\mu - 1).l_{it} + \varepsilon_{it}$$

$$\Rightarrow log(Y/L)_{it} = a + \lambda t + \beta log(K/L)_{it} + \gamma log(R/L)_{it} + \varphi log L_{it} \qquad \text{(C-5)}$$

Here, φ measures the departure from constant returns to scale, and γ measures the marginal contribution of R&D capital on a firm's output.

Table 4.1: Summary Statistics

The table reports summary statistics of total research and development (R&D), change in R&D, financial activity and legal status of both emerging (Non-OECD) and developed (OECD) economies during the period 1997-2006. R&D is decomposed into three sector-specific investments: R&D by the government (*GRD*), business (*BRD*) and education (*ERD*) sectors. By definition, the government sector includes central (federal), state and local government authorities; the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services; and the higher education institutions consider all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). Further details of the variables can be found in Appendix 4A.

NAME	Sample Size	Mean	Median	Std. Dev	Variance
TFPGR	613	0.043	0.035	0.088	0.008
Research and Development (*% of GDP*)					
GRD	475	0.281	0.222	0.213	0.045
BRD	454	0.462	0.495	0.207	0.043
ERD	462	0.246	0.229	0.142	0.020
Change in R&D (%)					
GRDGR	424	-0.800	-1.800	0.163	0.027
BRDGR	411	4.800	0.000	0.319	0.101
ERDGR	417	5.600	0.100	0.546	0.298
Financial Activity (Ratio)					
SMCAP	575	0.538	0.290	0.651	0.424
SMTURN	572	0.360	0.120	0.539	0.290
PCREDIT	578	0.628	0.468	0.501	0.251
Legal Status (Indices)					
SR	504	3.473	3.500	1.055	1.113
CR	621	1.957	2.000	1.043	1.087
ENF	324	7.677	8.503	2.054	4.219
Other Variables (Ratio)					
CAPACC	585	0.218	0.210	0.052	0.003
HC	549	0.063	0.065	2.308	5.325
OPEN	603	0.860	0.774	0.483	0.234
GOVT	594	0.163	0.169	0.051	0.003

Table 4.2: Characteristics of Emerging and Developed Economies

The table includes the cross-sectional differences in total research and development (R&D) investment, annual growth in R&D, financial activity, legal status and economic performance between emerging (Non-OECD) and developed (OECD) economies. R&D is decomposed into three sector-specific investments: R&D by the government (*GRD*), business (*BRD*) and education (*ERD*) sectors. By definition, the government sector includes central (federal), state and local government authorities; the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services; and the higher education institutions consider all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). The economic performance is measured by per capita GDP (*PCGDP*) in constant 2000 US$. ***, ** and * imply the significance of mean difference of each variable at the 1%, 5% and 10% level, respectively.

Indicators	Emerging economies	Developed economies	Mean differences (*t*-stat)
R&D (% of GDP)			
RD	0.618	1.678	-1.060*** (-5.000)
GRD	0.188	0.214	-0.026 (-0.876)
BRD	0.271	1.048	-0.777*** (-4.778)
ERD	0.141	0.387	-0.246*** (-5.993)
Growth in R&D (%)			
RDGR	28.400	10.200	18.200** (1.977)
GRDGR	2.600	-1.800	4.400* (1.805)
BRDGR	10.200	4.800	5.400 (1.358)
ERDGR	7.800	3.700	4.100 (1.168)
Financial Activity (% of GDP)			
SMCAP	38.200	68.700	-30.500** (-2.170)
SMTURN	18.900	58.600	-39.700*** (-3.331)
PCREDIT	43.400	87.500	-44.100*** (-4.054)
Legal Status (Indices)			
SR	3.586	3.352	0.234 (0.829)
CR	2.023	1.852	0.171 (0.655)
ENF	5.505	9.058	-3.553*** (-8.872)
Economic Performance (Constant 2000 US$)			
PCGDP	2733.832	14071.735	-11337.903*** (7.528)

Table 4.3: Pearson Correlation Matrix

The table reports the Pearson correlations among sector-specific R&D (Research and Development), financial activity, legal status and individual determinants of productivity growth (*TFPGR*) across emerging and developed economies. *GRD*, *BRD* and *ERD* imply R&D investments by the government, business and higher education sectors, respectively. Government sector includes central (federal), state and local government authorities. Business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services. Higher education institutions considers all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. The financial activity is measured by the ratio of stock market capitalization (total market value of listed shares) to GDP (*SMCAP*), the ratio of stock market total value traded to GDP (*SMTURN*) and the ratio of private credit by deposit money banks and other financial institutions to GDP (*PCREDIT*). Country-specific legal environment include shareholder rights index (*SR*), creditor rights index (*CR*) and the index of legal enforcement (*ENF*). The determinants of *TFPGR* include the ratio of physical capital to GDP (*CAPINT*), the level of human capital (*HC*), the degree of openness of an economy (*OPEN*) and the size of government consumption expenditures in an economy (*GOVT*). Further details about the variables and indices can be found in Appendix 4A. *p*-values are given in the parentheses. ***, ** and * imply the significance of correlation between two variables at the 1%, 5% and 10%, respectively.

	TFPGR	*GRD*	*BRD*	*ERD*	*CAPINT*	*HC*	*OPEN*	*GOVT*	*SMCAP*	*SMTURN*	*PCREDIT*	*SR*	*CR*	*ENF*
TFPGR	1													
	-													
GRD	-0.193***	1												
	0.000	-												
BRD	0.186***	0.801***	1											
	0.001	0.000	-											
ERD	-0.102*	-0.019	-0.501***	1										
	0.066	0.729	0.000	-										
CAPINT	-0.000	0.178***	-0.221***	0.012	1									
	0.994	0.001	0.000	0.824	-									
HC	0.019	-0.585	0.628***	-0.179***	-0.309***	1								
	0.725	0.000	0.000	0.001	0.000	-								
OPEN	0.152**	-0.372***	0.373***	-0.094*	0.176***	0.126**	1							
	0.006	0.000	0.000	0.090	0.001	0.023	-							
GOVT	0.088	-0.576***	0.608***	-0.135**	-0.258***	0.430***	0.195***	1						
	0.109	0.000	0.000	0.015	0.000	0.000	0.000	-						
SMCAP	-0.006	-0.408***	0.504***	-0.229***	-0.179***	0.342***	0.188***	0.287***	1					
	0.908	0.000	0.000	0.000	0.001	0.000	0.001	0.000	-					
SMTURN	0.069	-0.329***	0.471***	-0.300***	-0.036	0.339***	-0.025	0.272***	0.681***	1				
	0.212	0.000	0.000	0.000	0.518	0.000	0.651	0.000	0.000	-				
PCREDIT	0.133	-0.518***	0.542***	-0.185***	0.165***	0.458***	0.229***	0.413***	0.467***	0.470***	1			
	0.017	0.000	0.000	0.001	0.003	0.000	0.000	0.000	0.000	0.000	-			
SR	0.082	-0.033***	0.281***	-0.349***	0.159***	-0.002	0.131**	0.027	0.252***	0.148***	0.204***	1		
	0.142	0.000	0.000	0.000	0.004	0.959	0.018	0.633	0.000	0.001	0.000	-		
CR	0.016	-0.159***	0.301***	-0.146**	-0.068	0.297***	0.174***	0.338***	0.273***	0.178***	0.428***	0.306***	1	
	0.779	0.004	0.000	0.010	0.222	0.000	0.001	0.000	0.000	0.001	0.000	0.000	-	
ENF	0.124	-0.699***	0.739***	-0.231***	-0.003	0.679***	0.305***	0.759***	0.389***	0.439***	0.631***	0.049	0.374***	1
	0.025	0.000	0.000	0.000	0.962	0.000	0.000	0.000	0.000	0.000	0.000	0.380	0.000	-

Table 4.4: Contribution of Government-, Business- and Education-Sector R&D on Total Factor Productivity

The dependent variable is the growth in total factor productivity of individual economies during the period 1998-2006. Among the explanatory variables, *GRD*, *BRD* and *ERD* are R&D investments by the government, business and education sectors in an economy during 1997-2005, respectively. By definition, the government sector includes central (federal), state and local government authorities; the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services; and the higher education institutions include all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. *CAPINT* is a ratio of fixed capital formation to gross domestic product (GDP); *HC* is the human capital, which is the average percentage of population aged 15 and over who have completed schooling, estimated by Barro and Lee (2001); *OPEN* is a degree of openness of an economy with the rest of the world, measured by a ratio of total export and import to GDP, and *GOVT* is a ratio of government consumption expenditure to GDP. *PCGDP* is per capita GDP, which is a ratio of GDP to total population in an economy. The results are estimated by using an unbalanced panel data set. The observations are clustered by country. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. The models are statistically significant at the 1%.

Independent variables	(I)	(II)	(III)	(IV)	(V)
GRD	-0.002 (-0.088)	-	-	-0.022 (-0.818)	0.023 (0.799)
BRD	-	0.037* (1.894)	-	-	0.046* (1.830)
ERD	-	-	-0.031 (-1.289)	-0.044 (-1.565)	-
CAPINT	0.168** (2.218)	0.113 (1.486)	0.139* (1.852)	0.156** (2.042)	0.125* (1.601)
HC	0.008*** (4.090)	0.006*** (3.205)	0.007*** (3.472)	0.007*** (3.485)	0.007*** (3.249)
OPEN	0.008 (1.091)	0.006 (0.921)	0.007 (1.063)	0.008 (1.107)	0.009 (1.265)
GOVT	-0.045 (-0.547)	-0.010 (-0.126)	-0.005 (-0.067)	-0.044 (-0.536)	-0.052 (-0.620)
PCGDP	-0.000*** (-3.759)	-0.000*** (-4.607)	-0.000*** (-4.140)	-0.000*** (-3.957)	0.000*** (-4.027)
Constant	-0.083*** (-3.251)	-0.076*** (-3.355)	-0.066** (-2.691)	-0.055* (-1.822)	-0.089*** (-3.269)
N	389	379	384	373	364
R^2	0.328	0.334	0.319	0.329	0.338
Year dummy variables	Yes	Yes	Yes	Yes	Yes

Table 4.5: R&D Spillover among the Government, Business and Education Sectors

The dependent variable is the growth in total factor productivity of individual economies during the period 1998-2006. Among the explanatory variables, *GRD*, *BRD* and *ERD* are R&D investments by the government, business and education sectors in an economy during 1997-2005, respectively. By definition, the government sector includes central (federal), state and local government authorities; the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services; and the higher education institutions includes all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. *CAPINT* is a ratio of fixed capital formation to gross domestic product (GDP); *HC* is the human capital, which is the average percentage of population aged 15 and over who have completed schooling, estimated by Barro and Lee (2001); *OPEN* is a degree of openness of an economy with the rest of the world, measured by a ratio of total export and import to GDP, and *GOVT* is a ratio of government consumption expenditure to GDP. *OECDD* is a dummy variable that is equal to 1 for OECD (developed) countries or 0 for non-OECD (emerging) countries. The results are estimated by using an unbalanced panel data set. The observations are clustered by country. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. All models are statistically significant at the 1% level. Marginal effect of sector-specific R&D on *TFPGR* is tested from a joint hypothesis that the corresponding coefficients associated with a particular sector-specific R&D are significantly different from zero.

Independent variables	(I)	(II)	(III)	(IV)
GRD	-0.013 (-0.358)	0.018 (0.518)	-	-0.045 (-0.604)
BRD	-0.029 (-0.882)	-	0.032 (0.822)	-0.031 (-0.392)
ERD	-	-0.033 (-0.771)	0.029 (0.412)	0.051 (0.509)
GRD × *BRD*	0.314** (2.756)	-	-	0.307** (2.671)
GRD × *ERD*	-	0.010 (0.070)	-	-0.104 (-0.703)
BRD × *ERD*	-	-	-0.277* (-1.661)	-0.290 (-1.574)
CAPINT	0.132* (1.657)	0.206** (2.644)	0.133* (1.679)	0.113 (1.390)
HC	0.005** (2.344)	0.010** (2.657)	0.004* (1.830)	0.004** (2.067)
OPEN	0.012 (1.577)	0.008 (1.065)	0.011 (1.494)	-0.012* (-1.625)
GOVT	-0.059 (-0.703)	-0.079 (-0.932)	-0.008 (-0.097)	-0.012 (-0.131)

Table 4.5 (Continued)

OECDD	-0.005 (-0.611)	-0.002 (-0.202)	0.003 (0.339)	0.010 (1.107)
Constant	-0.079** (-2.808)	-0.077** (-2.357)	-0.062** (-2.219)	-0.053 (-0.797)
N	364	373	375	364
R^2	0.322	0.300	0.303	0.328
Time dummy variables	Yes	Yes	Yes	Yes
p-Value (Chi-square test)	0.000	0.000	0.000	0.000
$\Delta TFPGR/\Delta GRD$	0.132***	0.020	-0.036*	0.071
$\Delta TFPGR/\Delta BRD$	0.059***	-0.030	-0.099**	-0.016
$\Delta TFPGR/\Delta ERD$	-	-	-	-0.050

Table 4.6: Effectiveness of Sector-specific R&D on Total Factor Productivity between Emerging and Developed Economies

The dependent variable is the growth in total factor productivity of individual economies during the period 1998-2006. Among the explanatory variables, *GRD*, *BRD* and *ERD* are the R&D investments by the government, business and education sectors in an economy during 1997-2005, respectively. By definition, the government sector includes central (federal), state and local government authorities; the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services; and the higher education institutions includes all universities, technical colleges, post-secondary institutes, all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with higher educational establishments. *CAPINT* is a ratio of fixed capital formation to gross domestic product (GDP); *HC* is the human capital, which is the average percentage of population aged 15 and over who have completed schooling, estimated by Barro and Lee (2001); *OPEN* is a degree of openness of an economy with the rest of the world, measured by a ratio of total export and import to GDP, and *GOVT* is a ratio of government consumption expenditure to GDP. *OECDD* is a dummy variable that is equal to 1 for OECD (developed) countries or 0 for non-OECD (emerging) countries. The results are estimated by using an unbalanced panel data set. The observations are clustered by country. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. The models are statistically significant at the 1%.

Independent variables	(I)	(II)	(III)
GRD	0.016 (0.641)	-	-
BRD	-	0.048* (1.906)	-
ERD	-	-	-0.072** (-2.421)
GRD × *OECDD*	0.083 (1.454)	-	-
BRD × *OECDD*	-	-0.121*** (-3.044)	-
ERD × *OECDD*	-	-	0.129** (2.214)
CAPINT	0.195** (2.536)	0.168** (2.204)	0.211** (2.780)
HC	0.010*** (3.112)	0.010** (2.842)	0.006*** (3.016)
OPEN	0.008 (1.082)	0.005 (0.743)	0.008 (1.107)
GOVT	-0.055 (-0.652)	0.016 (0.184)	-0.009 (-0.114)
OECDD	-0.014 (-0.932)	0.049** (2.467)	-0.041** (-2.201)

Table 4.6 (Continued)

Constant	-0.089*** (-3.395)	-0.098*** (-3.996)	-0.073*** (2.868)
N	389	379	384
R^2	0.307	0.313	0.298
Year dummy variable	Yes	Yes	Yes
p-Value (Chi-square test)	0.000	0.000	0.000

Table 4.7: Impact of Finance and Law on Return of Government-Sector R&D

The dependent variable is the average growth in total factor productivity of individual economies during the period 1999-2006. Among the explanatory variables, *GRDGR* is the growth in R&D investment by the government sector during 1997-2004. By definition, the government sector includes central (federal), state and local government authorities. *CAPINT* is a ratio of fixed capital formation to gross domestic product (GDP); *HC* is the human capital, which is the average percentage of population aged 15 and over who have completed schooling, estimated by Barro and Lee (2001); *OPEN* is a degree of openness of an economy with the rest of the world, measured by a ratio of total export and import to GDP, and *GOVT* is a ratio of government consumption expenditure to GDP. *OECDD* is a dummy variable that is equal to 1 for OECD (developed) countries or 0 for non-OECD (emerging) countries. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). For a robustness check, two other measures of legal environment, *RL* (rule of law) and *RQ* (regulatory quality) are considered, which are provided at the country-level by the World Bank. *t*-statistics are calculated by using heteroskedasticity consistent standard error and given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. All models are estimated by using the ordinary least square method.

Independent variables	(I)	(II)	(III)	(IV)	(V)
GRDGR	-0.027 (-0.852)	0.046 (0.411)	-0.006 (-0.215)	-0.020 (-1.143)	-0.027* (1.678)
GRDGR × *SMCAP*	0.030*** (3.143)	-	-	0.033*** (3.190)	-
GRDGR × *SMTURN*	-	0.038** (2.917)	-	-	-
GRDGR × *PCREDIT*	-	-	0.069*** (3.772)	-	0.083** (2.743)
GRDGR × *SR*	0.003 (0.442)	-	-	-	-
GRDGR × *ENF*	-	-0.010 (-0.527)	-	-	-
GRDGR × *CR*	-	-	-0.018 (-1.407)	-	-
GRDGR × *RL*	-	-	-	-0.010 (-0.483)	-
GRDGR × *RQ*	-	-	-	-	-0.033 (-1.283)
CAPINT	0.001** (2.561)	0.001** (2.115)	0.001 (1.580)	0.001** (2.229)	0.001 (1.598)
HC	0.001* (1.758)	0.002** (2.291)	0.002* (1.980)	0.002** (2.004)	0.001* (1.957)
OPEN	0.003 (0.545)	0.003 (0.546)	0.007 (1.148)	0.004 (0.566)	0.006 (1.034)

Table 4.7 (Continued)

GOVT	-0.030 (-1.402)	-0.040** (-2.181)	-0.058*** (-3.000)	-0.038* (-1.755)	-0.045** (-2.376)
OECDD	-0.009** (-2.435)	-0.009** (-2.479)	-0.006* (-1.980)	-0.009** (-2.355)	-0.006* (-1.957)
Constant	-0.015 (-1.308)	-0.008 (-0.748)	-0.001 (-0.152)	-0.010 (-0.834)	0.011 (0.117)
N	50	54	53	54	53
R^2	0.436	0.405	0.416	0.402	0.407
p-Value (Chi-square test)	0.000	0.000	0.000	0.000	0.000
ΔTFPGR/ΔGRDGR	-0.005	-0.002	-0.009***	-0.005	-0.006**

Table 4.8: R&D Financing in the Business Sector

The dependent variable is R&D investments by individual firms of either emerging or developed countries during the period 1998-2006. Among the explanatory variables, *CASH/ASSET* is a ratio of a firm's total cash holdings to total assets, *DEBT/ASSET* is a ratio of a firm's long-term debt to total assets, *EQUITY/ASSET* is a ratio of a firm's total shareholders equity to total assets, and *SIZE* is the logarithm of a firm's total sales in individual year. Results are estimated by using an unbalanced panel data set. All observations are clustered by firm. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively.

Independent variables	Emerging economies	Developed economies	Developed economies (Excluding USA)	USA Only
	(I)	(II)	(III)	(IV)
CASH/ASSET	0.137*** (10.450)	1.433*** (10.270)	0.095*** (15.630)	2.039*** (3.953)
DEBT/ASSET	-0.102*** (-10.580)	0.126* (1.900)	0.017*** (10.290)	0.213*** (16.100)
EQUITY/ASSET	-0.119*** (-22.840)	-0.014 (-1.320)	-0.019*** (-19.260)	-0.015*** (-6.850)
SIZE	-0.020*** (-11.360)	-0.151*** (-3.700)	-0.027*** (-30.490)	-0.259** (-2.661)
Constant	0.186*** (12.970)	0.579*** (5.670)	0.220*** (32.050)	0.880* (1.785)
N	3077	49094	25898	23196
# of Firms	936	10421	6699	3722
R^2	0.326	0.130	0.088	0.200
Country dummy	Yes	Yes	Yes	-
Year dummy	Yes	Yes	Yes	Yes
p-Value (Chi-square test)	0.000	0.000	0.000	0.000

Table 4.9: Impact of Finance and Law on Return of Business-Sector R&D (Constant returns to scale is imposed)

The dependent variable is the logarithm of the ratio of value added to the total number of employees of individual firms during the period 1998-2006. By definition, the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services. Details about the theoretical model can be found in Appendix C. Among the explanatory variables, *K* and *R* are physical capital and R&D or knowledge capital, respectively. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). The models are regressed by using an unbalanced panel data set of a large number of sample firms of several emerging and developed economies. All observations are clustered by firm. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of each coefficient at the 1%, 5% and 10%, respectively. Models are statistically significant at the 1%.

Independent variables	(I)	(II)	(III)	(IV)	(V)	(VI)
log(K/L)	0.641*** (193.40)	0.696*** (220.40)	0.634*** (190.000)	0.623*** (180.200)	0.615*** (175.700)	0.527*** (141.600)
log(R/L)	0.047*** (5.166)	-0.319*** (-31.760)	0.268*** (20.391)	-0.097** (-2.615)	-0.588*** (-32.500)	-0.400*** (-34.280)
log(R/L) × SMCAP	-0.222*** (-38.230)	-	-	-	-	-0.301*** (-50.510)
log(R/L) × PCREDIT	-	0.310*** (42.140)	-	-	0.282*** (43.130)	0.321*** (42.330)
log(R/L) × SMTURN	-	-	-0.200*** (-40.570)	-0.241*** (66.100)	-	-
log(R/L) × SR	0.079*** (46.980)	-	0.013*** (5.172)	-	0.109*** (61.370)	0.142*** (46.060)
log(R/L) × CR	-	0.059*** (36.890)	-	-	-	-0.042*** (-15.630)
log(R/L) × ENF	-	-	-	0.048*** (11.770)	-	-
Constant	0.996*** (76.740)	0.902*** (68.560)	0.999*** (77.210)	1.101*** (77.510)	1.059*** (80.230)	1.256*** (95.090)
N	41193	40849	41193	40321	40849	40849
R^2	0.819	0.811	0.819	0.820	0.821	0.834
# of firms	8387	8278	8387	8091	8278	8278
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
$\Delta logy/\Delta logR$	0.202***	-0.010***	0.241***	0.185***	-0.032***	0.050***

Table 4.10: Impact of Finance and Law on Return of Business-Sector R&D (Constant returns to scale is *not* imposed)

The dependent variable is the logarithm of the ratio of value added to the total number of employees of individual firms during the period 1998-2006. By definition, the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services. Details about the theoretical model can be found in Appendix C. Among the explanatory variables, *K* and *R* are physical capital and R&D or knowledge capital, respectively. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). The models are regressed by using an unbalanced panel data set of a large number of sample firms of several emerging and developed economies. All observations are clustered by firm. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. Models are statistically significant at the 1%.

Independent variables	(I)	(II)	(III)	(IV)	(V)	(VI)
logL	0.055*** (17.910)	0.078*** (25.000)	0.051*** (16.220)	0.049*** (15.950)	0.065*** (21.350)	0.043*** (14.240)
log(K/L)	0.624*** (181.30)	0.666*** (198.20)	0.619*** (179.500)	0.609*** (171.400)	0.593*** (163.300)	0. 516*** (135.900)
log(R/L)	0.067*** (7.351)	-0.274*** (-27.050)	0.268*** (20.500)	-0.069* (-1.865)	-0.539*** (-47.440)	-0.376*** (-31.930)
log(R/L) × *SMCAP*	-0.208*** (-35.680)	-	-	-	-	-0.289*** (-48.260)
log(R/L) × *PCREDIT*	-	0.305*** (41.690)	-	-	0.278*** (42.750)	0.316*** (41.780)
log(R/L) × *SMTURN*	-	-	-0.187*** (-37.380)	-0.230*** (62.260)	-	-
log(R/L) × *SR*	0.077*** (45.610)	-	0.015*** (6.175)	-	0.105*** (59.020)	0.138*** (44.880)
log(R/L) × *CR*	-	0.057*** (35.560)	-	-	-	-0.041*** (-15.230)
log(R/L) × *ENF*	-	-	-	0.047*** (11.380)	-	-
Constant	0.820*** (50.600)	0.666*** (41.310)	0.838*** (51.530)	0.849*** (51.660)	0.855*** (52.720)	1.116*** (67.900)
N	41193	40849	41193	40321	40849	40849
R^2	0.820	0.814	0.821	0.822	0.823	0.835
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
$\Delta logy/\Delta logR$	0.223***	0.029***	0.253***	0.209***	0.0002***	0.066***

Table 4.11: Impact of Finance and Law on Return on Business-Sector R&D in Emerging Economies

The dependent variable is the logarithm of the ratio of value added to the total number of employees of individual firms during the period 1998-2006. By definition, the business sector includes all firms, organizations and institutions whose primary activity is the production of goods and services. Details about the theoretical model can be found in Appendix C. Among the explanatory variables, *K* and *R* are physical capital and R&D or knowledge capital, respectively. The financial activity is measured by stock market capitalization (*SMCAP*), stock market total value traded (*SMTURN*) and the size of private credit by deposit money banks and other financial institutions (*PCREDIT*). Country-specific legal environment is evaluated by shareholder rights index (*SR*), creditor rights index (*CR*) and legal enforcement index (*ENF*). The models are regressed by using an unbalanced panel data set of a large number of sample firms of several emerging economies. All observations are clustered by firm. *t*-statistics are given in the parentheses. ***, ** and * imply the significance of the coefficients at the 1%, 5% and 10%, respectively. Models are statistically significant at the 1%.

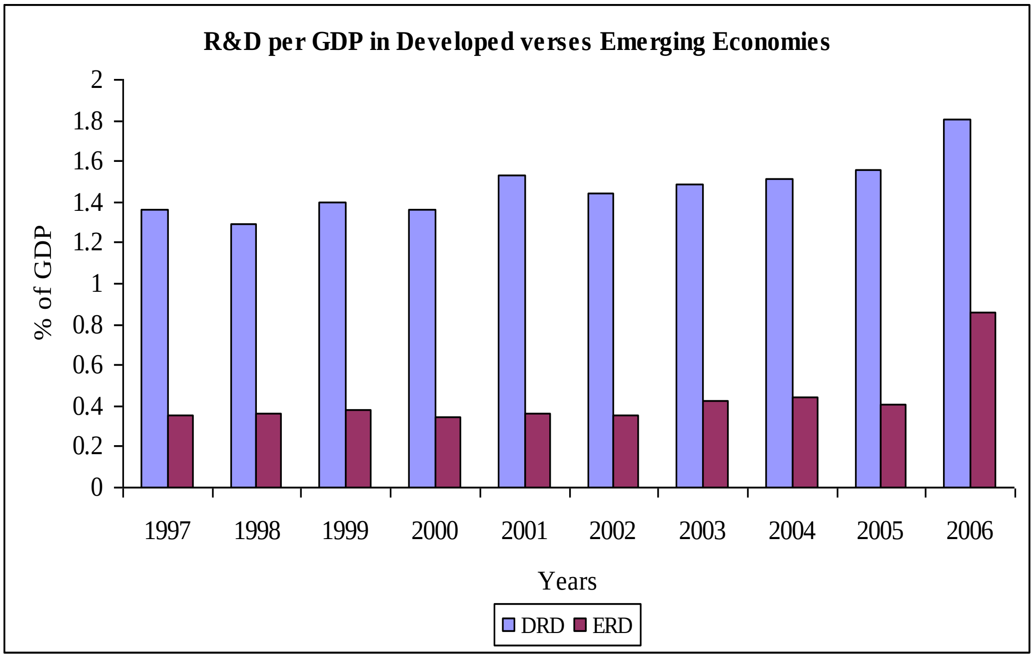
Independent variables	Constant returns to scale is imposed				Constant returns to scale is *not* imposed			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
logL	-	-	-	-	-0.035*** (-2.488)	-0.037** (-2.630)	-0.038** (-2.670)	-0.062*** (-3.372)
log(K/L)	0.513*** (30.940)	0.510*** (30.770)	0.511*** (30.810)	0.503*** (25.590)	0.520*** (30.940)	0.519*** (30.820)	0.519*** (30.870)	0.512*** (25.940)
log(R/L)	0.189*** (14.810)	0.113*** (3.338)	0.119*** (3.510)	0.629*** (6.798)	0.182*** (13.750)	0.099*** (2.926)	0.108*** (3.181)	0.639*** (6.948)
log(R/L) × SMCAP	-	-0.009 (-0.390)	-	-	-	-0.015 (-0.619)	-	-
log(R/L) × PCREDIT	-	-	-	0.387*** (3.876)	-	-	-	0.375*** (3.770)
log(R/L) × SMTURN	-	-	-0.033 (-0.746)	-	-	-	-0.044 (-0.999)	-
log(R/L) × SR	-	0.021** (2.111)	0.022** (2.524)	-	-	0.024** (2.335)	0.024** (2.720)	-
log(R/L) × CR	-		-	-0.239*** (-4.713)	-	-	-	-0.244*** (-4.841)
Constant	1.124*** (21.540)	1.406*** (3.892)	1.397*** (3.866)	1.019** (2.682)	1.236*** (17.960)	1.310*** (17.510)	1.314*** (17.620)	-1.480* (-1.970)
N	1391	1391	1391	1047	1391	1391	1391	1047
R^2	0.799	0.800	0.801	0.828	0.800	0.802	0.802	0.829
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
p-Value (Chi-square test)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta logy/\Delta logR$	0.189***	0.185***	0.192**	0.313***	0.182***	0.179**	0.186**	0.147***

Table 4.12: Differences in the education sector between Developed and Emerging Economies

Among 70 sample countries, all OECD (Non-OECD) economies are identified as developed (emerging) countries. *QMSE* is the quality of math and science education; *QMS* is the quality of management studies; *IAS* is the internet accessibility in academia; *RTS* is the research and professional training services; *QSRI* is the quality of scientific research institutions, and *UIC* is the university-industry collaboration in R&D. Details about the variables can be found in Appendix A. *** and ** imply the significance of mean difference of each variable between developed and emerging economies at the 1% and 5%, respectively.

Economies	*QMSE*	*QMS*	*IAS*	*RTS*	*QSRI*	*UIC*
(I) Developed economies						
Average	4.807	5.048	5.044	5.074	5.070	3.889
# of countries	27	27	27	27	27	27
(II) Emerging economies						
Average	4.093	4.188	3.650	4.078	4.005	3.523
# of countries	40	40	40	40	40	40
Mean differences between developed & emerging economies	0.715***	0.861***	1.394***	0.997***	1.065***	0.366**
t-stat	3.216	4.557	5.767	5.725	5.370	2.370

Figure 4.1: R&D investment during the period 1997-2006



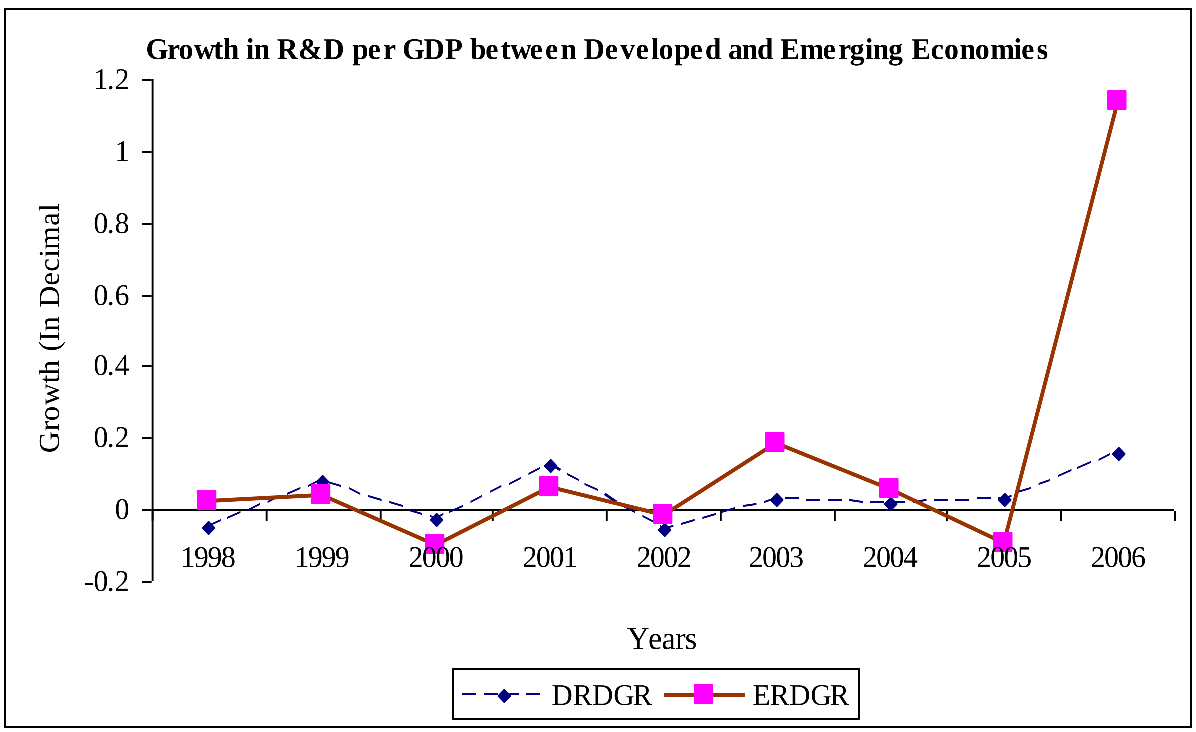
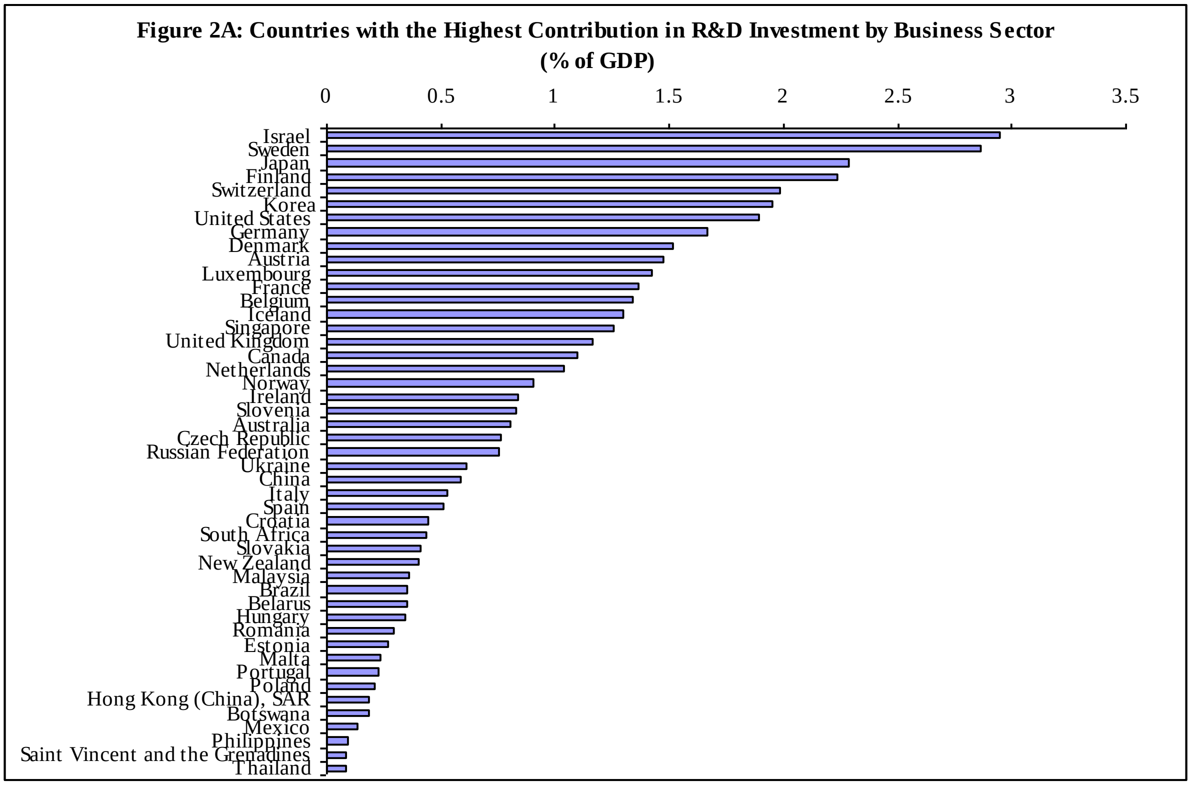


Figure 4.2: R&D activities by sector



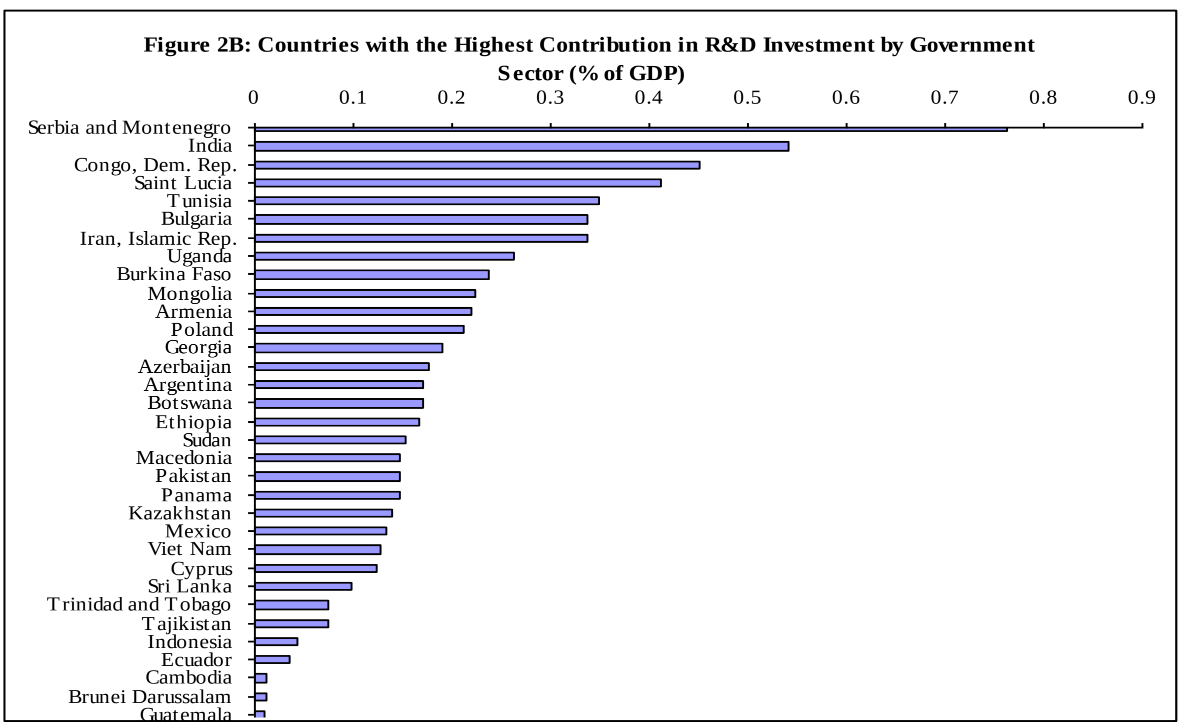


Figure 4.2 (Continued)