ABSTRACT

Title of dissertation: ESSAYS ON CORPORATE INVESTMENT

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This dissertation is comprised of three essays on corporate investment.

The first essay, titled "What If the Firm Does Not Diversify? A Self-Selection Free Bayesian Approach", takes a comprehensive look at the diversification discount. By employing a switching regression model with the Bayesian data augmentation methodology, I compare the actual post-acquisition firm value of diversifying acquirers to the counterfactual alternative which is a non-diversifying acquisition. I find that there is a considerable amount of acquirers that could improve their value by diversifying acquisitions more than what they would improve by non-diversifying acquisitions. When there are negative shocks to the acquirers' primary industries, when these industries are concentrated and the firms are not dominant players in the industries, diversifying acquisitions add values to the firms. The firm-by-firm analysis shows that on average, no diversification discount exists.

The next two essays study U.S. manufacturing firms' outsourcing activity, using a unique dataset of purchase obligations from firm 10-Ks. The second essay

is titled "Outsourcing and Firm Financial Structure", and the third essay is titled "Firm Risk Taking versus CEO Diversification: Evidence from Outsourcing Firms".

In the second essay, I explore the outsourcing decision and its implications on firm investment and capital structure. I first examine what kinds of firms use external contracts to provide a product or service as a major input to their production. I find that relatively young or large firms with a large number of patents are more likely to use external purchase contracts. Within high-technology industries, firms with purchase contracts tend to have higher R&D investment, while in low-technology industries, firms with purchase contracts are more likely to enter new markets. Outsourcing activity has important risk and capital structure implications, as firms that outsource have significantly less leverage. These results are consistent with outsourcing being used by firms to improve their flexibility. Faced with this increased firm flexibility and fewer fixed assets to pledge as collateral, outsourcing firms finance their operations proportionally more with equity.

In the third essay, I examine CEO compensation in outsourcing firms. I find that the intensity of outsourcing can significantly explain the variations in CEO compensation; the more the firms do outsourcing, the more they pay to their CEOs. Outsourcing firms promote managerial risk-taking by using proportionally more equity-based compensation. However, they also need to compensate additionally their CEOs for the higher risk exposure to the firms' increased total risks. I show that outsourcing firms determine their compensation level and structure based on this optimal trade-off.

ESSAYS ON CORPORATE INVESTMENT

by

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Dedication

This dissertation is dedicated to my husband, Inseok, and my daughter, Emily.

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Chapter 1

What If the Firm Does Not Diversify? A Self-Selection Free Bayesian Approach

1.1 Introduction

Extensive literature documents on the diversification discount (*e.g.* Lang & Stulz 1994; Berger & Ofek 1995). The diversification discount means that a typically diversified firm that operates in more than one industry is undervalued when compared with the average value of comparable single-segment firms. However, other strand of literature on diversification shows that errors in data and econometrics could create a false implication about the discount (*e.g.* Campa & Kedia 2002; Villalonga 2004), or that the discount itself is a result of value-maximizing investments of the firms that differ in their managerial and organizational skills (*e.g.* Maksimovic & Phillips 2002; Gomes & Livdan 2004). The critical assumption in the diversification discount is that diversifying firms have sufficiently equal features with comparable single-segment firms, with the exception of the diversification decision. However, comparable features between single-segments firms and diversified firms are limited to the observable data, which are usually accounting data.

In this paper, I take a more comprehensive look at the diversification discount by considering unobservable private information as well as public information. I analyze whether the diversification that acquires asset portfolios spanning several industries is value-enhancing, by comparing the actual post-diversification firm value and the counterfactual alternative. I define the counterfactual choice of a diversifying acquirer as the acquisition of assets in industries where the acquirer has already been operating. The counterfactual choice could not be no-merger, because the actions that an acquirer has already taken, such as payment to the target firm and other costs of acquisitions, are not reversible in the accounting data.

Previous studies have compared diversified firm value (in general, associated with Tobin's Q) with the same measure of single-segment firms. However, this comparison may generate spurious interpretation of the discount, because firms in those two categories are significantly different in their acquisition styles. The most commonly used method to reconfigure a firm's asset portfolio is mergers and acquisitions. Under current M&A accounting principles, the acquirer's Q mechanically drops after asset purchases. The purchase accounting requires acquirers to record the acquired assets in their book as market value, and this makes the market-to-book ratio of the new addition toward 1.[1] Therefore, if the acquirer's original Tobin's Q is greater than 1, it drops even though there is no fundamental value decrease. Custodio (2009) takes care of the goodwill term in the acquirer's book that also creates an incidental drop in the acquirer's Q. Therefore, in this paper I suggest a fair comparison between the post-diversification value of each diversifying acquirer and its own counterfactual alternative, to mitigate the mechanical problems in using

[1]The detailed derivation about the mechanical drop in Q is shown in Appendix A.1.

Tobin's Q.

My sample comprises of 2,826 mergers and acquisitions occurring between 1997 and 2006. I use the Corporate Segment data from Compustat after 1997 when the segment disclosure requirements were revised. Previous studies have recognized that the Compustat Industry Segment data might contain self-reporting problems. However, the disclosure requirements were revised in SFAS 131 in 1997. Most of the earlier studies recognizing the problems in the Compustat Industry Segment data cover pre-1997 data. Also, Berger and Hann (2003) show that SFAS 131 increased the number of reported segments and provided more disaggregated information after 1997. The IBM example in Berger and Hann (2003), which restates from one industry segment before revision to seven operating segments under the new standard, shows how effectively it works.

I use a two-step conditional event study which is free of self-selection bias. I first develop a corporate decision model of whether to expand within their own industries or to new industries. The private information that leads to each decision is estimated in the model. Including the private information, I next estimate the firm valuation for each endogenous decision. The firm value of unchosen investment regime is augmented as a by-product of Bayesian estimation. Then, with this counterfactual data, I compare the corporate values under the two exclusive investment regimes, to examine whether the acquirers truly reap benefits from the diversifying acquisitions.

My findings are summarized in two points. First, firms decide to expand their business to new industries, because it is desirable under the current firm and market conditions. The firm-level and the industry-level characteristics such as the firm's overall profitability, main segment market share, main industry competitiveness, and some unknown private conditions make a firm choose to operate in new industries. Second, I do not find diversification discount when diversifying acquirers are compared with non-diversifying acquirers, and also when the actual post-diversification value is compared with the counterfactual alternative. In my results, a large number of firms could actually improve their value by deciding to operate in other industries additionally. Diversifying acquisitions can add value to the firms, particularly when the firms are not dominant players in their primary industries, and when their primary industries are concentrated and especially experience declining demand. I also find evidence that the value decrease in some diversifying acquirers seem to be growth-option exercises at their best investment opportunities. These findings are consistent with implications of the model in Maksimovic and Phillips 2002 that growth and investment of conglomerate and single-segment firms are related to fundamental industry factors and individual segment level productivity.

1.2 Methodology

1.2.1 Switching Regression Model

The following switching regression involves a decision model of investment regimes and two valuation models. A firm chooses in equation (1) between the two exclusive investment regimes which are diversifying and non-diversifying acquisitions. By the choice, the firm is valued differently using the model of either (2) or

(3).

$$I^* = Z\gamma + \eta^* \tag{1.1}$$

$$Q_1^* = X_1\beta_1 + \epsilon_1^*, \tag{1.2}$$

$$Q_0^* = X_0\beta_0 + \epsilon_0^* \tag{1.3}$$

I^* is a latent variable representing the experienced utility level for the decision maker of the firm. Z is a set of observed firm characteristics and η^* is private information for the decision maker which is not observed by markets. η^* follows a normal distribution, as I assume a probit model for the decision procedure. Although I develop the decision model using a latent variable I^*, the actual data observed is a binary variable I, which is 1 when $I^* > 0$ and 0 otherwise. I define $I = 1$, when a firm chooses to diversify. Q_1^* and Q_0^* represent the firm value when the firm chooses its investment regime to expand into a new industry and to expand focused in its current industries, respectively. After a firm completes its acquisition, the post-acquisition valuation keeps following either (1.1) or (1.2) for several years, based on the decision the firm made.

This switching regression model allows the estimates of both regression coefficients and intercepts can vary with the two different investment regimes. The sets of observed firm characteristics, X_1 and X_0 in (1.2) and (1.3) have the same dimension and items. The regressors, Z, X_1 and X_0 are demeaned, as it is assumed $E[Z\hat{\gamma}] = 0$. The error terms in the three models are not independent of each other. Therefore, usual OLS estimates would be biased from the correlations. Heckman

(1979) addresses this correlated structure using the inverse Mills ratio. In this paper, I employ the Roy model (Roy 1951) instead, and assume that the error terms in (1.1), (1.2) and (1.3) are distributed as a trivariate normal.

[INSERT FIGURE 1.1 HERE]

Figure 1.1 illustrates the variable structures of the switching regression model. The variable I^*, Q_1^* and Q_0^* include unobserved data. The * is suffixed to the variables that have unobserved data. Although the decision indicator I is observed, the latent variable I^* which is private to the decision maker is not observed. On the other hand, Q_1^* and Q_0^* are partially observed. Let N_1 and N_0 denote the number of diversifying firms and non-diversifying firms in the sample. We get N_1 actual observations from the diversifying firms on the change in the firm's Q between pre- and post-acquisition, and Q_1o in Figure 1.1 represents these N_1 observations. However, we cannot observe what the value would be, if the firm chooses the alternative investment regime of expanding focused in its own industries at the given year. Q_0m^* in Figure 1.1 represents these N_1 counterfactual data. Similarly, Q_0o is the N_0 observations from the firms who expand focused in their own industries. Q_1m^* is the corresponding N_0 counterfactual data for the firms. The subscript, 1 or 0 represents the decision of diversifying acquisitions, and o or m refers to *observed* or *missing* (*unobserved*), respectively.

The previous empirical studies about diversification discount only analyze the difference between the observed variables, which is $E[Q_1o] - E[Q_0o]$. However, we can not conclude by this comparison that diversification destroys firm value. The real effect of the diversification decision on the firm value should be determined by $E[Q_1 o] - E[Q_0 m^*]$. In this paper, the Bayesian data augmentation technique is used to create the unobserved counterfactual data of $Q_1 m^*$ and $Q_0 m^*$, which are the shaded areas in Figure 1.1. The detailed methodology about the Bayesian data augmentation is discussed in the next section.

1.2.2 Bayesian Data Augmentation

The self-selection issue signifies the correlation between error terms, η^*, ϵ_1^* and ϵ_0^* in equation (1.1), (1.2) and (1.3). If valuation is related to the private information of the decision maker which is not fully observed to the markets, the error terms in valuation model are not random anymore and correlations between η^* and ϵ_1^* or ϵ_0^* would be expected. Let these correlation coefficients $\rho_{\eta 1}$, $\rho_{\eta 0}$ and ρ_{10}.

I impose a constraint that the variance of η^* should be 1. This constraint comes from the non-identification problem of a probit model. The probit estimates of coefficients are not uniquely identified, as the latent variable I^* which is artificially augmented during the Bayesian process is scalable unless the sign is not changed. Therefore, I impose a constraint on the variance of η^* to be 1 as the maximum likelihood probit estimation does. The distribution of three error terms, η^*, ϵ_1^* and ϵ_0^* follows a trivariate normal, $N_3(0_3, \Sigma)$, where the covariance matrix Σ is

$$\Sigma = \begin{pmatrix} \sigma_\eta^2 & \sigma_{1\eta} & \sigma_{0\eta} \\ \sigma_{1\eta} & \sigma_1^2 & \sigma_{10} \\ \sigma_{0\eta} & \sigma_{10} & \sigma_0^2 \end{pmatrix} = \begin{pmatrix} 1 & \rho_{\eta 1}\sigma_1 & \rho_{\eta 0}\sigma_0 \\ \rho_{\eta 1}\sigma_1 & \sigma_1^2 & \rho_{10}\sigma_1\sigma_0 \\ \rho_{\eta 0}\sigma_0 & \rho_{10}\sigma_1\sigma_0 & \sigma_0^2 \end{pmatrix} \tag{1.4}$$

and positive definite.

Following Koop and Poirier (1997) and McCulloch, Polson and Rossi (2000), I use a Gibbs sampler to get the posterior distributions for estimates, γ, β_1 and β_0. The latent data I^* and the counterfactual data, Q_1m^* and Q_0m^* in which we are more interested are generated as a by-product during this Gibbs sampling process. The full conditional posterior distributions of γ, β_1 and β_0 have a Normal-Wishart form, when their prior distributions are assumed to be normal. That is, γ, β_1 and β_0 have normal posterior distributions, and the inverse of the covariance matrix, Σ^{-1} has a Wishart posterior distribution. The constraint I impose on the variance of η^*, however, makes the generation of a random Wishart matrix complicated, since one of the matrix elements should be 1 always. I follow the direct simulation method of a Wishart distribution when there is a normalization constraint by Nobile (2000). By this direct simulation method, the positive definiteness of Σ is preserved.

$$\text{Let } \theta = \begin{bmatrix} \gamma \\ \beta_1 \\ \beta_0 \end{bmatrix}, \; W = \begin{bmatrix} Z & 0 & 0 \\ 0 & X_1 & 0 \\ 0 & 0 & X_0 \end{bmatrix} \text{ and } \; Y = \begin{bmatrix} I^* \\ Q_1^* \\ Q_0^* \end{bmatrix}.$$

(i) The posterior of the regression coefficient conditioning on all other data is:

$$\theta \mid \Sigma^{-1}, I^*, Q_1^*, Q_0^* \quad \sim \quad N(\,\overline{\theta}\,,\,\overline{\Omega}) \tag{1.5}$$

where

$$\overline{\theta} = \overline{\Omega}\,[\,\underline{\Omega}^{-1}\underline{\theta} + W'(\,\Sigma^{-1} \otimes I_N)Y] \tag{1.6}$$

and

$$\overline{\Omega} = [\, \underline{\Omega}^{-1} + W'(\, \Sigma^{-1} \otimes I_N)W \,]^{-1}. \tag{1.7}$$

$\underline{\theta}$ and $\underline{\Omega}$ represent the prior mean and variance of θ, for which I assume non-informative through the process.

(ii) The posterior of the inverse of the covariance matrix conditioning on all other data is:

$$\Sigma^{-1} \mid \theta, I^*, Q_1^*, Q_0^* \quad \sim \quad W(\, \overline{\nu} \,,\, \overline{V} \,) \tag{1.8}$$

given $\sigma_{11} = 1$ in Σ, that $E(\Sigma^{-1}) = \overline{\nu}\, \overline{V}^{-1}$. $\overline{\nu}$ and $\overline{V}$ are defined as

$$\overline{\nu} = \underline{\nu} + N \tag{1.9}$$

$$\overline{V} = \underline{\nu}\, \underline{V} + \delta'\delta \tag{1.10}$$

where $\delta = [\, \eta^* \quad \epsilon_1^* \quad \epsilon_0^* \,]'$, and $\underline{\nu}$ and $\underline{V}$ are the parameters of the prior distribution. They are also assumed non-informative.

(iii) Under the trivariate normal distribution

$$[\, I^* \quad Q_1^* \quad Q_0^* \,]' \;\sim\; N_3\,(\, \mu \,,\, \Sigma \,) \tag{1.11}$$

where $\mu = [\ Z\gamma \quad X_1\beta_1 \quad X_0\beta_0\ ]'$, the posterior distribution of each I^*, Q_1^* and Q_0^* conditioning on μ, Σ and the other augmented data is

$$I^* \mid Q_1^*, Q_0^*, \mu, \Sigma \quad \sim \quad \begin{cases} TN_{(0,\infty)}\ (\ \mu_I\ ,\ \omega_I\ ) & \text{if } I = 1 \\ TN_{(-\infty,0)}\ (\ \mu_I\ ,\ \omega_I\ ) & \text{if } I = 0 \end{cases} \tag{1.12}$$

$$Q_1^* \mid Q_0^*, I^*, \mu, \Sigma \quad \sim \quad N\ (\ \mu_1\ ,\ \omega_1\ ) \tag{1.13}$$

$$Q_0^* \mid I^*, Q_1^*, \mu, \Sigma \quad \sim \quad N\ (\ \mu_0\ ,\ \omega_0\ ). \tag{1.14}$$

The consecutive Gibb's draws from (1.5), (1.8), (1.12), (1.13) and (1.14) estimate the regression coefficients and fill up the latent/counterfactual data as well. I refer to Koop (1997) for the theoretical derivation of means (μ_I, μ_1, μ_0) and variances $(\omega_I, \omega_1, \omega_0)$.[2] I iterate the Markov Chain Monte Carlo process 10,000 times, and discard the first 5,000 iteration as a burn-in sample.

1.3 Data

1.3.1 Sample Construction

The acquirer sample comes from the merger and acquisition database in the Securities Data Company (SDC). The firms in the M&A sample are acquirers in all U.S. merger and acquisition deals completed between 1997 and 2006. I merge the sample with the Corporate Segment data and Fundamental Annual data from Compustat.

[2] The brief summary of the derivation is shown in Appendix A.2.

For a given year in my final sample, all firms have no missing assets, sales and equity data, and no missing yearly stock price and the number of shares outstanding. I require that the total sales of a firm should be greater than $20m, and exclude from the final sample the firms whose primary industry is financial services, regulated utilities, the government, or non-classifiable establishments. In addition, I exclude a firm's segments which operate in those 4 categories. If a firm has repeatedly acquired other firms or assets during the sample period, I treat each acquisition as a distinctive event and replicate all data of the repeat acquirer according to the number of acquisitions during the period.

Lastily, I only include the [-2, 2] firm-year observations relative to the acquisition event.[2] I drop acquirers from the sample if they have no accounting data the one year prior to or after the event, because it is important in this study to analyze changes in firm value between pre- and post-acquisition. I do not impose any restriction on non-acquire observations. Table 1.1 shows the composition of my final sample.

[INSERT TABLE 1.1 HERE]

I particularly study the recent time period from 1997 to 2006, as the revision of disclosure requirement of the Compustat Industry Segment data (SFAS 131) takes effect from 1997. Although Compustat tried to backdate this requirement up to 1990, those backdated data are not complete. The Compustat Industry Segment data may contain multiple segment records for a given fiscal year with different source years. This is due to the fact that companies can report segment data for

[2]For a robustness check, I test with the [-1,1] or [-3,3] window, and the results do not change.

a given year more than once. I use the segment data reported at the same source year as the given fiscal year. Using the restated segment records at the most recent source year yields similar results.

1.3.2 Variables of Interests

I classify each acquisition by the new corporate organizational structure that the acquisition generates. I define an acquisition as a diversifying acquisition and the acquirer as a diversifier, if the acquirer reports a new industry (a new 4-digit SIC code) in its segment reporting either at the year of acquisition or in the next year. Based on this definition, diversifiers are not equivalent to multi-segment firms. If a multi-segment firm does not enter into a new industry by the given acquisition, I classify the firm as a non-diversifier at the time of the acquisition. Table 1.2 describes the characteristics of diversifiers versus non-diversifiers.

[INSERT TABLE 1.2 HERE]

I use industry-adjusted Tobin's Q as a measure of firm value. Tobin's Q for each firm is the ratio of market value to book value of the firm's assets. Market value of assets refers to the sum of market value of common equity (the closing price $\times$ the number of shares outstanding), book value of preferred stock, minority interest and debt (long-term debt + current debt). I industry-adjust the actual Tobin's Q each year by subtracting the industry median. The results are consistent when subtracting the market value-weighted industry mean. I define segment industries based on the segment's 4 digit SIC code. If a firm is a multi-segment firm operating in more than one industry, I industry-adjust its Tobin's Q by subtracting the segment asset-weighted sum of each industry median. I winsorize the top and bottom 1% of the distribution for the industry-adjusted Q.

I include other control variables at the firm-, industry-, and macro-level in the model, such as firm size, age, profitability, investment on capital, R&D and advertising, leverage, cash reserve, and the number of different industries in which the firm operates at the given year. I consider the firm's performance in its primary industry as well, such as the main segment's operating margin, sales growth, market share, and the percentile rank of the firm in that industry. In addition, I include three variables that capture a firm's primary industry conditions; the competitiveness of the industry using the Herfindahl-Hirschman sales index, the industry sales growth, and the standard deviation of the industry sales (the log of sales) during the three years prior to the acquisition, which proxies a shock to the industry. I include the GDP growth, to control for the business cycles in the entire economy.

1.4 Results

1.4.1 Existence of Diversification Discount

I begin my analyses by first showing that the diversification discount still exists in my sample, when I follow the previous empirical methodology as in Lang and Stulz (1994) and Berger and Ofek (1995). Using the industry-adjusted Tobin's Q as a measure of firm excess value, I compare the average value of diversified firms with that of single segment firms, in Table 1.3. The diversifiers are defined as the firms which report that they operate in more that on industry, regardless of whether they are acquirers at the given year of my sample. Panel A in the table shows that firm value decreases as the number of segments increases. This confirms the results of Land and Stulz (1994). In Panel B, the effects of *ndiffseg* on the firm value in all specifications are significant and negative. The effect is greater in the acquirer sample than in the non-acquirer sample. Overall, the diversification discount in the usual meaning exists in my sample.

[INSERT TABLE 1.3 HERE]

1.4.2 Heckman Two-Stage Approach

The following OLS estimations in (1.15) and (1.16) attempt to examine the effect of diversification on the changes in firm value. However, η in (1.15) and ϵ in (1.16) might be correlated. Thus, the OLS estimates suffer from the omitted variable bias, which means a disregard of the private information partially revealed by the firm's investment decision in this case.

$$I_i^* = Z_i\hat{\gamma} + \eta_i \tag{1.15}$$

$$\Delta Q_i = \alpha \times DIVERSE_i + X_i\beta + \epsilon_i \tag{1.16}$$

Heckman (1979) corrects this omitted variable bias estimating a two-stage self-selection model. The two-stage approach introduces a correction term called the inverse Mill's ratio λ in order to put into the valuation model the partially known private information from the firm's decision model.

$$\Delta Q_i = \alpha \times DIVERSE_i + X_i\beta + \pi\ \lambda_i + \epsilon_i \tag{1.17}$$

, where $\lambda = \lambda_1\ DIVERSE + \lambda_2(1 - DIVERSE)$, $\lambda_1(Z\gamma) = \frac{\phi(Z\gamma)}{\Phi(Z\gamma)}$ and $\lambda_0(Z\gamma) = -\frac{\phi(Z\gamma)}{1-\Phi(Z\gamma)}$.

Table 1.4 reports the OLS estimates for the diversification discount. Panel A of the table reports firm value for the separate samples of non-diversifiers and diversifiers. The dummy variable, ACQ represents the state whether it is before or after the acquisition event. Panel B examines the diversification discount in the first difference of firm value between pre- and post-acquisition. The dummy variable $DIVERSE$ indicates whether the acquisition is a diversifying acquisition. It shows that acquisition discount exists in both diversifier and non-diversifier samples. It appears that the acquisition discount is slightly greater in the diversifier sample than in the non-diversifier sample (-0.172 versus -0.210). However, Panel B shows that the dummy variable of whether the firms is a diversifying acquirer or non-diversifying acquirer has no large effect on the firm value. The effect disappears for industry-adjusted Tobin's Q, while it still exists for unadjusted Tobin's Q.

Table 1.5 report the first- and the second-stage regression estimates of the Heckman (1979) self-selection model. In the second-stage, I find that λ is significantly negative, and thus the correlation between η in (1.15) and ϵ in (1.16) (Rho) is surely non-zero. This negative correlation implies that markets react negative to the news of diversification. It is possibly because markets may question about the firm's performance in the primary industry, when the firm announces that it intends to start a business in the new industry. The effect of diversification on the firm value turns out to be significantly positive, after controlling for the revealed private information using λ in the second-stage regression results.

[INSERT TABLE 1.4 AND 1.5 HERE]

Li and Prabhala (2006) note that near-multicollinearity could arise in the Heckman model, when the extra variable in Z are weak and have limited explanatory power. It is because λ is roughly linear in parts of its domain, while it is a nonlinear function. The exclusion restriction, which needs strong instruments in Z is required to generate credible estimates free from self-selection bias. The Bayesian switching regression model has the several advantages over the Heckman's two-stage approach in this sense. The firm-by-firm comparison between the actual post-diversification firm value and the counterfactual alternative provides a more direct examination how diversification affects firm value.

1.4.3 Bayesian Inferences and Diversification Effect

The posterior distributions of the regression coefficients in the Bayesian switching model, (1.1), (1.2) and (1.3) are reported in Table 1.6. As I use non-informative priors, the posterior results involve only actual data information and have a close relationship with OLS outcomes. I present the 95% Highest Posterior Density Interval which is similar to the confidence interval in frequentist econometrics. The estimated covariance matrix of the trivariate normal distribution shows how the investment decisions to expand into new industries are correlated with the market valuation. The correlations between the errors of equation (1.1) and (1.1) or between the errors of (1.1) and (1.3) ($\rho_{\eta 1}$ or $\rho_{\eta 0}$) can be interpreted as how much the decision maker's private information is partially revealed and incorporated in the market valuation. $\rho_{\eta 1}$ and $\rho_{\eta 0}$ are estimated as negative, and those are significant at the 95% of credibility level. This negative correlation is consistent with the previous results of the Heckman's two-stage model.

[INSERT TABLE 1.6 HERE]

The main objective of this paper is to examine the effect of diversification on firm value controlling for the self-selection of diversifying firms. In this section, I present the direct comparison between the observed diversification outcome and the counterfactual outcome augmented by the above Bayesian inferences. In Figure 1.2, Panel 0 shows that the mean distributions of 5,000 iterations of $\Delta Q_1 m^* - \Delta Q_0 o$ for non-diversifying firms. Panel 1 shows that the mean distribution $\Delta Q_1 o - \Delta Q_0 m^*$ for diversifying firms. From Panel 1, I find that diversifying acquisitions were, on average, desirable value-enhancing decisions. Furthermore, Panel 0 provides evidence that many non-diversifying acquirers missed profitable investment opportunities that they could have enjoyed if they chose the alternative investment regime.

[INSERT FIGURE 1.2 HERE]

One of the benefits that the Bayesian switching regression model provides is that it is able to determine whether each diversifying acquisition was truly value-enhancing or not. Panel 1 in Figure 1.2 shows that there still exists a large number of value-decreasing acquisitions in the diversifier sample ($\Delta Q_1 o - \Delta Q_0 m^* < 0$), even though the average of $\Delta Q_1 o - \Delta Q_0 m^*$ is greater than zero. Thus, separating the diversifier sample into two subsamples with value-enhancing and value-decreasing diversifications will provide more valuable intuitions about the diversification decisions than the do propensities in a probit model. Table 1.7 summarizes differences in firm characteristics and industry conditions between value-enhancing and value-decreasing diversifications. I find that the non-dominant players in their primary industries (when the industries are concentrated by other dominant players) are more likely to improve their value by expanding to new industries. Also, the primary industries of the value-improving diversifiers are more likely to experience declining demand. The firms that improve their value by the diversifications tend to have lower leverage and invest less in R&D.

[INSERT TABLE 1.7 HERE]

Moreover, Table 1.7 shows that the pre-acquisition Q and performance measures (*opmarg* and *mainseg opmarg*) are significantly higher in the firms with a decrease in their value after the diversifications. This finding suggests that the firms may exercise their growth-options at the best investment opportunities, and thus optimally lower their Qs. Also, the percentage of stock used in the method of payment is significantly higher for the value-decreasing diversifications. This is consistent with the literature on market valuation and mergers (*e.g.* Maksimovic & Phillips 2001; Jovanovic & Rousseau 2001) in that high market valuation seems to be correlated with high acquisition activity.

Overall, my results find that there exist no diversification discount, on average, and the decrease in Q for some diversifying acquirers is consistent with optimal growth options exercises.

1.5 Conclusion

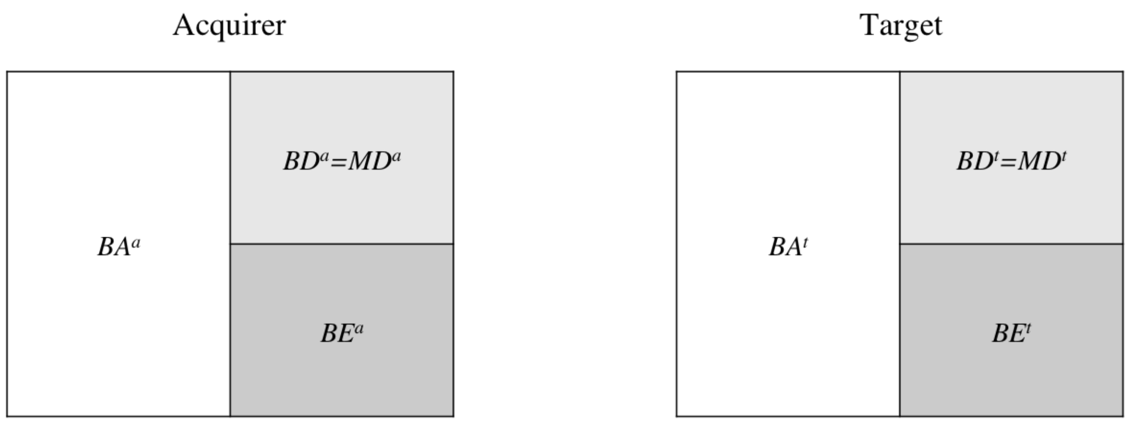
In this paper, I analyze the diversification discount in a more comprehensive way. Due to the spurious mechanical drop in the acquirer's Q caused by current accounting procedures, it is unfair to compare the value of diversified firms with that of comparable single-segment firms. Thus, I suggest a fair comparison between the actual post-diversification value and the counterfactual alternative, and show that there is no evidence that diversifying acquisitions destroy firm value.

From the Bayesian switching regression model which is free of self-selection bias, I find that the private information of decision makers is partially revealed to the markets and affects the valuation of the acquirers. While markets react negatively to the news of a firm's diversification, the actual effect of diversification on the firm value is positive when I control for the private information of decision makers. By comparing each firm value after the diversification to its counterfactual alternative, I find that the diversifying acquisitions are desirable for the firms that are not dominant players in their primary industries, particularly when the primary industries are concentrated and experience negative shocks.

Finally, I find that the firms with a value decrease after the diversification are more likely to have higher pre-acquisition Qs and better operating performance than the firms with a value increase. These results suggest that those firms exercise their growth-options at the best investment opportunities and optimally lower their Qs through diversifications.

Appendix A

A.1 Mechanical Drops in Acquirer's Q



Under the current M&A accounting procedures, the acquirer's Q mechanically drops after M&A. The above figure shows a general case of accounting books for an acquirer and a target. BA, BD and BE represent book value of assets, debt and equity, respectively. And MA, MD and ME represent market value. I assume market value of debt equals book value of debt.

Pre-acquisition Tobin's Qs for Acquirer and Target are defined as

$$Q^a = \frac{MA^a}{BA^a}\ , \quad Q^t = \frac{MA^t}{BA^t}. \tag{A.1}$$

Let's suppose that Acquirer buys Target by paying a premium p on top of Target's market value. ($p \geq 0$) Then, post-acquisition Q of Acquirer (or combined firm's Q) is computed as below according to what payment method is used.

(i) If the payment method is solely Acquirer's stock:

$$\begin{aligned} Q^{a+t} &= \frac{MA^a + MA^t}{BA^a + (MA^t + p)} \\ &= \frac{MA^a + (MD^t + ME^t)}{BA^a + ((MD^t + ME^t) + p)} \end{aligned} \tag{A.2}$$

(ii) If the payment method is solely cash and Acquirer finance the acquisition by using x cash reserve and issuing $(1-x)$ debt:

$$\begin{aligned} Q^{a+t} &= \frac{MA^a + MA^t - \overbrace{(ME^t + p)}^{\text{cash payment}} + \overbrace{(1-x)(ME^t + p)}^{\text{debt issue}}}{BA^a + (MA^t + p) - (ME^t + p) + (1-x)(ME^t + p)} \\ &= \frac{MA^a + MA^t - x(ME^t + p)}{BA^a + (MA^t + p) - x(ME^t + p)} \end{aligned} \tag{A.3}$$

When $x = 1$ and $p = 0$, *i.e.* , when the acquisition is financed by 100% cash from Acquirer's cash reserve and no premium is paid to Target,

$$Q^{a+t} = \frac{MA^a + MA^t - ME^t}{BA^a + MA^t - ME^t} = \frac{MA^a + MD^t}{BA^a + MD^t}.$$

In equation (A.2) and (A.3), the additional terms appended in the denominator after acquisition is always greater than or equal to those in the numerator. Therefore, if the pre-acquisition Tobin's Q of Acquirer was originally greater than 1, the post-acquisition Tobin's Q results in the smaller number than pre-acquisition Q.

A.2 Trivariate Normal Distribution

The means and variances, (μ_I, μ_1, μ_0) and $(\omega_I, \omega_1, \omega_0)$ of the conditional distributions of (1.12), (1.13) and (1.14) are

$$\mu_{Ii} = Z_i\gamma + \left[\frac{\sigma_{1\eta}\sigma_0^2 - \sigma_{0\eta}\sigma_{10}}{\sigma_1^2\sigma_0^2 - \sigma_{10}^2}\right](Q_{1i}^* - X_{1i}\beta_1) + \left[\frac{\sigma_{0\eta}\sigma_1^2 - \sigma_{1\eta}\sigma_{10}}{\sigma_1^2\sigma_0^2 - \sigma_{10}^2}\right](Q_{0i}^* - X_{0i}\beta_0) \quad \text{(A.4)}$$

$$\omega_{Ii} = \sigma_\eta^2 - \frac{\sigma_{1\eta}^2\sigma_0^2 - 2\sigma_{1\eta}\sigma_{0\eta}\sigma 10 + \sigma_{0\eta}^2\sigma_1^2}{\sigma_1^2\sigma_0^2 - \sigma_{10}^2} \quad \text{(A.5)}$$

, $(i = 1, ..., N)$

$$\mu_{1i} = X_{1i}\beta_1 + \left[\frac{\sigma_{10}\sigma_\eta^2 - \sigma_{1\eta}\sigma_{0\eta}}{\sigma_0^2\sigma_\eta^2 - \sigma_{0\eta}^2}\right](Q_{0i}^* - X_{0i}\beta_0) + \left[\frac{\sigma_{1\eta}\sigma_0^2 - \sigma_{10}\sigma_{0\eta}}{\sigma_0^2\sigma_\eta^2 - \sigma_{0\eta}^2}\right](I_i^* - Z_i\gamma) \quad \text{(A.6)}$$

$$\omega_{1i} = \sigma_1^2 - \frac{\sigma_{10}^2\sigma_\eta^2 - 2\sigma_{1\eta}\sigma_{0\eta}\sigma 10 + \sigma_{1\eta}^2\sigma_0^2}{\sigma_0^2\sigma_\eta^2 - \sigma_{0\eta}^2} \quad \text{(A.7)}$$

, $(i = N_1 + 1, ..., N)$

$$\mu_{0i} = X_{0i}\beta_0 + \left[\frac{\sigma_{0\eta}\sigma_1^2 - \sigma_{10}\sigma_{1\eta}}{\sigma_\eta^2\sigma_1^2 - \sigma_{1\eta}^2}\right](I_i^* - Z_i\gamma) + \left[\frac{\sigma_{10}\sigma_\eta^2 - \sigma_{1\eta}\sigma_{0\eta}}{\sigma_\eta^2\sigma_1^2 - \sigma_{1\eta}^2}\right](Q_{1i}^* - X_{1i}\beta_1) \quad \text{(A.8)}$$

$$\omega_{0i} = \sigma_0^2 - \frac{\sigma_{0\eta}^2\sigma_1^2 - 2\sigma_{1\eta}\sigma_{0\eta}\sigma 10 + \sigma_{10}^2\sigma_\eta^2}{\sigma_\eta^2\sigma_1^2 - \sigma_{1\eta}^2} \quad \text{(A.9)}$$

, $(i = 1, ..., N_1)$.

Proof.

Thrm 1. *Suppose Y has a $N_3(\mu, \Sigma)$ distribution, which is partitioned as $Y = [\ Y_a' \quad Y_b'\ ]'$, where Y_a and Y_b are of dimension 1 and 2, respectively. In the same way, partition the mean and covariance of Y; that is, $\mu = [\ \mu_a' \quad \mu_b'\ ]'$ and $\Sigma = \begin{bmatrix} \Sigma_{aa} & \Sigma_{ab} \\ \Sigma_{ba} & \Sigma_{bb} \end{bmatrix}$. Assume that Σ is positive definite.*
Then, the conditional distribution of $Y_a|Y_b$ is

$$N_1\ (\ \mu_a + \Sigma_{ab}\Sigma_{bb}^{-1}(Y_b - \mu_b)\ ,\ \Sigma_{aa} - \Sigma_{ab}\Sigma_{bb}^{-1}\Sigma_{ba}\ ).$$ [1]

Let $Y_a = Q_{1i}^*$ and $Y_b = [\ Q_{0i}^* \quad I_i^*\ ]'$, or $Y_a = Q_{0i}^*$ and $Y_b = [\ I_i^* \quad Q_{1i}^*\ ]'$. Then,

$$Q_1^* \mid Q_0^*, I^*, \mu, \Sigma \quad \sim \quad N\ (\ \mu_1\ ,\ \omega_1\ )$$

$$Q_0^* \mid I^*, Q_1^*, \mu, \Sigma \quad \sim \quad N\ (\ \mu_0\ ,\ \omega_0\ ),$$

where (A.6)-(A.9) hold by Thrm1.

When $Y_a = I_i^*$ and $Y_b = [\ Q_{1i}^* \quad Q_{0i}^*\ ]'$,

$$I^* \mid Q_1^*, Q_0^*, \mu, \Sigma \quad \sim \quad \begin{cases} TN_{(0,\infty)}\ (\ \mu_I\ ,\ \omega_I\ ) & \text{if } I = 1 \\ TN_{(-\infty,0)}\ (\ \mu_I\ ,\ \omega_I\ ) & \text{if } I = 0 \end{cases}$$

[1] The proof of Thrm 1 refers to Theorem 3.5.3 in the page 175 of Hogg, McKean and Craig 2005.

where (A.4) and (A.5) hold. It is because the sign of I_i^* is constrained by I_i as

$$I_i^* = \begin{cases} \geq 0 & \text{if } I_i = 1 \\ < 0 & \text{if } I_i = 0 \end{cases}$$

□

A.3 Variable Definitions

- *ACQ* is one, if the firm year is after the acquisition.
- *DIVERSE* is a firm-level variable which equals one if the firm is a diversifying acquirer.
- *log(asset)* is the log of total assets.
- *log(sales)* is the log of sales.
- *age* is firm age, defined as a given year minus the year when the firm first appeared in Compustat.
- *ebit/sales* is earnings before interest and taxes, divided by sales.
- *opmarg* is operating income before depreciation scaled by sales.
- *mainseg opmarg* is the main segment's operating income before depreciation scaled by sales.
- *ROA* is net operating income divided by total assets in the prior year.
- *Tobin Q* is Tobin's Q. Tobin's Q is market value of assets divided by book value of assets. Market value of assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest.
- Δ*ind Q* the difference between industry Tobin's Q and the value in the prior year. Industry Tobin's Q is the median of firm Tobin's Q in the 4-digit SIC code industry.
- *cash/assets* is cash and short-term investments, divided by assets.
- *capx/assets* is capital expenditures divided by total assets in the prior year.
- *rnd/assets* is R&D expenditures divided by total assets in the prior year.
- *adv/assets* is advertising expenditures divided by total assets in the prior year.
- *sales growth* is the percentage growth in sales in a given year.
- *disappear* is a dummy variable that equals to one if a firms in the sample disappears later during the sample period.
- *leverage* is the ratio of total debt to the book value of assets.
- *stnet debt* is short-term net debt that equals to current debt minus cash divided total assets.
- *nseg* is the total count of a firm's operating segments.

- *ndiffseg* is the total count of a firm's operating segments, which appear in different industries at the four-digit SIC code level.
- *mainseg indrank* is a firm's percentile rank of sales of its main industry segment. The smaller the variable, the greater its sales in the main industry.
- *mainseg mshare* is a firms' market share in its main industry.
- *mainseg sales growth* is the percentage growth in sales of a firm's main industry segment in a given year.
- *mainind HHI* is a measure of a firm's main industry competitiveness, which the Herfindahl index on sales using firms in Compustat.
- *mainind sales growth* is the percentage growth in total industry sales of a firm's main industry in a given year.
- *sd(mainind sales)* is the standard deviation of the log of sales during the prior three years in a firm's primary industry
- *GDP growth* is the percentage growth in GDP in a given year.
- *% stock used* is the percentage of stock used in the method of payment.
- *stock deal* is one, if the deal uses stock payment more than 50%.
- Δ*goodwill/asset* is the difference in goodwill between one year after and before the acquisition, adjusted by the pre-acquisition assets.
- *ind-adj* represents the subtraction by the 4-digit SIC industry median of the variable.

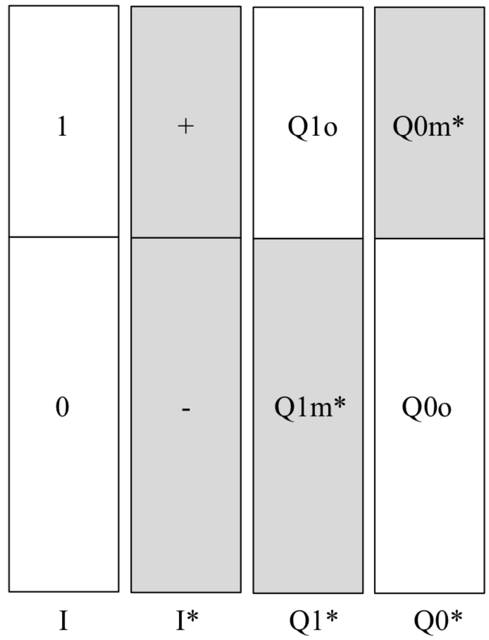


Figure 1.1: The Variable Structures in Bayesian Switching Regression Model

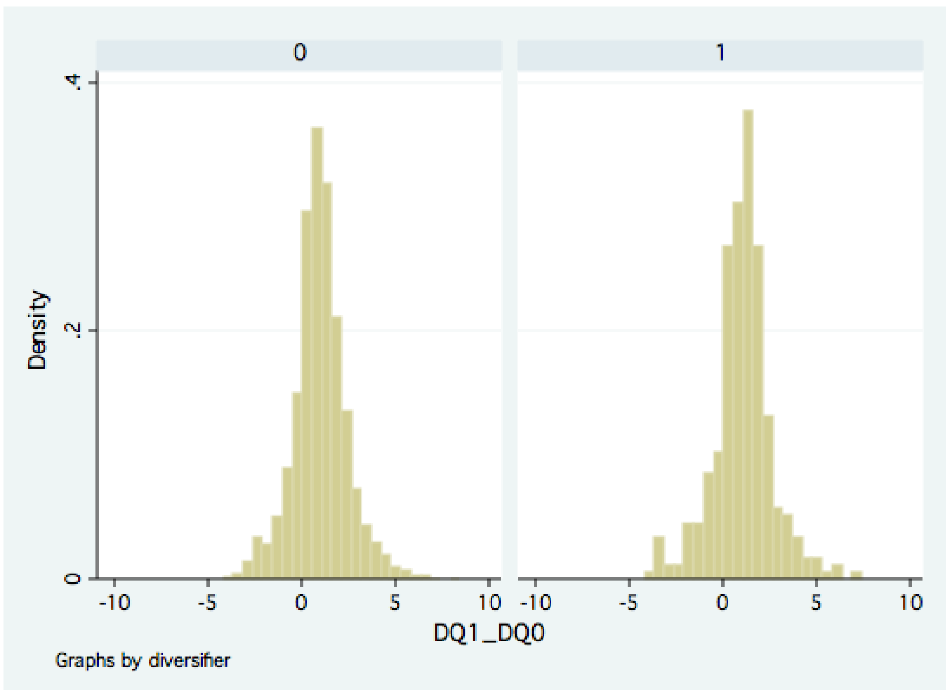


Figure 1.2: The Mean Distributions of $\Delta Tobin\ Q_1$ - $\Delta Tobin\ Q_0$

The figure shows the mean distribution of 5,000 Bayesian iterations of $\Delta Tobin\ Q_1$ *(ind-adj)* - $\Delta Tobin\ Q_0$ *(ind-adj)* for all 2,584 firms. The number of diversifiers ($DIVERSE = 1$) is 331, and the number of non-diversifier ($DIVERSE = 0$) is 2,495. It examines if firms could improve their value by diversifying into new industries through acquisitions. For $DIVERSE = 1$, the Bayesian augmented data is $\Delta Tobin\ Q_0$ *(ind-adj)*, while $\Delta Tobin\ Q_1$ *(ind-adj)* for $DIVERSE = 0$.

Table 1.1: Number of M&A Deals

The table describes the composition of my final sample over the period, 1997-2006. The merger and acquisition data are obtained from the SDC platinum M&A database. All M&A deals in the sample have U.S acquirers and targets and the completion years between 1997 and 2006. I require acquirers should have both -1 and + 1 relative year accounting data to the acquisition year. I classify each acquirer either the diversifier or non-diversifier based on whether the firm reports a new 4-digit SIC code for its operating segments in the Compustat Industry Segment reporting database at the year of the acquisition or within one year after the acquisition.

Total number of Deals in Final Sample			
Year	Non-diversifier	Diversifier	Total
1997	294	94	387
1998	265	76	341
1999	263	51	314
2000	264	18	282
2001	226	15	241
2002	256	16	272
2003	241	17	257
2004	229	22	251
2005	204	11	215
2006	253	11	263
Total	2495	331	2826

Table 1.2: The Characteristics of Diversifier

Table 2 reports different characteristics between Diversifier and Non-diversifier. Operating margin(*opmarg*), main segment operating margin(*mainseg opmarg*) and Tobin's Q are industry adjusted as well as winsorized. The industry-adjusted variable is the actual value minus the median value of all single segment firms having the same 4 digit SIC code. If the firm is a multi-segment firm, the industry value is computed as the segment asset-weighted sum of all industry medians of its multiple segments. Variable definitions are in Appendix.

	Diversifier					Non-diversifier					Difference	
variable	mean	median	sd	min	max	mean	median	sd	min	max	mean diff	t-stat
log(asset)	6.2	6.01	2.07	1.92	12.5	6.01	5.91	1.78	1.02	12.1	0.182	(1.71)
age	15.2	11	12.8	0	42	11.8	8	11.1	0	43	3.347***	(5.06)
opmarg (ind-adj)	0.0652	0.0414	0.147	-0.428	0.529	0.0849	0.051	0.168	-0.567	0.567	-0.0197*	(-2.03)
mainseg opmarg (ind-adj)	0.066	0.0437	0.148	-0.418	0.532	0.0865	0.0515	0.168	-0.578	0.578	-0.0205*	(-2.11)
Tobin Q (ind-adj)	0.21	0.167	1.09	-3.56	3.68	0.323	0.171	1.18	-3.75	3.8	-0.113	(-1.65)
cash/asset	0.106	0.053	0.133	0	0.763	0.14	0.0879	0.15	0	0.886	-0.0340***	(-3.92)
capx/asset	0.0594	0.0449	0.0704	0.00118	0.78	0.0622	0.0375	0.0745	0	0.615	-0.00287	(-0.66)
rnd/asset	0.0327	0.00833	0.053	0	0.266	0.0575	0.0195	0.0881	0	0.88	-0.0248***	(-5.00)
adv/asset	0.00669	0	0.0603	0	1.08	0.00932	0	0.031	0	0.574	-0.00263	(-1.26)
disappear	0.36	0	0.481	0	1	0.255	0	0.436	0	1	0.104***	(4.03)
leverage	0.205	0.195	0.173	0	0.737	0.171	0.125	0.173	0	0.872	0.0339***	(3.35)
stnet debt	-0.0655	-0.0269	0.157	-0.763	0.425	-0.11	-0.0697	0.173	-0.886	0.442	0.0441***	(4.40)
nseg	1.94	1	1.22	1	7	1.5	1	1	1	9	0.433***	(7.18)
ndiffseg	1.67	1	0.989	1	6	1.34	1	0.776	1	6	0.326***	(6.93)
mainseg indrank	0.319	0.273	0.24	0.0082	1	0.304	0.25	0.221	0.00319	1	0.0155	(1.18)
mainseg mshare	0.0803	0.0213	0.135	0.0000371	0.785	0.0634	0.0107	0.133	0.000001	0.993	0.0169*	(2.17)
mainseg sales growth	0.321	0.16	1.4	-0.927	24.3	0.329	0.163	0.959	-0.97	23.4	-0.00772	(-0.13)
mainind HHI	0.192	0.158	0.146	0.0211	0.977	0.162	0.127	0.139	0.0169	0.985	0.0302***	(3.68)
mainind sales growth	1.7	0.0774	10.2	-0.98	95.1	0.492	0.069	3.41	-0.989	95.1	1.206***	(4.35)
SD(mainind sales)	0.444	0.212	0.588	0.000213	3.9	0.39	0.246	0.427	0.0000658	3.57	0.0538*	(2.05)
GDP growth	3.68	3.75	0.995	0.759	4.55	3.25	3.69	1.2	0.759	4.55	0.426***	(6.17)
N			331					2495			2826	

Table 1.3: Existence of Diversification Discount

Panel A reports the mean discounts of diversified firms. I compare the average industry-adjusted Tobin's Qs between single segment firms and multi-segment firms. This confirms the result of diversification discount of Lang and Stulz (1994). Panel B shows the effect of the segment numbers on firm value over the sample period 1997-2006. *ndiffseg* represents the total number of different industries that a firm operates in (4-digit SIC code). Variable definitions are in Appendix.

PANEL A

Number of segment	1 seg	2 seg	3 seg	4 seg	5 seg
Mean Tobin Q (ind-adj)	0.194	0.009	-0.057	-0.045	-0.166
N	20508	3366	1458	471	220
Mean Difference (between 1 & n seg)	-	0.185	0.250	0.239	0.359
t-stat	-	(9.28)	(8.67)	(4.80)	(4.95)

PANEL B

	Dependent variable: Tobin Q (ind-adj)		
	(1) Whole sample	(2) Non-acquirers	(3) Acquirers
ndiffseg	-0.110***	-0.077***	-0.121***
	(-13.96)	(-5.01)	(-12.93)
log(asset)	0.069***	0.024***	0.085***
	(18.41)	(5.11)	(15.96)
ebit/sales	-0.000***	-0.001***	-0.000***
	(-3.83)	(-8.46)	(-12.33)
capx/asset	1.259***	1.260***	1.441***
	(17.47)	(13.12)	(13.50)
cash/asset	0.996***	0.724***	1.223***
	(17.33)	(9.13)	(15.36)
leverage	-0.698***	-0.385***	-0.833***
	(-19.21)	(-8.08)	(-16.82)
sales growth	0.008**	0.005***	0.026
	(2.85)	(3.94)	(1.63)
mainind sales growth	-0.002	-0.000	-0.003
	(-1.50)	(-0.24)	(-1.63)
GDP growth	0.017**	0.011	0.017*
	(3.18)	(1.52)	(2.36)
N	26099	9210	16889
R2-adj	0.056	0.046	0.066

Table 1.4: OLS estimates of Diversification Discount

Panel A reports the effect of acquisitions on the industry-adjusted Tobin's Q for the separate sample of Non-diversifier and Diversifier. I classify each acquirer in the sample either as a non-diversifier or a diversifier based on the new segment's 4-digit SIC code. If the firm reports a new SIC code in the Compustat industry segment reporting, it is regarded as a diversifier. The variable ACQ represents the state whether it is before or after the acquisition. All firm years are in the relative event window of [-2 year, +2 year] centering the acquisition year. Variable definitions are in Appendix.

PANEL A

	Dependent variable: Tobin Q (ind-adj)	
	(1) Non-diversifiers	(2) Diversifiers
ACQ	-0.172***	-0.210***
	(-8.65)	(-4.42)
log(asset)	0.082***	0.006
	(14.49)	(0.50)
ebit/sales	-0.000***	0.539***
	(-13.83)	(5.37)
capx/asset	1.606***	1.091***
	(13.89)	(4.37)
cash/asset	1.336***	1.160***
	(16.08)	(4.10)
leverage	-0.838***	-0.699***
	(-15.67)	(-5.07)
sales growth	0.026	0.060
	(1.55)	(1.68)
mainind sales growth	-0.005	0.001
	(-1.80)	(0.38)
GDP growth	0.013	-0.049*
	(1.68)	(-2.40)
N	14843	2046
R2-adj	0.067	0.068

Panel B reports the effect of diversification on the change in firm value. The variable *DIVERSE* is a dummy variable indicating whether the acquirer is a diversifier. The change in firm value(Δ *Tobin Q (ind-adj)* or Δ *Tobin Q*) is the actual firm value one year after the acquisition minus the actual firm value one year before the acquisition.

PANEL B

	(1) ΔTobin Q (ind-adj)	(2) ΔTobin Q
DIVERSE	-0.012	-0.084*
	(-0.22)	(-1.97)
log(asset)	0.054***	0.064***
	(5.28)	(7.95)
ebit/sales	0.028***	0.039***
	(3.88)	(4.27)
cash/asset	0.866***	1.338***
	(4.74)	(8.31)
leverage	-0.305**	-0.772***
	(-2.88)	(-8.79)
sales growth	0.252***	0.314***
	(4.80)	(4.71)
mainind sales growth	-0.001	0.022*
	(-0.10)	(2.38)
GDP growth	-0.052**	0.087***
	(-2.91)	(5.83)
Tobin Q (ind-adj, lagged)	-0.563***	
	(-28.62)	
Tobin Q (laggd)		-0.498***
		(-29.48)
Δind Q		0.139***
		(7.10)
N	2826	2826
R2-adj	0.317	0.398

Table 1.5: Two-Stage Heckman Estimates

Model (1) is a two-step consistent estimator, and (2) and (3) are full maximum likelihood estimators. The dependent variable *DIVERSE* is a dummy variable indicating whether the firm is a diversifier. All regressors in the first-stage estimation are one year lagged from the acquisition event. Variable definitions are in Appendix.

FIRST STAGE	DIVERSE		
	(1) TWO-STEP	(2) MLE	(3) MLE
age	0.011***	0.009***	0.007***
	(4.00)	(3.53)	(3.36)
cash/ asset	-0.304	-0.852**	-0.776***
	(-1.18)	(-3.13)	(-3.35)
leverage	0.323	0.374*	0.551***
	(1.65)	(2.04)	(3.38)
mainseg opmarg (ind-adj)	-0.294	-0.261	0.124
	(-1.37)	(-1.30)	(0.65)
Tobin Q (ind-adj)	-0.001	-0.003	-0.133***
	(-0.03)	(-0.10)	(-4.66)
mainseg sales growth	0.003	-0.001	-0.014
	(0.11)	(-0.03)	(-0.44)
mainseg indrank	0.120	0.139	0.086
	(0.82)	(0.96)	(0.67)
mainind HHI	0.702**	0.557**	0.565**
	(3.20)	(2.64)	(3.21)
mainind sales growth	0.015**	0.005	0.002
	(2.59)	(0.78)	(0.53)
SD(mainind sales)	0.024	0.034	0.014
	(0.32)	(0.50)	(0.23)
GDP growth	0.179***	0.198***	0.107***
	(5.83)	(6.67)	(3.59)
N	2826	2826	2826
chi2	1205.019	998.631	1441.531
p	0.000	0.000	0.000
log likelihood		-4841.531	-4169.401

Model (2) and (3) are different in the dependent variable and regressors. (3) uses the change in Tobin's Q level, and (2) uses industry-adjusted value.

SECOND STAGE	ΔTobin Q (ind-adj)	ΔTobin Q (ind-adj)	ΔTobin Q
	(1) TWO-STEP	(2) MLE	(3) MLE
DIVERSE	1.137***	1.102***	1.106***
	(3.71)	(9.23)	(19.98)
log(asset)	0.054***	0.054***	0.061***
	(4.95)	(5.11)	(7.18)
ebit/sales	0.027***	0.026***	0.035***
	(4.82)	(3.61)	(3.61)
capx/asset	1.021***	1.030***	0.810***
	(3.73)	(4.45)	(4.49)
cash/asset	1.091***	1.126***	1.484***
	(6.21)	(5.97)	(9.11)
leverage	-0.417***	-0.399***	-0.851***
	(-3.62)	(-3.65)	(-9.55)
sales growth	0.247***	0.241***	0.284***
	(6.63)	(4.49)	(4.01)
mainind sales growth	-0.001	0.000	0.020*
	(-0.06)	(0.04)	(2.36)
GDP growth	-0.056***	-0.058***	0.074***
	(-3.43)	(-3.29)	(5.21)
Tobin Q (ind-adj, lagged)	-0.559***	-0.559***	
	(-32.90)	(-28.11)	
Tobin Q (lagged)			-0.490***
			(-28.73)
Δind Q			0.171***
			(8.67)
Rho	-0.607***	-0.594***	-0.770***
Sigma	1.024	1.020	0.850
Lambda (Rho*Sigma)	-0.622***	-0.606***	-0.655***

Table 1.6: Posterior Results for γ, β_1, β_0, and Σ

The table reports the posterior distributions of γ, β_1 and β_0, and Σ from the 5,000 Bayesian iterations. *nse* stands for the numerical standard error. [*hpdil*,*hpdir*] shows the 95% Highest Posterior Density Interval which is similar to the confidence interval in frequentist econometrics. Variable definitions are in Appendix.

variables	mean	sd	nse	95% hpdil	95% hpdir
γ					
_const	−1.246	0.031	0.003	−1.297	−1.194
age (lagged)	0.061	0.022	0.003	0.024	0.095
cash/asset (lagged)	−0.781	0.252	0.042	−1.217	−0.313
leverage (lagged)	0.325	0.162	0.020	0.046	0.593
mainseg opmarg (ind-adj, lagged)	−0.288	0.189	0.029	−0.612	0.026
Tobin Q (ind-adj, lagged)	−0.001	0.026	0.003	−0.044	0.043
mainseg sales growth (lagged)	−0.009	0.028	0.004	−0.053	0.038
mainseg indrank (lagged)	0.339	0.163	0.023	0.071	0.581
mainind HHI (lagged)	0.669	0.222	0.035	0.246	1.041
mainind sales growth (lagged)	0.007	0.005	0.001	−0.002	0.016
GDP growth (lagged)	0.032	0.052	0.006	−0.044	0.125
β_1					
_const	0.217	0.026	0.004	0.175	0.259
log(asset)	0.680	0.052	0.008	0.599	0.767
ebit/sales	−0.001	0.030	0.005	−0.059	0.039
capx/asset	−0.069	0.028	0.005	−0.123	−0.030
cash/asset	0.951	0.663	0.107	−0.177	1.962
leverage	0.515	0.569	0.099	−0.440	1.520
sales growth	−0.954	0.370	0.066	−1.670	−0.391
mainind sales growth	0.245	0.164	0.031	−0.049	0.475
GDP growth	0.041	0.023	0.003	0.003	0.080
Tobin Q (ind-adj, lagged)	−0.183	0.047	0.008	−0.255	−0.103
β_0					
_const	−0.597	0.049	0.008	−0.673	−0.514
log(asset)	−0.347	0.025	0.003	−0.389	−0.306
ebit/sales	0.054	0.012	0.001	0.034	0.074
capx/asset	0.026	0.006	0.001	0.016	0.036
cash/asset	0.941	0.288	0.022	0.463	1.416
leverage	1.148	0.169	0.009	0.870	1.428
sales growth	−0.337	0.126	0.013	−0.549	−0.133
mainind sales growth	0.235	0.040	0.003	0.170	0.299
GDP growth	−0.005	0.010	0.001	−0.021	0.011
Tobin Q (ind-adj, lagged)	−0.042	0.017	0.001	−0.069	−0.015
Σ					
$\Sigma_{11}(\sigma_\eta^2)$	1.000	0.000	0.000	1.000	1.000
$\Sigma_{12}(\rho_{\eta 1}\sigma_1)$	−0.582	0.039	0.006	−0.651	−0.519
$\Sigma_{13}(\rho_{\eta 0}\sigma_0)$	−0.595	0.073	0.014	−0.709	−0.478
$\Sigma_{21}(\rho_{\eta 1}\sigma_1)$	−0.582	0.039	0.006	−0.651	−0.519
$\Sigma_{22}(\sigma_1^2)$	1.048	0.062	0.009	0.952	1.156
$\Sigma_{23}(\rho_{10}\sigma_1\sigma_0)$	−0.333	0.067	0.012	−0.442	−0.232
$\Sigma_{31}(\rho_{\eta 0}\sigma_0)$	−0.595	0.073	0.014	−0.709	−0.478
$\Sigma_{32}(\rho_{10}\sigma_1\sigma_0)$	−0.333	0.067	0.012	−0.442	−0.232
$\Sigma_{33}(\sigma_0^2)$	1.037	0.040	0.005	0.975	1.106

Table 1.7: Value-Enhancing versus Value-Decreasing Acquisitions

The table reports the firm-level and industry-level characteristics between value-enhancing and -decreasing firms with diversifying acquisitions. The columns of *Positive* (Δ*Tobin* Q_1-Δ*Tobin* Q_0) show the mean and median characteristics of the firms that would have an increase in firm value by diversify acquisitions. The columns of *Negative* (Δ*Tobin* Q_1-Δ*Tobin* Q_0) show the characteristics of the firms that would have a decrease in firm value. Variable definitions are in Appendix.

	Positive (ΔTobin Q_1-ΔTobin Q_0)		Negative (ΔTobin Q_1-ΔTobin Q_0)		Difference	
variable	mean	median	mean	median	mean difference	t-stat
log(asset)	6.04	5.91	6.03	5.94	0.00512	(0.06)
log(sales)	5.88	5.73	5.92	5.81	−0.0387	(-0.42)
age	12.4	8	11.3	7	1.063	(1.95)
ebit/sales	−0.0159	0.0845	0.0266	0.112	−0.0425	(-0.85)
opmarg (ind-adj)	0.0757	0.0438	0.112	0.0804	−0.0364***	(-4.59)
mainseg opmarg (ind-adj)	0.0771	0.0446	0.114	0.0827	−0.0369***	(-4.64)
Tobin Q (ind-adj)	0.26	0.136	0.522	0.34	−0.262***	(-4.69)
ROA (ind-adj)	0.0304	0.0226	0.0368	0.0237	−0.00634	(-1.18)
capx/asset	0.0619	0.0374	0.0619	0.0427	0.0000407	(0.01)
rnd/asset	0.0509	0.0135	0.0704	0.0391	−0.0195***	(-4.79)
adv/asset	0.00906	0	0.00882	0	0.000231	(0.13)
cash/asset	0.134	0.0799	0.145	0.101	−0.0108	(-1.51)
leverage	0.179	0.144	0.157	0.1	0.0222**	(2.66)
stnet debt	−0.102	−0.0594	−0.115	−0.0806	0.0127	(1.54)
disappear	0.272	0	0.25	0	0.0216	(1.01)
nseg	1.6	1	1.36	1	0.234***	(4.69)
ndiffseg	1.41	1	1.25	1	0.159***	(4.09)
mainseg indrank	0.313	0.261	0.276	0.223	0.0363***	(3.38)
mainseg mshare	0.0629	0.0113	0.0761	0.0116	−0.0132*	(-2.06)
mainseg sales growth	0.326	0.156	0.337	0.193	−0.0112	(-0.23)
mainind HHI	0.167	0.132	0.159	0.119	0.00824	(1.22)
mainind sales growth	0.549	0.069	0.999	0.0957	−0.450*	(-1.97)
SD(mainind sales)	0.391	0.245	0.42	0.255	−0.0282	(-1.31)
GDP growth	3.25	3.69	3.52	3.75	−0.262***	(-4.60)
% stock used	13.6	0	23.5	0	−9.912***	(-4.79)
stock deal	0.0924	0	0.167	0	−0.0748***	(-5.07)
Δgoodwill/asset	0.159	0.042	0.121	0.0266	0.0385	(1.06)
N	2294		532		2826	

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Chapter 2

Outsourcing and Firm Financial Structure

2.1 Introduction

Why do manufacturing firms use outside contracts to produce? Do high-technology and low-technology firms have different reasons? How is the use of outsourcing related to firm performance, investment, and financial structure? This paper attempts to address these questions using a new dataset of purchase obligations from firm 10-Ks. I examine which firms use outside contracts as a major input to their production, the industry determinants of this activity, and whether the outsourcing activity has an important relation with firm financial structure.

Evidence from the electronics, pharmaceuticals and automotive industries shows that the use of contract manufacturing has been growing significantly since the 1990s. In particular, the electronics industry outsourced $75 billion to contract manufacturers in 2000, representing 10% of total production (Plambeck and Taylor 2005). Many leading industrial companies, such as Apple Inc., IBM, General Electronics, Dodge, and Arizona Iced Tea directly manufacture an increasingly shrinking proportion of their products.[1] This increased outsourcing activity has

[1] See an article from Fortune, October 3, 1994, "You'll never guess who really makes". Sturgeon (1997) also cites a prominent example of Apple Inc. that sold its largest U.S. personal computer manufacturing facility in Fountain, Colorado to a small contract-manufacturer, SCI systems in 1996 and outsourced production to the company.

large implications for firm investment. Figure 2.1 presents long-run trends in corporate investment activity including mergers and acquisitions and lumpy capital investment in the U.S. manufacturing sector. Surprisingly, the number of firms with lumpy capital investment, as a fraction of the total number of firms in the same industry, decreases continuously over time. Without considering outsourcing activity, this long-run trend is difficult to explain. Yet, the corporate investment literature rather has focused on mergers and acquisitions and investment in the form of capital expenditures. Much less is known about firm-level outsourcing activity.

[INSERT FIGURE 2.1 HERE]

I examine the firm- and industry-level determinants of outsourcing activity. At the firm-level, I specifically examine whether a firm is more likely to outsource when its property rights are likely to be enforced through patents. At the industry-level, I investigate whether increased competition in both product and supplier markets leads firms to more outsourcing.

My results show that relatively young and large firms with a large number of patents are more likely to outsource their production. Industry factors are also important to explaining outsourcing activity. Firms in high-technology industries generally do more outsourcing. The greater the competition in the product market, the more firms in the industry outsource their production. Supplier market competition also has a positive effect on the likelihood of the outsourcing activity.

I report three major findings in regard to how outsourcing activity financially affects firms. First, by outsourcing, firms generally improve performance in generating cash flow. Outsourcing firms move to lowering operating leverage by using more variable costs versus fixed costs. As a result, they can achieve substantial increases in sales without committing to long-term spending for internal capacity growth. This helps outsourcing firms generate higher operating cash flow. Second, outsourcing firms can achieve operating flexibility in the aspects of streamlined production processes and the realization of cash flow. Operating flexibility in this paper refers to the ability of a firm to adjust its factors of operation such as production volumes, choices of suppliers, and product differentiation in response to product market changes. Based on this flexibility, outsourcing firms within high-technology industries are more likely to invest more heavily in R&D. This is consistent with firms focusing on their core competencies and leaving simple production process to contract manufacturers. On the other hand, low-technology outsourcing firms are more likely to enter new markets. Outsourcing firms do not need to develop their own facilities, and thus they can switch their products or operate additional segments in new industries at lower costs. Third, I find that firms that outsource have significantly less leverage. Debt markets may consider outsourcing firms with fewer fixed assets and more innovative investment riskier. Thus, the rates in debt financing will be higher for those outsourcing firms.

Overall, these findings imply that outsourcing is used by firms to improve their flexibility. This flexibility may allow the outsourcing firms to invest in product innovations or in new businesses. Outsourcing activity has important risk and capital structure implications. Being faced with fewer fixed assets to pledge as collateral, outsourcing firms have significantly less leverage.

Empirically establishing firms' incentives to engage in outsourcing activity and its financial impacts on the firms is difficult, mainly because such analysis requires detailed firm-level outsourcing data. Outsourcing activity is a transaction that is not included in a company's consolidated financial statements under generally accepted accounting principles (GAAP). Therefore, precise firm-level outsourcing data have not been collected. Although such data exist, they are limited to survey data.

In this paper, I use firm purchase obligations as a measure of firm-level outsourcing activity. I obtain my unique data on purchase obligations from firm 10-K filings on the Securities Exchange Commission (SEC) Edgar website, using web crawling and automated text analysis to extract the data.[2] A purchase obligation is defined as an agreement to purchase goods or services that is enforceable and legally binding on the company in the future. Thus, it may capture the firm's outsourcing activity. I document the validity of this measure of outsourcing first, by examining capital expenditures and capital intensity of firms with purchase obligations.

Theoretically, the extensive economics literature on incomplete contracts and industrial organization studies the bilateral contractual relationship between a buyer (an outsourcing firm) and a supplier (a contract manufacturer), and the organizational choice for procurement (*e.g.* Klein, Crawford and Alchian 1978; Williamson 1979; Mastern 1984; Grossman and Hart 1986; Hart and Moore 1990; Whinston 2003). The classic studies highlight the importance of the contracting costs and ex-ante investment incentives in deciding the types of contracts. However, more recent literature on trades develops various models in which outsourcing is viable under the

[2]In Section 3, I describe the purchase obligations data in detail.

costs of incomplete contracts (*e.g.* McLaren 2000, Grossman and Helpman 2002, 2004; Antras 2003, 2005; Antras and Helpman 2004). In these models, the tradeoffs between the costs of operating a vertically-integrated organization and the costs that arise from search frictions and incomplete contracting determine the mode of organization. These influential studies provide an understanding of the cross-industry difference in outsourcing activity and the growth of outsourcing activity across time. However, empirically little has been known about firm-level differences in outsourcing decisions and the financial implications of the outsourcing activity on the firms.

In addition to providing new data on firm-level outsourcing activity, my paper makes three additional contributions to the related literature. First, my results assist in understanding firms' incentives to use outside contracts. I find that increased competition in the product market leads firms to reduce production costs through outsourcing. Supplier market competition and property rights protection make outsourcing more viable by relieving incomplete contracting problems. Second, I document new stylized facts on outsourcing firms' investment. Outsourcing firms invest more heavily in product innovation or in starting new businesses, rather than investing in internal capacity growth. These investment styles have certain risk implications. Third, my paper connects the increasing use of outside contracting to the capital structure literature. Extensive literature studies the relation between liquidation value and firm financial structure (*e.g.* Shleifer and Vishny 1992; Morellec 2001; Benmelech and Bergman 2009). There has been no attempt, however, to uncover the financial structure of outsourcing firms that reduce their fixed assets and improve their flexibility.

My empirical strategy does not intend to show explicitly the causal effects of outsourcing on other corporate decisions, as the complex corporate decisions in production, investment, and financial structure are surely simultaneous. Using seemingly unrelated regressions (SUR), I rather contain the endogeneity of these corporate decisions in my model and focus on finding factors that nonetheless have significantly similar or differential effects on those decisions. By analyzing the similar or differential effects of significant factors including the residuals for omitted variables, my empirical strategy provides an understanding of the relations between these simultaneous corporate decisions.

The rest of this paper is organized as follows. Section 2 provides a discussion of possible relations between outsourcing, corporate investment and financial structure, and presents testable implications. In Section 3, I describe purchase obligations data in detail and discuss empirical methodology. Section 4 presents the results of empirical analyses. Section 5 concludes.

2.2 Conceptual Framework

In this section, I describe possible economic reasons for an increasing shift from in-house production to contract manufacturing, and discuss how this may affect firm financial structure.

2.2.1 Costs and Benefits of Outsourcing

Why do traditionally in-house manufacturing firms turn to outsourcing? At its heart, this is a question of the extent of vertical integration and the boundaries of the firms. Industrial organization theories clearly identify the difficulty in writing a contract that specifies all possible contingencies and all terms of business relationship. Williamson (1979) emphasizes on the importance of the contracting costs in deciding types of contracts or organization of production. Klen, Crawford and Alchian (1978) highlight the potential ex-post holdup problems between firms dealing with relationship-specific assets.

However, recent economic literature develops various trade models in which outsourcing is viable under these costs of incomplete contracting. McLaren (2000) empathizes the important role of market thickness (competition) in alleviating the holdup problems. The market thickness refers to the number of available partners that a firm can invest in a joint business with. Therefore, the costs of incomplete contracting can be reduced, when competition in both customer and supplier markets is large. In Grossman and Helpman (2002), it is also documented that the larger the number of potential business partners, the lower the search and matching costs. Grossman and Helpman (2004) model an incentive system that explores the tradeoff between the costly monitoring within the integrated firm and the costs of incomplete contracting. Antras (2003, 2005), and Antras and Helpman (2004) develop trade models in which firm (country) difference in endowments of factors such as labor, capital and productivity makes outsourcing viable.[3]

As Gorssman and Hart (1986), and Hart and Moor (1990) note, ownership may increase the incentives of both parties to participate in a joint business. In their model, which firm owns the relationship-specific assets affects ex-ante investment and contracting. In many cases of outsourcing, both outsourcing firms and contract manufacturers make relationship-specific investments. In general, outsourcing firms invest in product concept and design, and contract manufacturers make investment in production capacities. Therefore, regarding the outsourcing firms' perspectives, it is an essential factor in determining the feasibility of outsourcing how their ownership of product concept and design is protected.[4]

The potential benefits of outsourcing are directly addressed by the cost arguments. Outsourcing can reduce production costs (Lambrecht, Pawlina and Teixeira 2010). Specialized contract manufacturers can achieve economies of scale by pooling products and supplying many customers in the same industries. Outsourcing to the other regions (or countries) with cheaper labor or commodities can reduce production costs. Firms can also save inventory carrying costs by outsourcing production processes.

In addition to these advantages, the benefits of using outside contracts include

[3]See a survey paper of Spencer (2005) for the theoretical trade models on international outsourcing and incomplete contracts.

[4]The recent example of the growing importance in property rights protection is a patent war between Apple Inc. and Samsung. Samsung is a major supplier of components to Apple Inc., and also a strong competitor in the smart phone and tablet PC markets. A TIME article, "What a Patent War Means for South Korea's Samsung" (September 9, 2011), claims that the patent war can be seen as a litigation designed to protect competition and innovation, or a market trick to block challengers. See Harvard Business Review, September 2006, "When Your Contract Manufacturer Becomes Your Competitor" for a discussion on how outsourcing can heighten the competition.

increased firm flexibility. Outsourcing firms with fewer fixed costs versus variable costs can adjust production volumes according to the volatile market demands with less difficulty than non-outsourcing firms. This benefit of production flexibility increases with the extent of product market competition and the speed of market changes. Outsourcing firms' flexibility is not limited to the production. Piore and Sabel (1984) document that flexible production provides a firm capacity to quickly accommodate various changes and needs from the markets. By leaving simple or non-core processes of manufacturing to contract manufacturers, firms can extend their innovative capability in their specialties, and consequently improve their competitiveness by outsourcing. Several examples of large high-technology firms are consistent with firms outsourcing low-end products, while continuously introducing technological advances to their core products at the high-end level. Those examples include computer makers such as Apple inc. IBM, Intel, and automakers including Porsche and DaimlerChrysler. I conjecture that this firm flexibility gained by outsourcing can boost the firms' R&D efforts in their core businesses. This conjecture is more likely to apply to the high-technology firms. Therefore, in this paper, I test whether the outsourcing firms invest more heavily in R&D than non-outsourcing firms.

Another flexibility benefit arises from a different channel. Outsourcing firms do not need to develop their own facilities to produce new products by using third-party contractors. Therefore, they can add or switch products at lower costs. For example, a paper clip manufacturer that outsources the partial or whole production process of making clips can start a new business of producing (or outsourcing) aluminum foil containers at lower costs than non-outsourcing paper clip makers. I test a hypothesis that captures this benefit of lower costs in starting new businesses.

The following hypotheses based on the aforementioned costs and benefits of outsourcing are tested. The first two hypotheses concern the likelihood and the feasibility of outsourcing.

Hypothesis 2.1. *Large firms and firms with proper protective mechanisms for their property rights are more likely to outsource production.*

Hypothesis 2.2. *Increased competition in the product market and the supplier markets leads firms to more outsourcing.*

The following two hypotheses focus on outsourcing firms' investment. Key to testing these hypotheses is the degree of firm flexibility.

Hypothesis 2.3. *Outsourcing firms conduct more R&D than non-outsourcing firms.*

Hypothesis 2.4. *Outsourcing firms are more likely increase operating segments than non-outsourcing firms.*

2.2.2 Outsourcing and Firm Financial Structure

In this section, I discuss how different the outsourcing firms' financial structures are from non-outsourcing firms. The following four major facts characterize outsourcing firms: (1) From the benefits of cost reduction, outsourcing firms generate higher cash flow. (2) The proportion of fixed assets to total assets is significantly less. (3) The highly specialized workers are left in the firm. (4) Outsourcing firms are more likely to invest in new and innovative projects with less certainty, given that my last two hypotheses are verified. It is notable that all of these changes predict the same directional implication on firm financial structure; a decrease in the use of debt financing

First, it is less likely for a firm to use more debt, when the firm generates enough cash flow from operation. The cash flow realization also provides opportunities to adjust leverage (Faulkender, Flannery, Hankins and Smith 2011).

Second, The lower capital-intensity makes debt financing less viable than equity financing. Debt holders favor fixed assets over intangible assets. Therefore, all else being equal, if a firm has fewer fixed assets to be used as collateral when issuing bonds or taking loans, the price of credit should be higher (Benmelech and Bergman 2009).

Third, outsourcing firms are more likely to be disinclined to debt financing, due to the human costs of bankruptcy. By outsourcing a large portion of production processes, only highly specialized workers may remain in the firm and those workers are entrenched; *i.e.* it is costly for them to find a new job at the same wage. Therefore, the level of risk aversion of these entrenched employees against the benefits of debt will optimally determine firm leverage (Berk, Stanton and Zechner 2010). Hence, outsourcing firms will issue only modest levels of debt, assuming that remaining workers in the outsourcing firms are more risk-averse than production workers.

Fourth, innovations are more likely to be financed by equity, due to the intangible nature of their investment, asymmetric-information and moral hazard.

Asymmetric-information and moral hazard are two factors widely viewed as driving wedges between the cost of internal and external financing. These wedges are likely to be larger in the case of innovative investment, because of the highly uncertain and less informative characteristics of the investment (Hall 2005; 2009).

Based on the above discussion, I develop the following hypothesis regarding outsourcing firms' capital structure.

Hypothesis 2.5. *Outsourcing firms are less leveraged than non-outsourcing firms.*

2.3 Data and Methodology

I electronically collect purchase obligations data from the Edgar 10-K filings website. I utilize PERL programming for web crawling and to parse the documents.[5] I provide the detailed collection procedure in Appendix B.1. I obtain the primary firm data from the CRSP/Compustat merged database and link this to the purchase obligations data using the central index key (CIK). My sample period covers from 2004 to 2009, because firms are not required to disclose purchase obligations data before December 15, 2003. I only study public manufacturing firms (SIC codes 2000 to 3999). In the rest of this section, I describe purchase obligations data in detail, how I construct my sample and the variables of interest, and what is my empirical methodology is.

[5] Lee (2010) first collects and studies purchase obligations data. The description of his data can be found at http://faculty.haas.berkeley.edu/klee/Kwang Lee Purchase Obligations Data.htm.

2.3.1 Purchase Obligations Data

The SEC issued on January 2003 a final rule on Disclosure about off-balance sheet arrangements and aggregate contractual obligations.[6] This rule requires public companies other than small business issuers[7] to provide an explanation of its contractual obligations in a separately captioned subsection of the Management's Discussion and Analysis (MD&A) section. U.S. GAAP already requires firms to aggregate and assess all of the specified categories of contractual obligations; long-term debt obligations, capital lease obligations, and operating lease obligations. However, this SEC's final rule in particular includes "purchase obligations" category and requires to provide tabular disclosure of all four categories of contractual obligations.

The SEC defines a purchase obligation as an agreement to purchase goods or services that is enforceable and legally binding on the registrant in the future. Therefore, a firm's purchase obligations represent the amount of inputs in production that will be purchased in the near future (Lee 2010). Purchase obligations are different with open-market orders, in that a company legally submits purchase contracts to the third parties. Thus, purchase obligations are more likely to capture a firm's outsourcing activity.

For the fiscal years ending on or after December 15, 2003, all public firms (other than small business issuers) started disclosing purchase obligations in their

[6]This rule is to implement Section 401(a) of the Sarbanes-Oxley Act of 2002. See Final Rule: Disclosure in Managements Discussion and Analysis about Off-Balance Sheet Arrangements and Aggregate Contractual Obligations, Securities Act Rel. No. 33-8182, Exchange Act Rel. 34-47264, Financial Reporting Rel. No. FR-67, International Series Rel. No. 1266, http://www.sec.gov/rules/final/33-8182.htm (Jan. 27, 2003).

[7]SEC defines a small business issuer as a company that had less than $25 million in revenues in its last fiscal year, and whose outstanding publicly-held stock is worth no more than $25 million.

financial statements. Therefore, my primary sample includes filings associated with fiscal years ending in calendar years 2004 to 2009. Figure 2.2 shows examples of purchase obligations disclosures in firm 10-Ks.

[INSERT FIGURE 2.2 HERE]

Firms generally do not subcategorize purchase obligations in their tabular disclosures. They sometimes provide limited information on the types of purchase obligations in the following footnotes. For manufacturing firms, the most common type of purchase obligation is an inventory purchase commitment. A service agreement, including advertising, marketing and IT, is another common type of purchase obligation.[8] The payment due is classified by specified periods in the tabular disclosure format. Among those specified periods, I use the total amount of future payment as my measure for outsourcing activity, instead of using the amount within 1 year. This is due to the fact that firms sometimes pay after the actual deliveries of products, or they make installment payments. However, the majority of firms has purchase obligations due within one year. This may imply that prices in contracts are more likely to be adjusted yearly to the markets.

Table 2.1 presents descriptive statistics for purchase obligations by two-digit SIC code industries in the manufacturing sector. I assume that a firm other than small business issuers has no purchase obligation, if the firm does not disclose an amount of purchase obligation in its 10-K.[9] In total, more than 60% of firms use

[8]See Lee (2010) for discussion about the across-industry variation in the type of purchase obligations.

[9]The SEC final rule is adopting the "reasonably likely" disclosure threshold that currently applies to other portions of MD&A disclosure. In the SEC's 1989 MD&A Release, a company

outsourcing, and the mean value of purchase obligations reaches 7% of the total sales (11% of the total sales within firms with non-zero purchase obligations). The high-technology sectors including *Industrial machinery and equipment*, *Electrical and electronic equipment*, and *Instruments and related products* show considerably higher rates of firms that have purchase obligations. The outsourcing activity is least prevalent in the *Lumber and wood products* industry.

[INSERT TABLE 2.1 HERE]

2.3.2 Sample Construction and Variables of Interest

I create the primary sample by merging all of the public firms in 10-K filings database to the CRSR/Compustat database by the CIK. Then, I exclude firms whose maximum sales revenue is less than $25 million, because they are regarded as small business issuers which are not required to disclose contractual obligations. For the operating segment information, I link the firm-year database to the Compustat Industry Segment database.[10] In addition, I supplement this database with the NBER patent database for the firm patent counts.[11] I do not exclude any firm-year observation during this supplementation. I assume no firm activity of patenting for the firm, if it shows no observation. The above sample construction procedure leaves

had an obligation to disclose prospective information in its MD&A "where a trend, demand, commitment, event or uncertainty is both presently known to management and reasonably likely to have material effects on the companys financial condition or results of operations.

[10]The Compustat Industry Segment data has been reputed to possibly contain problems in reporting practice. However, Berger and Hann (2003) show that SFAS 131 increased the number of reported segments and provided more disaggregated information after 1997.

[11]The NBER U.S. patent citations data file can be found at http://www.nber.org/patents/. The database is extended by Bronwyn Hall to include matches to Compustat firms. I complement this by additionally matching to the LexisNexis Directory of Corporate Affiliations database.

me with 1,757 firms operating in 200 different four-digit SIC industries, and 8,211 firm-years during the period from 2004 to 2009.

I construct the following variables for outsourcing activity.

Outsourcing Dummy (*PO exists*): This firm-level variable is one, if a given firm has disclosed a non-zero amount of purchase obligations at least once during the sample period.

Increase in Outsourcing Dummy (*PO increases*): For a given firm-year, this variable is one if $\Delta PO > 0$.

Outsourcing Activity (*PO/sales*): For a given year, this variable is the total amount of purchase obligations disclosed in a firm's 10-K, scaled by total sales.

Annual Outsourcing Activity (*PO1year/COGS*): For a given year, this variable is the total amount of purchase obligations due within 1 year, scaled by costs of good sold.

I construct the following key variables to examine the feasibility of outsourcing and possible relations to the financial attributes.

High Technology Industry Dummy (*high-tech industry*): I use 31 different four-digit SIC codes to define the high-technology manufacturing industries.[12] High technology industries are: computers and office equipment,

[12]TechAmerica organization defines 45 sic-based high-technology industries on their website. Among those, I use the definition of 31 manufacturing industries. See http://www.techamerica.org/sic-definition. U.S. Bureau of Labor Statistics also defines NAICS-

consumer electronics, communications equipment, electronic components and accessories, semiconductors, industrial electronics, photonics, defense electronics, and electromedical equipment. Appendix B.2 shows these 31 industries in detail.

Product Market Competition (*compete-TNIC*): For a given year, this industry-year level variable is a measure of product market competitiveness, based on the Text-Based Network Industries by Hoberg and Phillips (2011). This is one minus the TNIC Herfindahl index.

Supplier Market Competition (*supplier compete*): For a given year, this industry-year level variables is one minus the weighted mean of supplier market Herfindahl indexes using sales of COMPUSTAT firms. I define supplier markets using the input-output benchmark table from the Bureau of Economic Analysis.[13] The weight of each supplier market equals the producers' value of inputs used by the customer industry as a fraction of total value of all inputs. I assume the Herfindahl index of the imported input market is zero, which refers to the highest competition.[14]

R&D Investment (*R&D/sales*): For a given firm-year, this variable is R&D

based high-technology industries. Although the definition of U.S. Bureau of Labor Statistics is broader, I find that these two definitions are congruous. My definition of high-technology industries does not include biotechnology firms. Biotechnology is not established yet with its own set of SIC codes, and rather spreads over the drugs sector (SIC code=283).

[13] Input output benchmark tables are publicly available from the website of Bureau of Economic Analysis at http://www.bea.gov/industry/io_benchmark.htm. I use the 2002 standard use tables at the detailed level, and match this data into four-digit SIC codes by correspondence tables between IO, NAICS and SIC codes.

[14] For a robustness check, I also employ the fitted HHI indexes constructed by using both public and private firms, instead of using COMPUSTAT firms. The procedure to construct these fitted HHI indexes is described in Hoberg and Phillips (2010a). The results remain similar.

expenditures, scaled by total sales.

Intellectual Property Right Protection (*log(1+#patent)*): This firm-level variable is a total patent count granted to the firm during the 20 year period from 1985 to 2004. Under the current U.S. patent laws, the term of a patent is 20 years from the filing date of the earliest application.

Operating Segments (*log(#seg)*): For a given year, this variable is a count of the operating segments which appear in different industries at the four-digit SIC code level.

Change in Operating Segments (Δ *seg*): For a given year, this variable is the change in the total number of four-digit SIC code industry segments. This variable shows whether the firm starts operating additional segments in new industries in the given year.

Leverage (*market leverage* or *book leverage*): This is the ratio of total debt to the market value or book value of assets. Market value of total assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest.

Table 2.2 presents the summary statistics. Panel A reports firm-level statistics for both firms with purchase obligations and without purchase obligations. I also tabulate firm characteristics for the sub-samples of high-technology and low-technology firms. Panel B reports firm-year level statistics for both firm-years with an increase in purchase obligations and without an increase. For each variable, I winsorize the top and bottom 1% of the distribution.[15]

[INSERT TABLE 2.2 HERE]

According to the statistics in Panel A, the firms with purchase obligations represent more than half of the total firms in the sample. It shows that the firms with purchase obligations differ from the firms without purchase obligations in many aspects. Particularly, firms with purchase obligations are larger and more profitable. Their growth opportunities (measured by Tobin's Q and industry adjusted Q) are higher than firms without purchase obligations. They also generate higher and more stable cash flows. The property rights of outsourcing firms are more enforced through patents. High technology firms are more likely to have purchase obligations. These differences are reasonably explained. If various components of a complex (high-technology) product require special technology, firms are more likely to outsource components other than their specialties. In this case, intellectual property right protection (measured by total patent counts of the firm) is an important factor to make contract manufacturing feasible and safe. Most notably, outsourcing firms are significantly less leveraged, and summary statistics show that they are not financially distressed (measured by profitability, cash holdings and payout ratios). Both product market competition and supplier market competition are significantly greater for the outsourcing firms' industries. Therefore, both outsourcing firms and their suppliers tend to face more available partners to make joint business contracts

[15] Several biotechnology firms excessively spend on R&D, and commonly show firm-years with *R&D/sale* over 1. To avoid a possible outlier effect, I drop the firms with the mean $R\&D/sales > 5$ and winsorize the top and bottom 2% of the distribution of *R&D/sale*. I do not find any outlier problem in using *R&D/assets*.

with.

ind outside input is a measure of industry dependence on outside inputs, which is the value of total outside inputs as a fraction of the value of the total outputs of an industry. This should be significantly higher for the outsourcing industries, if my outsourcing measure based on purchase obligations only captures the raw material contracts. However, this industry measure shows an insignificant difference between outsourcing and non-outsourcing firms in the whole sample. It rather turns out to be significantly less for high-technology outsourcing firms. Hence, purchase obligations are more likely to capture outsourcing activity, not just represent raw material supplying contracts.

According to Panel B, the amount of purchase obligations increases in almost half of the firm-years in the sample of firms with purchase obligations. The statistics indicate that the firm-years with growing outsourcing activity differ from the firm-years without an increase. The firm-years with an increase tend to have greater sales growth and significantly higher Tobin's Q. This implies that outsourcing firms with growing sales and higher investment opportunities may expand their capabilities by outside contracting, not by investing in fixed assets internally. *long-run* Δ *PPE/assets* and *long-run* Δ *emp/sales* confirm that both capital intensity and labor intensity significantly decrease over the long run for the firms with increasing purchase obligations. The firms with growing outsourcing activity also have significantly less leverage than the firms without an increase.

2.3.3 Empirical Methodology

In this paper, I analyze the possible relations in outsourcing activity, corporate investment and financial structure. However, outsourcing firms are not randomly selected. Moreover, the combination of complex decision processes in production, investment, and financial structure are surely simultaneous. Therefore, endogeneity concerns are present in my study. Given the limited purchase obligations data available (from 2004 to 2009), proper identification strategies are restricted. Therefore, I do not attempt to make any inference in the causes and consequences. I rather acknowledge the endogeneity of my models and focus on finding factors that have significantly similar or differential effects on the corporate decision processes.

I use a simultaneous equation approach in which endogenous corporate decisions are allowed. That is, the relevant equations are estimated together under the identical regressors with the residuals correlated. Specifically, I estimate

$$\begin{aligned} X_{i,t} &= f(Size,\ Age,\ TobinQ,\ Patents,\ Competition,\ Hightech\ Industry) + \epsilon_{i,t} \\ Y_{i,t} &= g(Size,\ Age,\ TobinQ,\ Patents,\ Competition,\ Hightech\ Industry) + \eta_{i,t}, \end{aligned}$$

where i indexes firms, t indexes years, $X_{i,t}$ is the outsourcing decision, and $Y_{i,t}$ is the other corporate decision of interest, such as R&D investment and capital structure. I estimate this system of equations using seemingly unrelated regressions (SUR), in which the residuals, $(\epsilon_{i,t},\ \eta_{i,t})$ are correlated. No instrumental variable is presented in these regressions. From this specification, I am able to analyze which factors have significantly similar or differential effects on each endogenous decision. Then, I present the propensity score matching estimates using matching variables including those critical factors.

My identification strategy can be illustrated with an example. Let the variable of interest be capital intensity. Outsourcing likelihood and capital intensity are simultaneously estimated by regressing on the exact set of following variables: size, age, Tobin's Q, total counts of patents, competition, and high-tech industry dummy. Suppose that the estimated signs of coefficients of (size, age, Tobin's Q, patents, competition, high-tech) are $(+, -, +, +, +, +)$ for outsourcing likelihood. On the other hand, they are $(+, +, -, -, -, -)$ for capital intensity. Suppose also that the residuals, $(\epsilon_{i,t},\ \eta_{i,t})$ are negatively correlated. The result for Tobin's Q implies that firms that have higher Tobin's Qs are more likely to outsource. At the same time, the firms with high Tobin's Qs are less likely to be capital intense. Similar interpretations are possible for age, total counts of patents, competition and high-technology industry dummy. This empirical strategy using SUR provides additional implications on omitted variables, as the correlation of the residuals is estimated. In this example, the residuals are negatively correlated. This reveals that the omitted variables have differential effects on the corporate decisions of outsourcing and capital intensity. According to this example, outsourcing firms are more likely to be associated with less capital intensity.

This empirical strategy does not intend to show explicitly the causal effects of outsourcing on other corporate decisions. However, analyzing the similar or differential effects of those significant factors assists in understanding the relation between simultaneous corporate decisions.

2.4 Results

This section presents the paper's results. I begin by examining what determines the likelihood and feasibility of outsourcing. Then, I examine capital expenditures and capital intensity of outsourcing firms to verify the validity of my outsourcing measure. If my outsourcing measure based on purchase obligations data is valid, capital expenditures and capital intensity (labor intensity as well) of outsourcing firms should be less. Then, I further investigate how outsourcing firms differ from non-outsourcing firms in their financial structure. I specifically examine market leverage and book leverage. The proportion of the fixed assets among total asset portfolios is one of the most important variables that explain the cross-sectional variance in leverage ratios. Therefore, outsourcing firms are expected to have less leverage, as they operate fewer fixed assets than non-outsourcing firms. To better understand this difference in leverage, I further examine outsourcing firms' investment. In particular, I test whether outsourcing firms engage in any type of investment that affects firm risks and financial structure, by focusing on their R&D expenditures and the number of operating segments.

2.4.1 The Likelihood of Outsourcing and Firm Attribute Changes

This section begins by examining what determines the likelihood of outsourcing. I use probit models and Table 2.3 presents the results. In Panel A, I examine the outsourcing decision. The firm-level dependent variable, *PO exists* equals to one, when the firm discloses non-zero amount of purchase obligations at least once during the sample period. In Panel B, I examine the growth of outsourcing activity. The firm-year level dependent variable, *PO increases* equals to one, when the firm increases the amount of purchase obligations in the given year. I include the industry characteristics of the product market competition (*compete-TNIC*), the supplier market competition (*supplier compete*), the high technology industry dummy, the industry dependence on the outside inputs (*ind outside input*), and the lagged industry trend of outsourcing activity (*ind PO/sales*). In Panel B, I also include the macro credit spread, which is the spread between the Baa corporate bond yield and the 10 year treasury rate (*macro credit spread*) as a measure for aggregate liquidity, instead of using the year-fixed effects.

[INSERT TABLE 2.3 HERE]

Panel A of Table 2.3 shows that a firm is more likely to use outside contracts, if it is young, large and a growth firm. My hypothesis regarding ownership protection suggests that firms with proper protective mechanisms for their property rights are more likely to outsource. The results show that outsourcing firms' property rights tend to be more enforced through patents. This relation is economically and statistically significant. Industry factors are also important to predict the outsourcing likelihood. Firms in high-technology industries are more likely to use outside contracts. Competition in the product market and the supplier markets positively predicts the outsourcing activity, which is consistent with Hypothesis 2.2.

Overall, these findings reveal that firms use outsourcing when their incomplete contracting costs are not severe. The greater marginal costs of operating a vertically-integrated organization incentivize a relatively large firm to use more outside contracts. The ownership protection enforcement also has an important impact on the firm's outsourcing feasibility. A large number of available business partners (measured by product market and supplier market competition) can reduce the costs of incomplete contracting such as the hold-up problems and search costs. As a result, competition in both product and supplier markets plays a key role to predict the outsourcing likelihood.

Panel B of Table 2.3 reports results for an increase in outsourcing activity. A firm is more likely to increase its share of outsourcing, when its investment opportunities (measured by Tobin's Q) and sales growth are higher.[16] Industry characteristics are not important to predict an increase in outsourcing activity. However, the macro variable of aggregate liquidity is significantly and positively related to the growth of outsourcing.

2.4.2 Capital Expenditures and Capital Intensity

I now test the validity of my outsourcing measure. To show that my measure properly captures outsourcing activity, I examine the following firm attributes: capital expenditures and capital intensity (labor intensity). Outsourcing contracts are in a number of cases the single largest source of purchase obligations, and the disclo-

[16]Lee (2010) confirms that the growth in purchase obligations is associated with higher future sales and earning.

sure rule may bring increased visibility to the terms of outsourcing transactions.[17] However, in the examples of actual firm disclosures, I discover that firms sometimes record their construction projects under the category of purchase obligations in their own discretion. Therefore, outsourcing firms should spend less in capital expenditures and have less capital intensity (labor intensity), if purchase obligations largely and properly represent outsourcing activity. Table 2.4 and Table 2.5 present the results.

In Table 2.4, I estimate a system of two equations with *PO exists* and *CAPX/sales* as the dependent variables. The *PO exists* equation is a probit estimation. The residuals of the two equations are correlated. I estimate the between-effect, year-fixed effect, and industry-year fixed effect models. The regression results for *PO exists* are similar in both magnitude and statistical significance to those reported in Table 2.3. In the *CAPX/sales* equation, capital investment rates are higher, when Tobin's Q and sales growth are larger. They are lower in high-technology industries and competitive industries. From these regressions, I separately generate a table showing the effects of significant factors on each dependent variable. The table shows that the effects of patents, Tobin's Q, competition and high-tech are significantly opposite for the *PO exists* and the *CAPX/sales*. This implies that larger firms in highly competitive and technology-oriented industries respond differently to the outsourcing and capital expenditure decisions.

[INSERT TABLE 2.4 HERE]

[17] See "Outsourcing Advisory: New MD&A Requirements Under Sarbanes-Oxley May Impact Outsourcing Transactions" of ALSTON+BIRST LLP at http://www.alston.com/resources/advisories/ (July 30, 2004).

Table 2.5 presents the results for capital intensity. I now estimate a system of two equations with *PO exists* and *PPE/assets* as the dependent variables. In the *PPE/asset* equation, capital intensity is higher when the firm is larger, older and has lower Tobin's Q. *PPE/asset* is lower in the high-technology industries and the competitive industries. I also generate a table showing the effects of significant factors on each dependent variable. This table finds that age, patents, Tobin's Q, competition and high-tech have the significantly opposite effects for *PO exists* and *PPE/assets*. According to these results, firms with purchase obligations are more likely to be associated with less capital intensity, when conditioning on firm size.[18]

[INSERT TABLE 2.5 HERE]

2.4.3 Outsourcing Firms' Capital Structure

In this section, I examine how firm financial structure is related to outsourcing activity. So far, I document that outsourcing firms have fewer fixed assets. The fixed asset proportion among a firm's asset portfolios is one of the most important variables that explain the firm's leverage ratio. Table 2.6 presents the results of this prediction. In Table 2.6, I estimate a system of two equations with *PO exists* and *market leverage* as the dependent variables.[19] In the *market leverage* equation, the level of debt is higher when the firm is larger and younger. The higher the Tobin's Q, the less leveraged the firm. High-technology firms with a large number

[18] In the unreported table, I find the similar results for labor intensity. Outsourcing firms are more likely to be associated with less labor intensity, when conditioning on firm age.

[19] In unreported results, I use *book leverage* as the dependent variable and also find the similar results.

of patents are also less leveraged. The separate table of significant factors shows that the effects of patents, Tobin's Q, competition and high-tech are significantly opposite for *PO exists* and *market leverage*. According to these results, outsourcing firms are more likely to be associated with less leverage, when conditioning on firm size and age.

In Table 2.7, I examine more directly whether outsourcing firms are less leveraged, using the propensity score matching estimates. Consistent with Hypothesis 2.5, outsourcing firms' use of debt is significantly less than non-outsourcing firms. The results for both market leverage and book leverage are robust over the different year samples and regardless of industry adjustment. The probit regression of *PO exists* uses the following matching variables: *log(sales)*, *log(1+age)*, *log(1+#patents)*, *Tobin's Q*, *operating margin*, *high-tech industry* and *PPE/assets*. I intentionally add *PPE/assets* for the matching variable in this specification, to determine whether the results are solely driven by the fewer fixed assets of outsourcing firms. The magnitude and statistical significance get larger, when I do not include *PPE/assets* in the matching variables.

[INSERT TABLE 2.6 AND 2.7 HERE]

In addition to the above tests, I analyze the relation between outsourcing and leverage using instrumental variables in Table 2.8. A valid instrument in my study is a variable that affects the decision of outsourcing, but has no impact on firm leverage. I use distance to the closest seaport as a primary instrumental variable. The distance to the closest seaport proxies for the firm's feasibility to purchase products from foreign suppliers by water transportation. Assuming a large number of U.S. manufacturing firms hire foreign suppliers, distance to international entry ports is an important factor to the firm's decision to offshore production. The details on the instrumental variables are provided in Chapter 3.

[INSERT TABLE 2.8 HERE]

In Table 2.8, I alternately estimate OLS and IV regressions, and find the results did not change between the two estimation methods. I control for year, and industry in each four-digit SIC code. The estimates show that the industry-adjusted market leverage decreases a 7 percentage point when the firm uses outsourcing. Also, higher outsourcing intensity is more likely to lead to lower leverage. An increase of outsourcing intensity by 0.1 is associated with a 0.9 percentage point decrease in firm leverage. These tests include the *PPE/assets* variable to control for the effect of fixed assets on firm leverage. Although fixed assets are likely to explain the relation between outsourcing and leverage, it does not appear to be the sole reason. Therefore, I investigate possible risk-related reasons in the next section.

2.4.4 Outsourcing Firms' Investment

In this section, I test whether outsourcing activity is associated with particular investment styles. I focus on Hypothesis 2.3 and Hypothesis 2.4, and examine differences in investment between high-technology and low-technology outsourcing firms. Table 2.9 presents the results of how outsourcing activity is related to firm R&D investment. I estimate a system of two equations with *PO exists* and *R&D/sales*

as the dependent variables. I drop the *log(1+#patents)* variable for this specification, as the number of patents are possibly too much related to the firm R&D level. In both *PO exists* and *R&D/sales* equations, the high-tech dummy variable shows a significantly positive effect. Then, I estimate the same specification for the two different sub-samples; low-technology and high-technology firms. Only in the high-technology firm sample, age and competition have the same directional effect on both *PO exists* and *R&D/sales*. In the low-technology firm sample, no factor shows the same directional effect. These results are consistent with high-technology firms responding in like manner to the outsourcing and R&D investment decisions. Table 2.10 confirms this using the propensity score matching estimates. I find strong support for Hypothesis 2.3 only in the high-technology firm sample. I do not find evidence that low-technology outsourcing firms also invest more heavily in R&D than non-outsourcing firms.

[INSERT TABLE 2.9 AND 2.10 HERE]

The relation between heavier R&D expenditures and outsourcing is not just driven by the strong relation between the number of patents and the outsourcing likelihood. Firms that have a large number of patents are not necessarily high-technology firms or firms extensively investing in R&D. Patents include a considerable amount of design and concept inventions. In Table 2.3, the number of patents still significantly explains the likelihood of outsourcing in the low-technology firm sample. However, the results in Table 2.9 and Table 2.10 show that low-technology firms' outsourcing activity is irrelevant to the higher R&D expenditures.

I now turn to examining the likelihood of entering new markets. By outsourcing production processes, firms do not need to develop their own manufacturing facilities for a new business. Therefore, they can switch their products or operate an additional business at relatively lower costs than non-outsourcing firms. In Table 2.11, I estimate a system of two equations with *PO exists* and *log(#seg)* as the dependent variables. The high-tech dummy variable shows the significantly opposite effects on *PO exists* and *log(#seg)*. In the high-technology firm sample, the effects of age and competition are also significantly opposite. These results imply that there exists a positive relation between outsourcing and the number of business segments, and this relation appears to be significant only for low-technology outsourcing firms. I confirm this in Table 2.12 using the propensity score matching estimates. High-technology outsourcing firms are more focused, and low-technology outsourcing firms are more likely to add business segments in new industries.

[INSERT TABLE 2.11 AND 2.12 HERE]

Overall, my results on investment are consistent with outsourcing being used by firms to improve their flexibility. With this increased firm flexibility, outsourcing firms invest more heavily in R&D or more likely explore new market opportunities. This tendency in investment may be another important contributing factor for the outsourcing firms' less leverage.

2.5 Conclusion

I use a new dataset of purchase obligations in firm 10-Ks to measure firm-level outsourcing activity. Based on these purchase obligations, I examine what kinds of firms use external contracts to provide a product or service and what are the potential economic reasons for using outsourcing. I also analyze how this outsourcing activity and firm financial attributes are related. Specifically, my analysis focuses on firm capital structure.

I first find that purchase obligations are a valid measure for capturing outsourcing activity, as capital expenditures and the capital intensity of outsourcing firms decrease. I show that a firm is more likely to outsource its production to outside contractors when it is large and young and when its property rights are likely to be enforced through patents. I also show that an industry tends to have more outsourcing firms when it is technology-oriented and when its product market competition and supplier market competition are at high levels.

Outsourcing firms are significantly less leveraged than non-outsourcing firms. I determine whether this finding is solely driven by the fewer fixed assets in outsourcing firms. I find that outsourcing firms' investment may be another important factor that contributes to their having less leverage. My results show that high-technology outsourcing firms invest more heavily in R&D and that low-technology outsourcing firms are more likely to add operating segments in new industries. These findings are consistent with outsourcing being used by firms to improve firm flexibility and these firms investing in product innovation or exploring new market opportunities.

Appendix B

B.1 Collection of Purchase Obligations Data

This appendix describes how I collect the purchase obligations data. I first electronically gather all "10-K"s and "10-K405"s by PERL web crawling[1] to the SEC Edgar database, and searching for the filings from 2004 to 2009. I do not include "10KSB"s and "10KSB40"s, because small business issuers are not required to disclose purchase obligations by the SEC's final rules. Then, using PERL programming I specifically extract purchase obligations data in the MD&A section and other identifying information including the CIK number in each 10-K.

There are two types of reporting practices. First, firms use HTML documents. In this case, purchase obligations are disclosed in tabular formats. Second, firms use TEXT documents. In this case, it is highly likely that the firms disclose purchase obligations also in textual formats. For the HTML groups, I extract all tables first and then sort out the certain tables including search keywords. The search keywords are the combinations of *"purchase"* and one of the following terms: *"obligation" "commitment"*, *"agreement"*, *"order"* and *"contract"*. From the tables including the search terms, I extract the proper rows that contain the amount of purchase obligations. For the TEXT document group, I use page breaks instead

[1] I acknowledge that Andy Leone's Perl resource page at http://sbaleone.bus.miami.edu/PERLCOURSE/Perl_Resources.html provides a useful help to get started Edgar web crawling algorithms using PERL.

of tables. From the pages including the above search terms, I extract the proper sentences that contain information on the amount of purchase obligations.

In case that my extraction process cannot sort out a table or a page containing search terms, I reexamine the whole document and search for another terms including either *"contract obligation"*, or *"contract commitment"*. When the extracted information does not contain *"purchase"* or there still exist no match, I conclude that the firm has no purchase obligations.

The reporting units vary with reporting firms. Therefore, I normalize the units of disclosed purchase obligations in million dollars, by matching other information in the extracted tables or pages with the corresponding COMPUSTAT data item.

B.2 High Technology Industries

SIC Code	Industry Description
Computers and Office Equipment	
3571	Electronic Computers
3572	Computer Storage Devices
3575	Computer Terminals
3577	Computer Peripherals
3578	Calculating and Accounting Machines
3579	Office Machines
Consumer Electronics	
3651	Household Audio and Video Equipment
3652	Phonographic Records and Prerecorded Tapes and Disks
Communications Equipment	
3661	Telephone and Telegraph Apparatus
3663	Radio and TV Broadcast and Communications Equipment
3669	Other Communications Equipment
Electronic Components and Accessories	
3671	Electron Tubes
3672	Printed Circuit Boards
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils, Transformers, and Inductors
3678	Electronic Connectors
3679	Other Electronic Components
Semiconductors	
3674	Semiconductors and Related Devices
Industrial Electronics	
3821	Laboratory Apparatus
3822	Environmental Controls
3823	Process Control Instruments
3824	Fluid Meters and Counting Devices
3825	Instruments to Measure Electricity
3826	Laboratory Analytical Instruments
3829	Other Measuring and Controlling Devices
Photonics	
3827	Optical Instruments and Lenses
3861	Photographic Equipment and Lenses
Defense Electronics	
3812	Search and Navigation Systems, Instruments, and Equipment
Electromedical Equipment	
3844	X-Ray Apparatus and Tubes and Related Irradiation Apparatus
3845	Electromedical and Electrotherapeutic Apparatus

By high-technology, I refer to micro-electronics rather than other technologies. I do not include biotechnology firms in the high-technology industries. Biotechnology is not established yet with its own set of SIC codes, and rather widely spreads over the drugs sector (SIC code=283).

B.3 Variable Definitions

- *PO exists* is the firm-level variable that equals one, if a given firm has disclosed a non-zero amount of purchase obligations at least once during the sample period.

- *PO increases* is one, if the firm increases purchase obligations in comparison to the prior year.

- *PO/sales* is the total amount of purchase obligations disclosed in a firm's 10-K, scaled by sales.

- *PO1year/COGS* is the total amount of purchase obligations due within 1 year, scaled by costs of good sold.

- *POlong/POtot* is the ratio of purchase obligations due more than 1 year to the firm's total amount of purchase obligations.

- *log(sales)* is the log of sales.

- *log(1+age)* is the log of one plus firm age, defined as a given year minus the year when the firm first appeared in Compustat.

- *log(1+#patents)* is the log of one plus the total patent count granted to the firm during the 20 year period from 1985 to 2004.

- *Tobin's Q* is market value of assets divided by book value of assets. Market value of assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest.

- *sales growth* is the percentage growth in sales in a given year.

- *profit/assets* is operating income before depreciation plus interest expenses plus deferred taxes, divided by total assets in the prior year.

- *operating margin* is operating income before depreciation, scaled by sales.

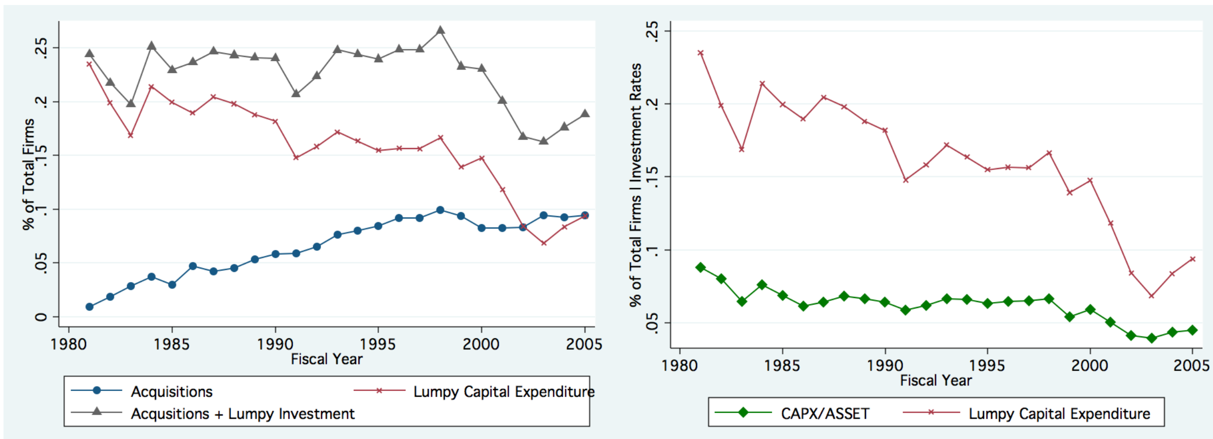
- *SD(profit/assets* is the firm-level standard deviation of *profit/assets*.

- *SD(operating margin* is firm-level the standard deviation of *operating margin*.

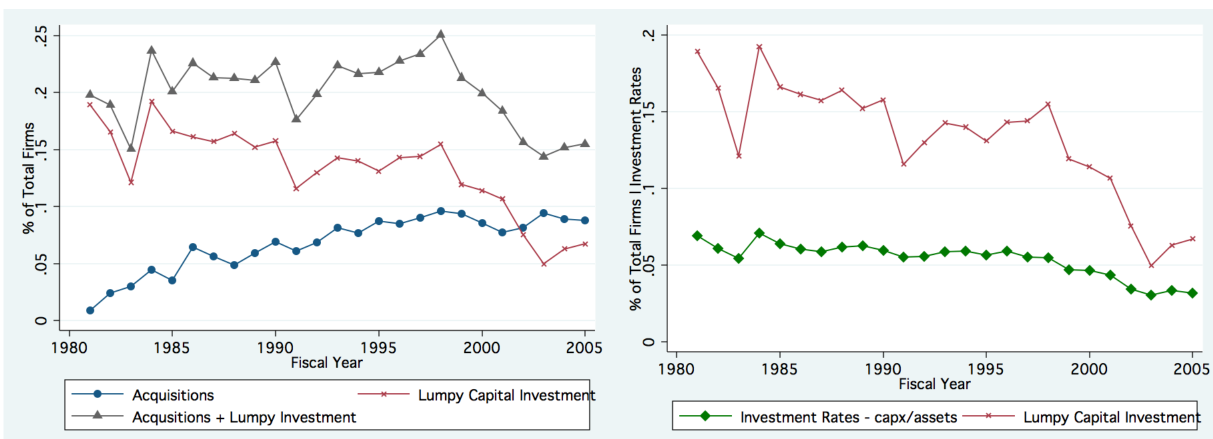
- *fcf/equity* is free cash flow (operating income before depreciation - interest expenses - income tax - dividends on common and preferred stock) divided by book value of equity.

- *cash/assets* is cash and short-term investments, divided by assets.
- *payout/earnings* is cash dividends plus purchase of common and preferred stock, divided by operating income before depreciation.
- *emp/sales* is the number of employees divided by sales. (persons/million dollar)
- *CAPX/assets* is capital expenditures divided by total assets in the prior year.
- *R&D/assets* is R&D expenditures divided by total assets in the prior year.
- *CAPX/sales* is capital expenditures divided by sales in the same year.
- *R&D/sales* is R&D expenditures divided by sales in the same year.
- *PPE/assets* is gross property, plant and equipment divided by total assets in the prior year.
- *long-run* Δ *PPE/assets* and *long-run* Δ *emp/sales* are long-run changes in *PPE/assets* and *emp/sales*. The long-run change is defined as the log of a three-year average from 2001 to 2003, divided by the three-year average from 2007 to 2009.
- *log(#seg)* is the log of the count of a firm's operating segments which appear in different industries at the four-digit SIC code level.
- Δ *seg* is the change in the total number of four-digit SIC code industry segments.
- *firm has a debt rating* is a dummy variable showing whether the firm has a credit rating.
- *firm credit rating* is a numerical score of the Standard & Poors ratings with 1 representing a AAA rating and 22 reflecting a D rating.
- *market leverage* and *book leverage* are the ratio of total debt to the market value and book value of assets, respectively. Market value of assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest.
- *high-tech industry* is a dummy variable indicating the 31 four-digit SIC codes defined as high technology manufacturing industries by TechAmerica organization.

- *ind outside input* is the total value of outside input as a fraction of total value of industry output. This variable is created using the 2002 input-output benchmark table from the Bureau of Economic Analysis.
- *compete (TNIC)* is a measure of product market competitiveness based on the Text-Based Network Industries by Hoberg and Phillips (2011). This is one minus the TNIC Herfindahl index.
- *supplier compete* is one minus the weighted mean of supplier market Herfindahl sales indexes using firms in Compustat.
- *ind PO/sales* is the industry median of *PO/sales*.
- *ind-adj* represents the subtraction by the 4-digit SIC industry median of the variable.
- *hist-adj* represents the subtraction by the three-year median of the variable from 2001 to 2003.
- *macro credit spread* is the spread between the Baa corporate bond yield and the 10 year treasury rate.



(a) U.S. Aggregate



(b) Manufacturing Sector

Figure 2.1: Investment Trend

	Total	Payments Due in Less Than 1 year	Payments Due in 1-3 years	Payments Due in 4-5 years	Payments Due in More Than 5 years
Operating Leases	$ 865	$ 108	$ 211	$ 192	$ 354
Purchase Obligations	1,994	1,994	—	—	—
Asset Retirement Obligations	14	—	2	2	10
Other Obligations	4	4	—	—	—
Total	$ 2,877	$ 2,106	$ 213	$ 194	$ 364

(a) In the Apple Inc.'s 10-K for the fiscal year 2005

	Total	Payments Due in Less Than 1 Year	Payments Due in 1-3 Years	Payments Due in 4-5 Years	Payments Due in More Than 5 Years
Operating leases	$ 1,760	$ 195	$ 409	$ 368	$ 788
Purchase obligations	5,378	5,378	—	—	—
Asset retirement obligations	28	—	8	7	13
Other obligations	471	242	124	105	—
Total	$ 7,637	$ 5,815	$ 541	$ 480	$ 801

(b) In the Apple Inc.'s 10-K for the fiscal year 2008

($ in thousands)	Less than 1 year	1-3 years	3-5 years	After 5 years	Total
Stand-by letters of credit	$ 5,765	$ —	$ —	$ —	$ 5,765
Operating leases (1)	71,306	132,133	119,303	191,911	514,653
Inventory purchase obligations (2)	136,757	—	—	—	136,757
Other purchase obligations (3)	8,578	2,941	1,008	504	13,031
Total contractual cash obligations	$ 222,406	$ 135,074	$ 120,311	$ 192,415	$ 670,206

(c) In the Gymboree Corporation's 10-K for the fiscal period 2008

Figure 2.2: Examples of Purchase Obligations Disclosures

(b) Description of purchase obligations excerpted from the footnotes of the Apple Inc.'s 2008 10-K: "The Company utilizes several contract manufacturers to manufacture sub-assemblies for the Companys products and to perform final assembly and test of finished products. These contract manufacturers acquire components and build product based on demand information supplied by the Company, which typically covers periods ranging from 30 to 150 days. The Company also obtains individual components for its products from a wide variety of individual suppliers. Consistent with industry practice, the Company acquires components through a combination of purchase orders, supplier contracts, and open orders based on projected demand information. Such purchase commitments typically cover the Companys forecasted component and manufacturing requirements for periods ranging from 30 to 150 days. In addition, the Company has an off-balance sheet warranty obligation for products accounted for under subscription accounting pursuant to SOP No. 97-2 whereby the Company recognizes warranty expense as incurred. As of September 27, 2008, the Company had outstanding off-balance sheet third-party manufacturing commitments, component purchase commitments, and estimated warranty commitments of $5.4 billion. During 2006, the Company entered into long-term supply agreements with Hynix Semiconductor, Inc., Intel Corporation, Micron Technology, Inc., Samsung Electronics Co., Ltd., and Toshiba Corporation to secure supply of NAND flash memory through calendar year 2010. As part of these agreements, the Company prepaid $1.25 billion for flash memory components during 2006, which will be applied to certain inventory purchases made over the life of each respective agreement. The Company utilized $567 million of the prepayment as of September 27, 2008."

(c) Description of purchase obligations excerpted from the footnotes of the Gymboree Corporation's 2008 10-K: "Inventory purchase obligations include outstanding purchase orders for merchandise inventories that are enforceable and legally binding on the Company and that specify all significant terms (including fixed or minimum quantities to be purchased), fixed, minimum or variable price provisions, and the approximate timing of the transaction. Other purchase obligations include commitments for information technology and professional services."

Table 2.1: Descriptive Statistics of Outsourcing Activity by Industry

The sample consists of 200 different 4-digit sic code industries in the fiscal year period of 2004-2009. The purchase obligations data are from firm 10-Ks. *PO/sales* is the amount of purchase obligations normalized by sales. *PO/sales* is winsorized at the top and bottom 1 of the distribution. (1) is for the whole sample and (2) is for a sub-sample of firms with non-zero purchase obligations.

							(1) Whole Sample		(2) PO exist=1	
Industry Description	SIC Code	High-tech Firms(%)	Firm Years(#)	Total Firms(#)	Outsourcing Firms(#)	Outsourcing Firms(%)	PO/sales Mean	PO/sales Median	PO/sales Mean	PO/sales Median
Food and kindred products	20	0	379	83	47	0.566	0.086	0.009	0.152	0.089
Tobacco manufactures	21	0	32	7	4	0.571	0.082	0.036	0.144	0.15
Textile mill products	22	0	55	12	7	0.583	0.014	0.005	0.024	0.013
Apparel and other textile products	23	0	166	37	20	0.541	0.061	0.011	0.114	0.105
Lumber and wood products	24	0	78	14	5	0.357	0.012	0	0.033	0.019
Furniture and fixtures	25	0	120	23	11	0.478	0.027	0	0.056	0.031
Paper and allied products	26	0	168	39	29	0.744	0.11	0.069	0.148	0.105
Printing and publishing	27	0	218	48	23	0.479	0.029	0	0.06	0.035
Chemicals and allied products	28	0	1413	306	190	0.621	0.098	0.015	0.156	0.076
Petroleum and coal products	29	0	113	22	17	0.773	0.197	0.046	0.255	0.123
Rubber and miscellaneous plastics products	30	0	156	35	17	0.486	0.039	0	0.081	0.044
Leather and leather products	31	0	97	18	12	0.667	0.067	0.046	0.1	0.103
Stone, clay, glass, and concrete products	32	0	80	16	12	0.75	0.06	0.016	0.08	0.034
Primary metal industries	33	0	245	60	41	0.683	0.162	0.018	0.237	0.112
Fabricated metal products	34	0	274	56	33	0.589	0.054	0.004	0.091	0.028
Industrial machinery and equipment	35	0.267	1084	232	151	0.651	0.052	0.025	0.081	0.064
Electrical and electronic equipment	36	0.77	1669	356	239	0.671	0.065	0.027	0.097	0.072
Transportation equipment	37	0	414	86	42	0.488	0.076	0	0.156	0.071
Instruments and related products	38	0.664	1293	274	163	0.595	0.048	0.011	0.08	0.053
Miscellaneous manufacturing industries	39	0	157	33	15	0.455	0.024	0	0.054	0.029
Total		0.295	8211	1757	1078	0.614	0.07	0.014	0.114	0.067

Table 2.2: Summary Statistics

The sample consists of 1,757 manufacturing firms with 8,211 firm-years in the fiscal year period of 2004-2009. Panel A is the summary statistics of firms with non-zero purchase obligations versus firms with no purchase obligation. Panel B is the summary statistics of firm-years with increasing purchase obligations versus firm-years without an increase. The summary statistics of sub-samples of non high-technology and high-technology firms are in (2) and (3). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A	(1) Whole Sample			(2) Non High-Technology			(3) High-Technology		
	PO exists=1	PO exists=0	Difference	PO exists=1	PO exists=0	Difference	PO exists=1	PO exists=0	Difference
Outsourcing-Related Characteristics									
PO1year/COGS	0.143	0.000	0.143***	0.136	0.000	0.136***	0.158	0.000	0.158***
POlong/POtot	0.166	0.000	0.166***	0.200	0.000	0.200***	0.158	0.000	0.158***
General Firm Characteristics									
log(sales)	6.219	5.167	1.052***	6.491	5.328	1.163***	5.621	4.724	0.897***
log(1+age)	2.507	2.415	0.093*	2.57	2.405	0.165***	2.368	2.44	−0.072
log(1+#patents)	2.631	1.818	0.813***	2.43	1.651	0.778***	3.074	2.277	0.796***
Tobin's Q	1.775	1.68	0.094*	1.734	1.692	0.042	1.864	1.649	0.215**
sales growth	0.135	0.121	0.014	0.134	0.126	0.008	0.137	0.108	0.029
profit/assets	0.081	0.052	0.029***	0.092	0.057	0.034***	0.056	0.035	0.021*
operating margin	0.049	−0.007	0.056***	0.051	−0.014	0.065***	0.044	0.011	0.033
cash/assets	0.236	0.217	0.019*	0.189	0.199	−0.01	0.34	0.267	0.072***
payout/earnings	0.216	0.149	0.067***	0.211	0.153	0.058***	0.228	0.139	0.090***
Investment-Related Firm Characteristics									
emp/sales	4.213	5.601	−1.388***	4.135	5.684	−1.549***	4.386	5.372	−0.986***
CAPX/sales	0.048	0.042	0.006*	0.046	0.046	0	0.052	0.031	0.021***
R&D/sales	0.098	0.092	0.006	0.077	0.084	−0.007	0.146	0.116	0.030***
PPE/assets	0.468	0.457	0.01	0.517	0.496	0.02	0.361	0.352	0.01
long-run Δ PPE/assets	−0.065	−0.111	0.046	−0.067	−0.122	0.056	−0.062	−0.084	0.021
long-run Δ emp/sales	−0.336	−0.362	0.026	−0.368	−0.387	0.019	−0.264	−0.3	0.037
Leverage-Related Firm Characteristics									
market leverage	0.163	0.186	−0.024***	0.191	0.21	−0.019	0.099	0.122	−0.022*
book leverage	0.185	0.2	−0.015*	0.215	0.225	−0.011	0.118	0.131	−0.012
market leverage ind-adj	0.039	0.06	−0.022***	0.032	0.059	−0.027***	0.054	0.065	−0.011
book leverage ind-adj	0.045	0.057	−0.012	0.036	0.054	−0.017*	0.065	0.066	−0.001
market leverage hist-adj	−0.026	−0.018	−0.007	−0.035	−0.025	−0.011	−0.005	−0.002	−0.003
book leverage hist-adj	−0.02	−0.005	−0.015*	−0.026	−0.01	−0.016*	−0.006	0.008	−0.015
Industry Characteristics									
high-tech industry	0.313	0.267	0.046**	0	0	0	1	1	0
ind outside input	0.615	0.609	0.006	0.616	0.602	0.014**	0.612	0.628	−0.016**
compete (TNIC)	0.76	0.695	0.065***	0.737	0.683	0.054***	0.811	0.726	0.085***
supplier compete	0.611	0.596	0.015***	0.593	0.577	0.016***	0.649	0.647	0.002
Observations	1078	679		741	498		337	181	

Panel B	(1) Whole Sample			(2) Non High-Technology			(3) High-Technology		
	PO increases=1	PO increases=0	Difference	PO increases=1	PO increases=0	Difference	PO increases=1	PO increases=0	Difference
Outsourcing-Related Characteristics									
PO1year/COGS	0.198	0.094	0.104***	0.189	0.092	0.097***	0.219	0.099	0.119***
POlong/POtot	0.193	0.150	0.043***	0.228	0.180	0.048***	0.114	0.078	0.036***
General Firm Characteristics									
log(sales)	6.517	6.211	0.306***	6.815	6.46	0.355***	5.877	5.656	0.220**
log(1+age)	2.749	2.601	0.149***	2.843	2.665	0.178***	2.548	2.457	0.091*
log(1+#patents)	2.968	2.678	0.291***	2.838	2.474	0.364***	3.249	3.131	0.117
Tobin's Q	1.817	1.61	0.208***	1.776	1.599	0.177***	1.907	1.633	0.274***
sales growth	0.141	0.059	0.082***	0.14	0.059	0.081***	0.142	0.057	0.085***
profit/assets	0.092	0.07	0.022***	0.102	0.079	0.023***	0.07	0.051	0.019***
operating margin	0.072	0.039	0.033***	0.075	0.036	0.040***	0.066	0.048	0.018
cash/assets	0.234	0.23	0.004	0.187	0.185	0.002	0.335	0.332	0.003
payout/earnings	0.241	0.237	0.004	0.236	0.222	0.014	0.252	0.271	−0.019
Investment-Related Firm Characteristics									
emp/sales	3.995	4.180	−0.185*	3.835	4.070	−0.235**	4.341	4.425	−0.084
CAPX/sales	0.048	0.048	0	0.044	0.045	−0.001	0.056	0.052	0.003
R&D/sales	0.099	0.096	0.002	0.08	0.075	0.005	0.139	0.144	−0.005
PPE/assets	0.462	0.47	−0.009	0.513	0.516	−0.003	0.351	0.368	−0.017
long-run Δ PPE/assets	−0.099	−0.041	−0.059***	−0.085	−0.049	−0.036*	−0.132	−0.022	−0.110***
long-run Δ emp/sales	−0.366	−0.313	−0.054***	−0.403	−0.339	−0.064***	−0.283	−0.254	−0.029
Leverage-Related Firm Characteristics									
market leverage	0.146	0.18	−0.034***	0.171	0.207	−0.036***	0.093	0.12	−0.027***
book leverage	0.178	0.187	−0.009	0.206	0.216	−0.01	0.117	0.121	−0.005
market leverage ind-adj	0.026	0.045	−0.019***	0.017	0.035	−0.018***	0.046	0.068	−0.023***
book leverage ind-adj	0.039	0.044	−0.004	0.029	0.034	−0.004	0.061	0.065	−0.005
market leverage hist-adj	−0.037	−0.01	−0.026***	−0.048	−0.019	−0.029***	−0.011	0.009	−0.020**
book leverage hist-adj	−0.029	−0.018	−0.011**	−0.035	−0.024	−0.011*	−0.015	−0.005	−0.01
Industry Characteristics									
high-tech industry	0.318	0.31	0.008	0	0	0	1	1	0
ind outside input	0.612	0.614	−0.002	0.613	0.617	−0.004	0.610	0.608	0.002
compete (TNIC)	0.771	0.752	0.019***	0.75	0.723	0.027***	0.816	0.816	0
supplier compete	0.609	0.601	0.008***	0.593	0.582	0.011***	0.642	0.641	0.001
Observations	2022	2380		1380	1643		642	737	

Table 2.3: Determinants of PO existence / PO increase

The table displays the marginal effects of probit regressions. In Panel A, the dependent variable, *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. The regression (4) and (5) are for the sub-samples of non high-technology and high-technology firms. (6) of Panel A estimates a Tobit regression of *PO/sales* with the industry-fixed effects. In Panel B, the sample only includes the firms with purchase obligations. The dependent variable, *PO increases* is a firm-year level variable that equals one, if the firm increases purchase obligations. (5) of Panel B estimates a regression of *PO/sales* with the firm-fixed effects. The sample consists of firm-years with available data in the period of 2004-2009. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level (unless they are for between-regressions). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A	Whole Sample			Non High-Tech	High-tech	Whole Sample
	(1) PO exists	(2) PO exists	(3) PO exists	(4) PO exists	(5) PO exists	(6) PO/sales
log(sales)	0.203***	0.218***	0.207***	0.206***	0.204***	0.0239***
	(8.98)	(9.87)	(9.14)	(7.94)	(4.42)	(6.92)
log(1+#patents)	0.0493**	0.0497**	0.0475**	0.0401*	0.0518	0.00566**
	(2.52)	(2.55)	(2.42)	(1.75)	(1.34)	(2.01)
log(1+age)	-0.100**	-0.107***	-0.102**	-0.0680	-0.152*	-0.0138**
	(-2.44)	(-2.75)	(-2.46)	(-1.41)	(-1.85)	(-2.38)
Tobin's Q	0.0633*	0.0562*	0.0544	0.0507	0.0786	0.00145
	(1.86)	(1.69)	(1.59)	(1.28)	(1.11)	(0.29)
sales growth	0.147	0.104	0.109	0.0958	0.187	0.123***
	(1.04)	(0.77)	(0.76)	(0.56)	(0.70)	(3.72)
high-tech industry	0.204***	0.178**	0.149*			
	(2.66)	(2.22)	(1.83)			
ind outside input	-0.0716	-0.188	-0.0977	0.219	-1.537	
	(-0.20)	(-0.52)	(-0.26)	(0.53)	(-1.53)	
compete (TNIC)	0.406***		0.335**	0.156	0.676**	
	(2.77)		(2.24)	(0.90)	(2.07)	
supplier compete		1.361***	0.968**	1.236**	1.925	
		(3.03)	(2.05)	(2.39)	(1.17)	
Observations	1638	1697	1638	1147	491	1703
Pseudo R^2	0.079	0.081	0.081	0.079	0.096	1.244
Between Effects	YES	YES	YES	YES	YES	YES
Industry Fixed Effect	NO	NO	NO	NO	NO	YES

Panel B	PO exist=1		Non High-Tech	High-tech	PO exist=1
	(1) PO increases	(2) PO increases	(3) PO increases	(4) PO increases	(5) PO/sales
log(sales)	0.0664***	0.0677***	0.0741***	0.0429*	-0.0474**
	(5.03)	(5.07)	(4.55)	(1.80)	(-2.36)
log(1+#patents)	-0.00365	-0.00328	0.00207	-0.00939	
	(-0.34)	(-0.30)	(0.16)	(-0.47)	
log(1+age)	-0.00525	-0.00194	-0.00874	-0.00144	0.0169
	(-0.17)	(-0.06)	(-0.24)	(-0.03)	(0.77)
Tobin's Q	0.0809***	0.0801***	0.0598**	0.135***	0.00726
	(3.76)	(3.73)	(2.24)	(3.70)	(1.50)
sales growth	0.379***	0.374***	0.376***	0.348***	0.0145
	(5.33)	(5.24)	(4.29)	(2.82)	(1.07)
high-tech industry	0.0571	0.0475			
	(1.21)	(0.97)			
compete (TNIC)	0.0648	0.0402	0.0757	-0.0718	0.00166
	(0.73)	(0.44)	(0.70)	(-0.39)	(0.10)
supplier compete		0.183	0.277	-0.0746	-0.211
		(0.65)	(0.92)	(-0.08)	(-1.38)
ind PO/sales, lagged	-0.469	-0.457	-0.488	-0.731	0.0948
	(-1.50)	(-1.42)	(-1.44)	(-0.55)	(1.26)
macro credit spread	-0.0994***	-0.0972***	-0.124***	-0.0345	-0.00215
	(-5.11)	(-4.88)	(-5.17)	(-0.89)	(-0.70)
Observations	4044	4012	2757	1255	4012
Pseudo R^2	0.027	0.027	0.030	0.027	0.702
Firm Fixed Effect	NO	NO	NO	NO	YES

Table 2.4: PO Exists and Capital Expenditures

The table presents the estimated relations between PO existence and capital expenditures using seemingly unrelated regressions with the identical regressors. The two dependent variables are *PO exists* and *CAPX/sales*. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. *CAPX/sales* is capital expenditures divided by total sales in the same year. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. *Rho* refers to the correlation of the residuals in the two equations. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level (unless they are for between-regressions). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1)		(2)		(3)	
	PO exists	CAPX/sales	PO exists	CAPX/sales	PO exists	CAPX/sales
log(sales)	0.0708***	-0.00289**	0.198***	-0.00290***	0.218***	-0.00254**
	(10.04)	(-2.18)	(10.16)	(-3.25)	(9.34)	(-2.41)
log(1+age)	-0.0376***	-0.00820***	-0.116***	-0.00741***	-0.115**	-0.00606***
	(-2.58)	(-3.74)	(-2.79)	(-4.38)	(-2.54)	(-3.44)
log(1+#patents)	0.0156**	0.00423***	0.0510***	0.00371***	0.0534***	0.00402***
	(2.49)	(3.87)	(2.96)	(5.09)	(2.61)	(4.80)
Tobin's Q	0.0232**	0.00355*	0.0310	0.00506***	0.0154	0.00379***
	(2.00)	(1.78)	(1.40)	(5.59)	(0.65)	(3.80)
sales growth	0.0510	0.0672**	0.0174	0.0114*	-0.0420	0.00913
	(1.03)	(2.52)	(0.32)	(1.89)	(-0.74)	(1.47)
compete (TNIC)	0.149***	-0.00214	0.335***	0.00434	0.180	-0.0151*
	(2.80)	(-0.25)	(2.90)	(0.75)	(1.32)	(-1.76)
high-tech industry	0.0696***	-0.00781*	0.166**	-0.00693*	-0.420	0.0670***
	(2.64)	(-1.76)	(2.34)	(-1.90)	(-0.59)	(9.40)
Rho	0.0540**		0.0656***		0.0659***	
	(2.27)		(2.61)		(2.64)	
Observations	1644		7629		7629	
Log Likelihood	1147.6		4808.7		5739.3	
Chi-squared	213.2		208.7		.	
p-value	< 1%		< 1%		< 1%	
Between Effects	YES		NO		NO	
Year Fixed Effects	NO		YES		YES	
Industry Fixed Effects	NO		NO		YES	

	SIZE	AGE	# PATENTS	TOBIN'S Q	SALES GROWTH	COMPETITION	HIGH-TECH
PO Exists	+	−		+		+	+
CAPX/sales	−	−	+	+	+	−	−

Table 2.5: PO Exists and Capital Intensity

The table presents the estimated relations between PO existence and capital intensity using seemingly unrelated regressions with the identical regressors. The two dependent variables are *PO exists* and *PPE/assets*. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. *PPE/assets* is gross property, plant and equipment divided by total assets in the prior year. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. *Rho* refers to the correlation of the residuals in the two equations. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level (unless they are for between-regressions). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1)		(2)		(3)	
	PO exists	PPE/assets	PO exists	PPE/assets	PO exists	PPE/assets
log(sales)	0.203***	0.0248***	0.198***	0.0214***	0.218***	-0.00506
	(9.27)	(5.26)	(10.17)	(4.49)	(9.34)	(-1.15)
log(1+age)	-0.102**	0.0617***	-0.116***	0.0680***	-0.115**	0.0478***
	(-2.47)	(6.48)	(-2.78)	(6.47)	(-2.53)	(5.39)
log(1+#patents)	0.0502***	-0.0135***	0.0510***	-0.0105**	0.0533***	0.00830**
	(2.61)	(-3.18)	(2.96)	(-2.35)	(2.61)	(2.02)
Tobin's Q	0.0645*	-0.0409***	0.0311	-0.0310***	0.0161	-0.00796*
	(1.91)	(-5.78)	(1.41)	(-6.30)	(0.67)	(-1.76)
sales growth	0.149	-0.0233	0.0168	0.0174	-0.0439	0.0299***
	(1.05)	(-0.61)	(0.31)	(1.22)	(-0.79)	(2.69)
compete (TNIC)	0.405***	-0.0952***	0.336***	-0.114***	0.182	-0.0931***
	(2.77)	(-2.84)	(2.91)	(-3.84)	(1.35)	(-3.22)
high-tech industry	0.199***	-0.103***	0.165**	-0.107***	-0.420	0.0386
	(2.62)	(-6.60)	(2.33)	(-6.66)	(-0.59)	(1.05)
Rho	0.0232		0.00660		-0.00632	
	(0.72)		(0.23)		(-0.22)	
Observations	1644		7629		7629	
Log Likelihood	-1352.9		-6789.5		-4379.6	
Chi-squared	146.9		208.6		.	
p-value	< 1%		< 1%		< 1%	
Between Effects	YES		NO		NO	
Year Fixed Effects	NO		YES		YES	
Industry Fixed Effects	NO		NO		YES	

	SIZE	AGE	# PATENTS	TOBIN'S Q	SALES GROWTH	COMPETITION	HIGH-TECH
PO Exists	+	−	+	+		+	+
PPE/assets	+	+	−	−		−	−

Table 2.6: PO Exists and Leverage

The table presents the estimated relations between PO existence and market leverage using seemingly unrelated regressions with the identical regressors. The two dependent variables are *PO exists* and *market leverage*. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. *market leverage* is the ratio of total debt to the market value of assets. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. *Rho* refers to the correlation of the residuals in the two equations. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level (unless they are for between-regressions). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1)		(2)		(3)	
	PO exists	market leverage	PO exists	market leverage	PO exists	market leverage
log(sales)	0.204***	0.0229***	0.198***	0.0230***	0.218***	0.0177***
	(9.26)	(8.90)	(10.16)	(9.72)	(9.29)	(7.12)
log(1+age)	-0.102**	-0.0166***	-0.116***	-0.0113**	-0.113**	-0.0141***
	(-2.48)	(-3.00)	(-2.79)	(-2.09)	(-2.49)	(-2.64)
log(1+#patents)	0.0499***	-0.00991***	0.0507***	-0.0101***	0.0537***	-0.00794***
	(2.59)	(-4.63)	(2.95)	(-4.85)	(2.63)	(-3.60)
Tobin's Q	0.0658**	-0.0595***	0.0317	-0.0491***	0.0177	-0.0431***
	(1.97)	(-12.09)	(1.43)	(-17.12)	(0.74)	(-15.39)
sales growth	0.146	0.0168	0.0172	-0.00240	-0.0440	0.000464
	(1.05)	(0.77)	(0.31)	(-0.30)	(-0.79)	(0.07)
compete (TNIC)	0.404***	-0.0764***	0.336***	-0.0679***	0.179	-0.0253
	(2.76)	(-3.80)	(2.91)	(-4.46)	(1.33)	(-1.56)
high-tech industry	0.198***	-0.0604***	0.165**	-0.0547***	-0.429	-0.114***
	(2.61)	(-7.26)	(2.33)	(-6.90)	(-0.61)	(-3.50)
Rho	-0.102***		-0.0911***		-0.110***	
	(-3.19)		(-3.58)		(-4.21)	
Observations	1644		7629		7629	
Log Likelihood	-306.9		-2184.5		-901.8	
Chi-squared	146.4		208.1		.	
p-value	< 1%		< 1%		< 1%	
Between Effects	YES		NO		NO	
Year Fixed Effects	NO		YES		YES	
Industry Fixed Effects	NO		NO		YES	

	SIZE	AGE	# PATENTS	TOBIN'S Q	SALES GROWTH	COMPETITION	HIGH-TECH
PO Exists	+	−	+	+		+	+
market leverage	+	−	−	−		−	−

Table 2.7: Propensity Score Based Effect of Outsourcing on Leverage

The table presents the effects of outsourcing on leverage. The probit regressions of *PO exists* on matching variables, *log(sales)*, *log(1+age)*, *log(1+#patents)*, *Tobin's Q*, *operating margin*, *PPE/assets*, *high-tech industry* estimate outsourcing propensity. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. The control observations are the 10 nearest neighbors across the matching variables with the exact SIC code or the code as close as possible. The variable of interest is *market leverage* or *book leverage*, which is the ratio of total debt to the market value or book value of assets. Market value of total assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest. *ind-adj* represents the subtraction by the 4-digit SIC industry median of the variable. Other variables are defined in Appendix. Results are robust to using different numbers of control observations. The sample consists of firm-years with available data in the period of 2004-2009. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A: Whole Sample

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	market leverage - industry adjusted				
2004-2009 (*unadjusted*)	−0.024***	0.009	-2.824	0.005	1706
2004-2009	−0.030***	0.008	-3.797	0.000	1706
2004	−0.005	0.008	-0.561	0.575	1378
2005	−0.006	0.008	-0.739	0.460	1349
2006	−0.020**	0.008	-2.549	0.011	1321
2007	−0.032***	0.009	-3.405	0.001	1293
2008	−0.045***	0.013	-3.413	0.001	1285
2009	−0.032***	0.010	-3.122	0.002	1227

Panel B: Whole Sample

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	book leverage - industry adjusted				
2004-2009 (*unadjusted*)	−0.015	0.009	-1.605	0.109	1706
2004-2009	−0.018**	0.009	-2.108	0.035	1706
2004	0.001	0.010	0.069	0.945	1378
2005	0.006	0.009	0.650	0.516	1349
2006	−0.008	0.010	-0.793	0.428	1321
2007	−0.020*	0.011	-1.931	0.054	1293
2008	−0.021*	0.011	-1.877	0.061	1285
2009	−0.019*	0.010	-1.869	0.062	1227

Table 2.8: Outsourcing and Leverage in IV Estimation

The table presents the effects of outsourcing existence (*PO ever exists*) and outsourcing intensity (*PO1year/COGS*) on firm leverage. The dependent variable is *market leverage*, which is the ratio of total debt to the market value of assets. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. Year and industry (in each four-digit SIC code) fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	Dependent variable: market leverage					
PO ever exists	-0.0204**	-0.0316***	-0.0701***			
	(-2.27)	(-3.51)	(-3.44)			
PO1year/COGS				-0.0604***	-0.0502***	-0.0896***
				(-3.73)	(-2.92)	(-3.30)
log(sales)		0.0183***	0.0209***		0.0167***	0.0174***
		(7.34)	(7.06)		(6.83)	(6.67)
log(1+age)		-0.0240***	-0.0253***		-0.0225***	-0.0222***
		(-4.39)	(-4.18)		(-4.10)	(-3.75)
Tobin's Q		-0.0445***	-0.0446***		-0.0445***	-0.0448***
		(-16.62)	(-14.95)		(-16.47)	(-14.83)
operating margin		-0.0333***	-0.0324***		-0.0318***	-0.0294***
		(-5.08)	(-4.09)		(-4.91)	(-3.95)
sales growth		-0.000605	-0.0000166		0.00126	0.00290
		(-0.09)	(-0.00)		(0.20)	(0.40)
PPE/assets		0.0450***	0.0523***		0.0443***	0.0508***
		(2.87)	(3.01)		(2.83)	(2.95)
compete (TNIC)		-0.0357**	-0.0359*		-0.0355**	-0.0362*
		(-2.11)	(-1.87)		(-2.08)	(-1.86)
supplier compete		-0.000399	-0.0000625		-0.0000204	0.000709
		(-0.05)	(-0.01)		(-0.00)	(0.09)
Observations	9248	7627	6191	9219	7627	6191
Adjusted R^2	0.257	0.339	0.333	0.258	0.337	0.336
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Estimation Method	OLS	OLS	IV	OLS	OLS	IV

Table 2.9: PO Exists and R&D Expenditures

The table presents the estimated relations between PO existence and R&D expenditures using seemingly unrelated regressions with the identical regressors. The two dependent variables are *PO exists* and *R&D/sales*. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. *R&D/sales* is R&D expenditures divided by sales in the same year. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. *Rho* refers to the correlation of the residuals in the two equations. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level (unless they are for between-regressions). ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1)		(2)		(3) Non High-Tech		(4) High-Tech	
	PO exists	R&D/sales	PO exists	R&D/sales	PO exists	R&D/sales	PO exists	R&D/sales
log(sales)	0.223***	-0.0277***	0.246***	-0.0194***	0.249***	-0.0215***	0.235***	-0.0142***
	(10.67)	(-13.95)	(11.55)	(-11.37)	(9.56)	(-10.13)	(6.24)	(-5.13)
log(1+age)	-0.0641*	-0.00258	-0.0767*	-0.00569*	-0.0182	0.00165	-0.197**	-0.0235***
	(-1.68)	(-0.86)	(-1.80)	(-1.90)	(-0.36)	(0.49)	(-2.47)	(-4.04)
Tobin's Q	0.0786**	0.0297***	0.0238	0.0110***	0.0185	0.0120***	0.0305	0.00913**
	(2.37)	(8.04)	(1.00)	(4.32)	(0.66)	(3.67)	(0.67)	(2.38)
sales growth	0.134	0.0527***	-0.0547	0.00220	-0.0982	0.0145**	0.0753	-0.0325***
	(0.96)	(2.62)	(-0.99)	(0.34)	(-1.54)	(1.97)	(0.68)	(-2.58)
compete (TNIC)	0.434***	0.202***	0.197	0.0984***	0.0678	0.0932***	0.492**	0.104***
	(2.96)	(15.73)	(1.45)	(10.56)	(0.42)	(8.15)	(1.99)	(6.37)
high-tech industry	0.248***	0.0204***	-0.605	-0.0210				
	(3.38)	(3.06)	(-0.69)	(-1.58)				
Rho	0.0829***		0.0752***		0.0652**		0.0933*	
	(2.59)		(2.83)		(2.06)		(1.88)	
Observations	1644		7629		5345		2284	
Between Effects	YES		NO		NO		NO	
Industry-Year Fixed Effects	NO		YES		YES		YES	

		SIZE	AGE	TOBIN'S Q	SALES GROWTH	COMPETITION	HIGH-TECH
Whole Sample	PO Exists	+	−	+		+	+
	R&D/sales	−		+	+	+	+
Non High-Tech	PO Exists	+					
	R&D/sales	−		+	+	+	
High-Tech	PO Exists	+	−			+	
	R&D/sales	−	−	+	−	+	

Table 2.10: Propensity Score Based Effect of Outsourcing on R&D

The table presents the effects of outsourcing on R&D expenditures. The probit regressions of *PO exists* on matching variables, *log(sales)*, *log(1+age)*, *Tobin's Q*, *operating margin* estimate outsourcing propensity. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. The control observations are the 10 nearest neighbors across the matching variables with the exact SIC code or the code as close as possible. The variable of interest is *R&D/sales - industry adjusted*, which is the industry adjusted R&D expenditures divided by sales in the same year. *ind-adj* represents the subtraction by the 4-digit SIC industry median of the variable. Other variables are defined in Appendix. Results are robust to using different numbers of control observations. The sample consists of firm-years with available data in the period of 2004-2009. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A: Non High-Technology Industries

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	R&D/sales - industry adjusted				
2004-2009	0.006	0.005	1.374	0.169	1236
2004	0.003	0.006	0.561	0.575	992
2005	0.006	0.006	0.949	0.343	976
2006	0.008	0.006	1.263	0.207	979
2007	0.003	0.007	0.495	0.621	945
2008	0.007	0.006	1.111	0.267	927
2009	−0.000	0.007	-0.013	0.990	903

Panel B: High-Technology Industries

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	R&D/sales - industry adjusted				
2004-2009	0.017*	0.010	1.692	0.091	518
2004	0.002	0.012	0.186	0.853	431
2005	0.016	0.011	1.518	0.129	421
2006	0.014	0.010	1.364	0.173	404
2007	0.024**	0.011	2.107	0.035	408
2008	0.037***	0.011	3.287	0.001	391
2009	0.027**	0.012	2.262	0.024	369

Table 2.11: PO Exists and Operating Segments

The table presents the estimated relations between PO existence and the number of operating segments using seemingly unrelated regressions with the identical regressors. The two dependent variables are *PO exists* and *log(#seg)*. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. *log(#seg)* is the log of a total count of the operating segments which appear in different industries at the four-digit sic code level. Other variables are defined in Appendix. The sample consists of firm-years with available data in the period of 2004-2009. *Rho* refers to the correlation of the residuals in the two equations.

	(1)		(2)		(3) Non High-Tech		(4) High-Tech	
	PO exists	log(#seg)	PO exists	log(#seg)	PO exists	log(#seg)	PO exists	log(#seg)
log(sales)	0.203***	0.0893***	0.218***	0.0746***	0.219***	0.0688***	0.215***	0.0859***
	(9.26)	(13.50)	(9.33)	(9.87)	(7.73)	(7.53)	(5.07)	(6.63)
log(1+age)	-0.101**	0.112***	-0.115**	0.115***	-0.0653	0.128***	-0.221***	0.0728***
	(-2.47)	(9.74)	(-2.53)	(8.25)	(-1.21)	(7.31)	(-2.59)	(3.36)
log(1+#patents)	0.0500***	-0.000833	0.0531***	0.00274	0.0642**	0.0109	0.0325	-0.0142
	(2.60)	(-0.13)	(2.60)	(0.38)	(2.53)	(1.31)	(0.93)	(-1.05)
Tobin's Q	0.0648*	-0.0339***	0.0161	-0.0189***	0.00733	-0.0236***	0.0286	-0.0115
	(1.92)	(-4.25)	(0.67)	(-2.91)	(0.26)	(-2.96)	(0.62)	(-1.05)
sales growth	0.149	0.0334	-0.0438	0.0183	-0.0865	0.0222	0.0858	-0.00352
	(1.05)	(1.12)	(-0.79)	(1.44)	(-1.34)	(1.47)	(0.78)	(-0.15)
compete (TNIC)	0.406***	-0.176***	0.182	-0.0723	0.0604	0.00368	0.476*	-0.296***
	(2.77)	(-3.66)	(1.35)	(-1.47)	(0.37)	(0.07)	(1.94)	(-2.94)
high-tech industry	0.200***	-0.0760***	-0.420	-0.290				
	(2.63)	(-3.61)	(-0.59)	(-1.31)				
Rho	-0.0672*		-0.0399		-0.00511		-0.144**	
	(-1.95)		(-1.26)		(-0.13)		(-2.54)	
Observations	1644		7629		5345		2284	
Between Effects	YES		NO		NO		NO	
Industry-Year Fixed Effects	NO		YES		YES		YES	

		SIZE	AGE	# PATENTS	TOBIN'S Q	SALES GROWTH	COMPETITION	HIGH-TECH
Whole Sample	PO Exists	+	−	+	+		+	+
	log(#seg)	+	+		−		−	−
Non High-Tech	PO Exists	+		+				
	log(#seg)	+	+		−			
High-Tech	PO Exists	+	−				+	
	log(#seg)	+	+				−	

Table 2.12: Propensity Score Based Effect of Outsourcing on the Number of Segments

The table presents the effects of outsourcing on the number of business segments. The probit regressions of *PO exists* on matching variables, *log(sales)*, *log(1+age)*, *log(1+#patents)*, *Tobin's Q*, *operating margin* estimate outsourcing propensity. *PO exists* is a firm-level variable that equals one, if the firm has disclosed a non-zero amount of purchase obligations at least once during the sample period. The control observations are the 10 nearest neighbors across the matching variables with the exact SIC code or the code as close as possible. The variable of interest is *log(#seg)*, which is the log of a total count of the operating segments which appear in different industries at the four-digit sic code level. Δ *seg* is the change in the total number of four-digit SIC code industry segments. Other variables are defined in Appendix. Results are robust to using different numbers of control observations. The sample consists of firm-years with available data in the period of 2004-2009. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A: Non High-Technology Industries

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	log(#seg)				
2004-2009 (Δ *seg*)	0.034***	0.012	2.838	0.005	1086
2004-2009	0.039	0.026	1.503	0.133	1101
2004	0.046	0.031	1.481	0.139	858
2005	0.073**	0.031	2.366	0.018	839
2006	0.075**	0.031	2.401	0.016	832
2007	0.084**	0.033	2.570	0.010	805
2008	0.068**	0.032	2.090	0.037	786
2009	0.063*	0.036	1.756	0.079	687

Panel B: High-Technology Industries

Year	[Outsourcing - Non outsourcing]	Std. Err.	z	P>z	N
	log(#seg)				
2004-2009 (Δ *seg*)	0.016	0.015	1.036	0.300	451
2004-2009	−0.053*	0.032	-1.651	0.099	459
2004	−0.043	0.037	-1.139	0.255	360
2005	−0.065*	0.038	-1.693	0.090	347
2006	−0.094**	0.037	-2.506	0.012	333
2007	−0.042	0.038	-1.091	0.275	340
2008	−0.045	0.040	-1.115	0.265	318
2009	−0.016	0.046	-0.347	0.729	262

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Chapter 3

Firm Risk Taking versus CEO Diversification: Evidence from Outsourcing Firms

3.1 Introduction

I examine CEO compensation of outsourcing firms, using a new dataset of purchase obligations from firm 10-Ks. I first document two stylized facts: 1. CEOs in outsourcing firms receive significantly higher compensation than do CEOs in non-outsourcing firms (50% more in total compensation on average[1]). 2. The use of equity-based compensation in outsourcing firms is greater than in non-outsourcing firms by 5% on average. Can this relatively high compensation in outsourcing firms be justified? Is this rise in CEO compensation related to the greater use of equity-based compensation? This paper attempts to address these questions.

[INSERT FIGURE 3.1 HERE]

Outsourcing firm compensation policies are interesting to examine, particularly because firm risk-taking incentives and CEO diversification incentives coexist in outsourcing firms. Such a tension between the two different incentives of the firm and its CEO creates an optimal trade-off in the use of equity-based compensation.

[1]See Figure 3.1 for the average CEO pay in outsourcing vs. non-outsourcing firms from 2004 to 2010.

A firm's investment is influenced by many factors such as the firm's financial constraints, product market competition, and operating overhead. With these constraints, the firm cannot fully exert its efforts in long-term projects such as R&D. Moon (2011) shows that outsourcing increases firm flexibility. The firm flexibility refers to the ability of a firm to adjust its factors of operation in response to product market changes. Based on this flexibility, outsourcing firms would have greater risk tolerance and capacity in investment spendings. Therefore, outsourcing firms can invest more heavily in R&D than non-outsourcing firms. However, even in outsourcing firms, the highly uncertain and long-term nature of R&D projects lead to agency problems, which may result in suboptimal R&D investment (Jensen 1986; Ryan and Wiggins III 2002). For example, managers could pass up risk-increasing positive net present value R&D projects that would be beneficial to shareholders, because their human capital tied up to the firm value (Amihud and Lev 1981; Smith and Stulz 1985). Therefore, to incentivize their managers to invest optimally in R&D, outsourcing firm shareholders are more likely to rely on equity-based compensation.

At the same time, outsourcing has a negative effect on the use of equity-based compensation as well. Outsourcing activity inevitably increases risks of the firm. For example, outsourcing firms are exposed to international risks and supplier firm-specific risks by using other firms' products or services. Also, with heavier R&D investment, they may bear more risks in the outcomes of their R&D projects than do non-outsourcing firms. Most of these risks are firm-specific, and shareholders of the firm can diversify away these risks. However, firm-specific risk is not completely diversifiable for the firm's manager whose personal wealth ties up in the firm with especially equity-based compensation. Therefore, outsourcing firms should pay more to their CEOs to additionally compensate for this increased firm-specific risk.

The additional compensation equals to the deadweight loss incurred when managers value the equity-based compensation at less than the price at which firms could otherwise issue in the market. The understating of these costs departs from the previous finance and accounting literature on private valuation of executives with the loss of diversification (*e.g.* Hall and Murphy 2000; Jin 2000; Hall and Murphy 2002). This further advances with Meulbroek (2001) who emphasizes that the non-systematic, firm-specific risk as more costly to managers. This paper focuses on this deadweight loss of equity-based compensation in outsourcing firms that have higher firm-specific risk. Jin (2000) finds that firms appear to recognize this trade-off between the benefits and costs of using equity-based compensation, by showing that the pay-performance sensitivity is less as firm-specific risk increases. The level of firm-specific risk is given in the previous studies and yet, there is no study exists about the direct tension between the firm's promoting risk-taking behavior (the more R&D) and the manager's need to diversify the risk. Using a sample of outsourcing firms, this paper examines such a direct tension.

My analyses use a unique dataset of purchase obligations from firm 10-K fillings to measure firm-level outsourcing activity. A purchase obligation is defined as an enforceable and legally binding agreement to purchase goods or services from other companies in the future. Using this measure, my analyses begin by examining the relation between outsourcing intensity and the level of CEO compensation. I find that CEO pay increases with outsourcing intensity, and this increase is most likely from outsourcing firms' greater reliance on equity-based compensation.

Next, I examine whether the outsourcing firms' greater reliance on equity-based compensation arises from their efforts to spur R&D. I control for the fact that R&D investment and outsourcing activity may be endogenous, using the firm's distance to the closest seaport as a primary instrument for outsourcing activity. I find that R&D increases significantly as outsourcing intensity increases. As in Guay (1999) and Coles, Daniel, and Naveen (2006), the two primary characteristics in equity-based compensation that promote risk-taking are the sensitivity of CEO wealth to stock price (delta) and the sensitivity of CEO wealth to stock price volatility (vega). I show that the effectiveness of delta or vega in encouraging higher R&D investment increases in general, as outsourcing intensifies.

I also find that outsourcing increases firm-specific (idiosyncratic) risk. This finding suggests that outsourcing firms compensate their managers more to adjust this additional firm-specific risk. I further examine whether outsourcing firms recognize the significant deadweight loss of granting equity-based compensation, particularly when the managers are severely undiversified and highly risk-averse (for example, CEOs with high delta and low vega). I find that the use of equity-based compensation depends on the extent of managerial diversification and risk-aversion. Outsourcing firms with CEOs having high-delta and low-vega compensation portfolios do not increase their reliance on equity-based compensation as much as outsourcing firms with CEOs having low-delta and high-vega portfolios. Overall, these results suggest that the direct tension between the firm's pursuit of spurring R&D and the manager's need to diversify risks is well revealed in the outsourcing firms as an optimal trade-off of using equity-based compensation.

Related literature looks at the relation between compensation contracts and managerial risk-taking behaviors. First strand of this literature examines why firms increasingly use stock options as opposed to the other forms of incentive-aligned compensation. This literature focuses on the role of convexity features in stock options to mitigate CEO risk-aversion. Guay (1999) finds that convexity of the CEO compensation structure is positively related to firm risk-taking behaviors, such as R&D expenditures and growth opportunities. Coles, Daniel, and Naveen (2006) provides empirical evidence of a strong relation between the convexity in manager compensation and riskier policy choices including R&D investment, the number of lines of business, and leverage. Chava and Purnanandam (2010) further show that the convexity is negatively related to cash balances.

Another strand of literature does not support the view that convexity can increase a manger's incentive to take risks. Ross (2004) shows that there exists no incentive schedule that will make all expected utility maximizers more or less risk averse. Empirically, Lewellen (2006) finds that higher option ownership tends to increase the volatility costs of debt, and thus decrease the manager's preference for debt financing. These are the opposite results to those of Coles, Daniel, and Naveen (2006). Hayes, Lemmon, and Qiu (2011) provides new evidence that the decline in option usage following the accounting rule change (FAS 123R) has no association with corresponding reductions in risky firm policy choices.

This paper makes a contribution to the literature by examining a trade-off between benefits and costs of using equity-based compensation, as outsourcing intensity varies cross-sectionally. I provide unique empirical evidence using an outsourcing firm sample that outsourcing firms realize this trade-off and determine their compensation level and structure based on the optimal trade-off. My results support the view in the first strand of the literature that the use of equity-based compensation plays an important role to induce optimal R&D investment from managers.

This paper is also related to the literature on executive pay rise. The CEO compensation level in large U.S. companies has surged over the past several decades. Previous studies on the literature generally focus on flawed corporate governance and policy issues as possible causes for this pay rise. For example, Core, Holthausen, and Larcker (1999) show empirical evidence that CEOs at firms with weaker governance structure receive greater compensation, and those firms suffer from the greater agency problems and worse performance. Bertrand and Mullainathan (2001) find that CEO pay responds to a lucky dollar, and better governed firms pay their CEOs less for luck. Bebchuk and Fried (2003, 2004) also show how managerial power and influence might lead to substantially inefficient executive compensation. However, recent works argue that the high level and structure of CEO compensation reflects market equilibrium by which firms can motivate and retain their CEOs. Gabaix and Landier (2008) show that the increase in the level of CEO compensation can be fully attributed to the corresponding increase in market capitalization of large companies. Faulkender and Yang (2009) find that firms with highly paid CEOs are more likely to be chosen as members of the peer group, so this increases the level of median pay at the peer group and provides a mechanism for the pay manipulation.

However, the dramatic increases in total compensation are particularly pronounced in the manufacturing and financial services sectors (Faulkender, Kadyrzhanova, Prabhala, and Senbet 2010). Thus far, firm production (outsourcing) decisions and ensuing risk-taking behaviors have never been considered as direct explanation for the executive pay rise. My results assist in understanding why managers in manufacturing firms (that possibly use incasing shares of outsourced production) should be paid higher, by investigating their exposure to additional firm-specific risk.

The rest of this paper is organized as follows. In the next section, I discuss underlying framework of my analyses in outsourcing firms' use of equity-based compensation. Section 3 details purchase obligations data and other data used throughout the paper. Section 4 presents my empirical methodology and the results. Section 5 concludes.

3.2 Conceptual Framework

In this section, I discuss how outsourcing firms determine their optimal proportion of equity-based compensation in the total compensation package. The framework in this discussion is based on two theories in executive compensation. First, the higher sensitivity to stock price (volatility) in the managerial compensation scheme gives the manager incentives to invest in riskier assets (Guay 1999). Second, managers with incomplete diversification privately value equity-based compensation at less than the market value (Jin 2000; Meulbroek 2001; Hall and Murphy 2002). Therefore, the firm's costs of equity-based compensation depend on the private valuation of the manager. Outsourcing firms are relevant examples to test these theories, in that both the benefits and costs of using equity-based compensation may increase with outsourcing intensity.

My first objective is to understand how outsourcing influences R&D investment of the firm. Outsourcing can provide flexibility to the firm. Moon (2011) shows that outsourcing firms lower operating leverage and generate higher cash flow. Based on this operating flexibility, outsourcing firms would have higher capacity in investment spendings. In other words, their risk tolerance is greater. Figure 3.2 illustrates this change in R&D investment, as outsourcing intensity varies. I hypothesize that greater use of outsourcing will lead to greater use of equity-based compensation and to higher R&D investment as a result. In Figure 3.2, the optimal level of R&D rises from a to b to c, as outsourcing intensity increases. To induce the optimal level of R&D from the manager, the proportional use of equity-based compensation should increase as well from S^a to S^b to S^c. This relation is shown as the upright shifts of the R&D investment curve with increases in outsourcing activity.

[INSERT FIGURE 3.2 AND 3.3 HERE]

However, the costs of granting equity-based compensation rise with outsourcing intensity at the same time. Previous studies recognize the costs of grating equity-based compensation as the risk premium associated with such compensation (Ross 2004). This risk premium depends on the extent of the manager's outside wealth, risk-aversion, diversification and the firm's total risks. Outsourcing inevitably increases risks of the firm, and most of these risks are idiosyncratic. The manager needs to be compensated additionally for this increase in idiosyncratic risk, while shareholders might not concern about it. Therefore, the risk premium associated with equity-based compensation increases with outsourcing, so the level of CEO compensation would rise by the additional risk premium. This additional compensation is the deadweight loss of granting equity-based compensation from the perspective of shareholders.

Based on these benefits and costs of using equity-based compensation, the firm optimizes the proportion of equity-based compensation in the total compensation package at the point where the marginal benefit is equal to the marginal cost. Figure 3.3 depicts the optimal proportion of equity-based compensation in a non-outsourcing firm as S^*. This moves to $S^{*'}$ when the firm outsources. The increased benefits of using equity-based compensation by outsourcing are depicted as the upward shift of the marginal benefit curve in both (a) and (b). At the same time, the increased costs of using such compensation by outsourcing are depicted also as the upward shift of the marginal cost curve.

(a) depicts the case of an outsourcing firm with a relatively diversified or less risk-averse manager. The shift of marginal benefit curve exceeds the shift of marginal cost curve. Thus, the firm use proportionally more equity-based compensation than does the non-outsourcing firm ($S^{*'} > S^*$). (b) depicts the case of an outsourcing firm with a less diversified or more risk-averse manager. The shift of marginal cost curve exceeds the shift of marginal benefit curve. Therefore, the firm uses less equity-based compensation than does the non-outsourcing firm ($S^{*'} < S^*$). From this illustration, we expect that the positive effect of outsourcing on the use of equity-based compensation will be manifested only in the outsourcing firms with relatively diversified or less risk-averse managers.

Based on the above discussion, the following hypotheses are formed and tested.

Hypothesis 3.1. *Firm idiosyncratic risk is more likely to increase with outsourcing intensity. Therefore, this increased firm risk leads higher compensation for outsourcing firm CEOs.*

Hypothesis 3.2. *Outsourcing firms use proportionally more equity-based compensation in the total CEO compensation package to induce higher R&D investment.*

Hypothesis 3.3. *The positive effect of outsourcing on the proportional usage of equity-based compensation depends on the extent of managerial diversification and risk-aversion.*

3.3 Data

My primary dataset is the public manufacturing firms (SIC codes from 2000 to 3999) that disclose purchase obligations information to the Securities Exchange Commissions (SEC). I electronically obtain this dataset by web-crawling to the Edgar 10-K fillings site and parsing the documents using Perl programming. Then, I supplement this dataset with the ExecuComp and Compustat databases by the central index key (CIK).

3.3.1 Purchase Obligations Data

The SEC issued in January 2003 a final rule on Disclosure about off-balance sheet arrangements and aggregate contractual obligations.[2] This rule requires public companies other than small business issuers[3] to provide an explanation of its contractual obligations in a separately captioned subsection of the Management's Discussion and Analysis (MD&A) section. U.S. GAAP already requires firms to aggregate and assess all of the specified categories of contractual obligations; long-term debt obligations, capital lease obligations, and operating lease obligations. This SEC's final rule in January 2003 particularly includes the "purchase obligations" category and requires firms to provide tabular disclosure of all four categories of contractual obligations.

The SEC defines a purchase obligation as an agreement to purchase goods or services that is enforceable and legally binding on the registrant in the future. Therefore, a firm's purchase obligations represent the amount of inputs in production that will be purchased in the near future (Lee 2010). Purchase obligations are different with open-market orders, in that a firm legally submits purchase contracts to the third parties. Thus, purchase obligations are more likely to capture a firm's outsourcing activity.

[INSERT FIGURE 3.4 HERE]

[2]This rule is to implement Section 401(a) of the Sarbanes-Oxley Act of 2002. See Final Rule: Disclosure in Managements Discussion and Analysis about Off-Balance Sheet Arrangements and Aggregate Contractual Obligations, Securities Act Rel. No. 33-8182, Exchange Act Rel. 34-47264, Financial Reporting Rel. No. FR-67, International Series Rel. No. 1266 (Jan. 27, 2003), at http://www.sec.gov/rules/final/33-8182.htm.

[3]SEC defines a small business issuer as a company that had less than $25 million in revenues in its last fiscal year, and whose outstanding publicly-held stock is worth no more than $25 million.

Figure 3.4 shows examples of purchase obligations disclosures from Apple Inc.'s 10-Ks. Firms generally do not subcategorize purchase obligations in their tabular disclosures. They sometimes provide limited information on the types of purchase obligations in the following footnotes. For manufacturing firms, the most common type of purchase obligation is an inventory purchase commitment. A service agreement, including advertising, marketing and IT, is another common type of purchase obligation.[4] The payment due is classified by specified periods in the tabular disclosure format. Among those specified periods, I use the the amount of purchase obligations within 1 year.

3.3.2 Variables of Interest

My sample period covers from 2004 to 2010, because purchase obligations data is completely available from 2004.[5] Over the sample period, SEC also changed the reporting requirement for executive compensation for fiscal years ending after December 15, 2006 (the adoption of FAS 123R). The new disclosure rule redefined certain compensation components. For example, the definitions of total direct compensation (TDC1) and value of option awards (OPTION_AWARDS_FV) in the ExecuComp database are different between pre- and post-FAS 123R periods. The FAS 123R also separated the details of stock and option awards in two additional tables, the outstanding equity award table and the plan-based award table in the ExecuComp database. Therefore, I adjust each component of the variables under

[4] See Lee (2010) for discussion about the across-industry variation in the type of purchase obligations.

[5] For the fiscal years ending on or after December 15, 2003, all public firms (other than small business issuers) are required to disclose purchase obligations in their financial statements.

the new formats to the value under the old formats, in order to make important compensation variables of interest comparable between pre- and post-FAS 123R.[6]

I construct the following key variables to examine possible relations in outsourcing activity, firm risk-taking, and CEO compensation. For outsourcing activity (*PO1year/COGS*), I use the dollar amount of purchase obligations due within 1 year, scaled by costs of goods sold. This captures annual outsourcing activity of a firm for a given year. I study R&D investment as a primary and relevant measure of risk-taking behaviors in a firm. To measure a firm's R&D investment, I use *R&D/sales* which is R&D expenditures for a given year, scaled by sales in the prior year. I use two measures of firm risks, the log of total risks and the log of idiosyncratic risks. *Log(total risks)* is the log of standard deviation of the firm's daily stock returns over the 252 trading days starting from June to May in the next year. *Log(idiosyncratic risks)* is the log of standard deviation of residuals from a regression of the firm's daily excess stock returns (raw returns less the risk-less rate) on the Fama-French 3 factors.[7] The regression uses daily stock returns of a firm over the one year period from June to May in the next year and yield one firm-year observation of idiosyncratic risks.

My measures of CEO compensation are total direct compensation (TDC1 in the ExecuComp database), cash compensation (salary plus bonus), and equity-based compensation (stock and option awards). I take the logs of these variables to use

[6]I refer to the existing literature for this component adjustment (*e.g.* Coles, Daniel, and Naveen 2010; Kini and Williams 2011; Hayes, Lemmon and Qiu 2012). In particular, I recalculate the Black-Scholes value of the option under the new formats, following the ExecuComp assumptions for old formats which is available in the Wharton Data Research Services website.

[7]For a robustness check, I also use the CAPM model and get similar results.

as dependent variables in my regressions, following Murphy (1999). To calculate incentive measures, I follow the methodology in Guay (1999) and Core and Guay (2002). I define *CEO delta* as the change in the dollar value of the CEO's annual compensation for a 1 % change in stock price, and *CEO vega* as the change in the dollar value of the CEO's annual compensation for a 0.01 change in stock price volatility. Details on how I construct variables including these incentive measures are provided in Appendix C.1.

Table 3.1 and Table 3.2 present summary statistics on selected variables for firm and compensation characteristics. I tabulate separate statistics for the different quantile groups of outsourcing intensity; No purchase obligations (PO1year/COGS=0) and Quantile 1 to 3 of *PO1year/COGS* (Low, Medium, and High). For each variable, I winsorize the top and bottom 1% of the distribution. According to the summary statistics, firms with purchase obligations represent more than two third of total firms in the sample. In the original purchase obligations dataset, the percentage of firms with purchase obligations is around 50%. The percentage rises slightly, after I merge the dataset to the ExecuComp database. It is because the ExecuComp database only tracks compensation for executives of companies within the S&P 1500. Small firms that generally do not have outside purchase contracts are dropped out after merging.

[INSERT TABLE 3.1 AND 3.2 HERE]

Table 3.1 shows that firms with purchase obligations differ from the firms without purchase obligations in many aspects. Particularly, outsourcing intensity rises with firm size, based on the percentiles of NYSE market capital. Market-to-book ratio, sales growth and R&D investment also increase with outsourcing intensity, while leverage decreases.

The CEO compensation variables in Table 3.2 show interesting linear relations to outsourcing intensity. Both total compensation and equity-based compensation increase, as outsourcing intensity increases. However, I don't find this relation between cash compensation and outsourcing. Looking at the structure of compensation, firms use equity-based compensation increasingly more, when the firms do more outsourcing. The difference in the proportional usage of equity-based compensation between non-outsourcing firms and firms most intensely using outsourcing is about 7.3%. I find that the similar linear relation is more pronounced between outsourcing and the risk-taking incentives, measured as CEO delta and vega. Also, managers are more likely to sell their equity shares granted, as outsourcing intensity increases. The probability that the CEO sells her shares is higher than by 6% in the most intense outsourcing firm group than in the non-outsourcing firm group.

Overall, the more the firms do outsourcing, the more compensation the CEOs in the firms receive, particularly with more equity-based compensation. With the increased incentives in managerial risk-taking, outsourcing firms appear to invest more heavily in R&D. However, it also appears that the managers desire to diversify away their risks by selling their equity shares of the firms.

3.4 Empirical Methodology and Results

This section presents the paper's empirical methodology and results. I begin by examining how much more the outsourcing firm CEOs receive, and whether any specific form of compensation is preferred in outsourcing firms. Next, I examine risk taking behaviors in outsourcing firms, by focusing on their R&D investment. I further investigate the need for diversification from the CEO's perspective, and then whether outsourcing firms take into account this trade-off of firm risk-taking versus CEO diversification to determine their optimal compensation level and structure.

3.4.1 Identification Strategy

In this paper, I analyze the possible relations in outsourcing activity, corporate investment, and CEO compensation. I focus on the cross-sectional relations, because outsourcing activity is relatively invariant in the time-series and most of the variations arise in the cross-section. Outsourcing firms are not randomly selected. Moreover, the combination of complex decision processes in production, investment, and compensation are surely simultaneous. Therefore, endogeneity concerns are present in my study. I solve the identification problem using instrumental variables. A valid instrument in my study is a variable that affects the amount of outside purchase contracts, but has no impact on R&D investment and CEO compensation. I use distance to the closest seaport as a primary instrumental variable in my analyses.

The distance to the closest seaport proxies for the firm's feasibility to purchase products from foreign suppliers by water transportation. Assuming a large number of U.S. manufacturing firms hire foreign suppliers, distance to international entry ports is an important factor to the firm's decision to offshore production. Water transportation is the cheapest method of transporting and still carries most imports to the U.S., while the importance has decreased due to air transportation. This study is not the first to examine the impact of distance to entry port on outsourcing. Fort (2011) shows that plants over 200 miles away from a deep water port are 2.4 percentage points less likely to fragment (outsource), relative to plants within 50 miles of the closest port.

I construct a variable of *Distance to closest seaport* by calculating the distance between the main business location of the firm and the firm's closest seaport. The information of the U.S. seaports are provided by the Maritime Administration's Port Import Export Reporting Service in their website. I identify 40 seaports that carry with a value of imports greater than 500 TEUs.[8] The complete list of these 40 seaports is provided in Appendix C.2. Then, I calculate the great-circle distances between the firm location and the 40 seaports using their latitudes and longitudes to find the closest distance of the firm to an international port of entry.

There might be a concern in using this variable to identify the relation between outsourcing and R&D investment, because technology firms tend to cluster in the west coastal states. For example, the southern part of the San Francisco Bay Area in Northern California (Silicon Valley) which is very close to the port of Oakland,

[8] A TEU is a nominal unit of measure equivalent to a 20 x 8 x 8 shipping container. The results remain similar, when I use 100, 300 or 500 TEUs for the cutoff.

is home to many of the world's largest technology firms and high-tech businesses. To address this concern, I include coastal region fixed effects in all regressions. The U.S. has 4 coastal state regions, which are Atlantic Ocean states, Pacific Ocean states, Gulf of Mexico states, and Great Lake states. I control for these coastal regions using the Atlantic Ocean, Pacific Ocean and Gulf of Mexico states dummy variables.[9] As a result, the relation between outsourcing activity and R&D investment (or compensation) adjusted by the coastal region fixed effects is analyzed in my analyses. For a robustness check, I also include a dummy variable of whether the firm is close to the Silicon Valley (less than 200 miles) in the R&D regressions. I find that this does not change results.

I also add two additional variables in the first-stage regressions that might capture the geographical feasibility of outsourcing; the distances to the closest airport (large airports with cargo services), and the distance to the closest border of entry. However, these variables are not significant to explain the cross-sectional variations of outsourcing activity. A possible explanation for the insignificant explanatory power of air transportation is that airports with cargo services are not uncommon at any location. In the data, the distances to cargo airports range from 0.25 to 400 miles with an average of 60 miles, while the distances to seaports range from 0.15 to 1150 miles with a mean of 225 miles. Another explanation is that firms might not use air transportation as their primary method of transporting due to higher costs. Also, a possible explanation for the insignificant explanatory power of the distance

[9]The map of the U.S. coastal states region is provided in Figure C.2 of Appendix. I do not include Great Lake states dummy, because deep water ports are only relevant in my study.

to border crossings is that this variable only concerns the trades with the Canada and the Mexico, while manufacturing firms increasingly use Asian suppliers.

I report the first-stage regression results in Table C.3 of Appendix. In all instrumental regressions, the above three variables and *PO1year/COGS (lagged)* are used as excluded instruments. (1) is the exact specification used at the first-stage in all instrumental variable regressions. (2) and (3) are the extended specifications to better examine the economic effects of the instrumental variables. The results show that *Distance to the closest seaport* is the most important instrumental variable in my identification strategy. A firm's outsourcing activity is decreasing, as distance to the closet seaport increases. Considering a lagged variable of *PO1year/COGS* is also included in the first-state regression, the 1.2 percent increase of a firm's outsourcing activity relative to the last year's activity can be explained by whether the firm is close to the seaport.

I conduct an additional set of tests to show that these variables are good instruments. All instrumental variable regressions pass the weak, under- and over-identification tests. For *R&D* regressions, the F-test statistic of excluded instruments is 239.81.[10] The regressions are not over-identified (Hansen's J-statistic is 1.627). For *% Equity Comp* regressions, the F-test statistic of excluded instruments is 257.05.[11] The regressions are also not over-identified (Hansen's J-statistic is 0.730).

[10] Kleibergen-Paap LM statistic for under-identification is 104.674, and Cragg-Donald Wald F-statistic for weak identification is 1310.841.

[11] Kleibergen-Paap LM statistic is 104.798, and Cragg-Donald Wald F statistic is 1329.823.

3.4.2 CEO Compensation and Firm Risk in Outsourcing Firms

In Table 3.3, I begin my regression analyses by examining whether outsourcing activity has an impact on CEO compensation. I use the logs of total compensation, cash compensation, and equity-based compensation as dependent variables in (1), (2), and (3), respectively. I alternately estimate OLS and IV regressions, and find the results did not change between the two estimation methods. I control for year, and industry in each three-digit SIC code. In addition, I control for coastal region using the costal states definition in Figure C.2. The estimates show that the increased outsourcing activity is more likely to lead to the firm's manager receiving greater compensation. An increase of outsourcing intensity by 0.1 is associated with a 2.7 percentage point increase in total compensation. This relation is more pronounced in equity-based compensation. An increase of outsourcing intensity by 0.1 is associated with a 3.5 percentage point increase in equity-based compensation. In contrast, the results for cash compensation do not show this relation.

[INSERT TABLE 3.3 HERE]

Next, I further test whether an increase in firm risk in outsourcing firms is likely to cause the increase in compensation. I separately examine total firm risk and idiosyncratic risk. I do not examine changes in systematic risk, because the market price movement of the firm's securities will compensate for the changes in systematic risk of equity-based compensation. I measure a firm's total risk using the firm's daily stock return volatility in the given year's 252 trading days. I also use the monthly stock return volatility in the last 36 months for a robustness check, and the results are similar. A firm's idiosyncratic risk is computed as the standard deviation of residuals from a regression of the firm's daily excess stock returns on the Fama-French 3 factors. Using the CAPM model for the regression does not yield different results.

Table 3.4 reports the results. I estimate between-, OLS, and IV regressions alternatively for each risk measure. The estimated coefficients suggest that the intensity of outsourcing is significantly associated with firm total risk and idiosyncratic risk. The association is greater for the idiosyncratic risk. A rise in outsourcing intensity by 0.1 results in a 1.3 percentage point increase in firm total risk, and a 1.7 percentage point increase in firm idiosyncratic risk. Thus far, the empirical results suggest that outsourcing firm CEOs are exposed to more risks (particularly, more idiosyncratic risk) and the firms compensate their CEOs for these additional risk exposures with higher compensation.

[INSERT TABLE 3.4 HERE]

3.4.3 R&D Investment in Outsourcing Firms

This section examines R&D investment in outsourcing firms. Kothari, Laguerre, and Leone (2002) provide empirical evidence that R&D expenditures are high-risk investments compared to capital expenditures. And we also know from the previous section that a firm's outsourcing intensity significantly explains the firm's (idiosyncratic) risk. Therefore, now I examine whether outsourcing itself directly affects the firm's R&D investment.

[INSERT TABLE 3.5 HERE]

In Table 3.5, I estimate the effect of outsourcing intensity on R&D expenditures scaled by firm sales.[12] While my main focus is the estimated coefficient of *PO1year/COGS*, I also control for the other important variables in explaining a firm's investment. These control variables are growth opportunities, operating profitability, stock returns, and CEO characteristics such as age, tenure, and delta/vega of CEO compensation portfolios. The results indicate that the effect of outsourcing on the firm's R&D investment is more than double the effect of the firm's growth opportunities (measured by market-to-book). I also confirm the results of previous studies by Coles, Daniel, and Naveen (2006) that higher CEO vega is associated with higher R&D investment. However, in contrast with their results, I find higher CEO delta also increases the firm's R&D investment. CEO age and tenure do not explain significantly the variations in firm R&D investment.

[INSERT TABLE 3.6 HERE]

Next, in Table 3.6, I investigate whether the effectivenesses of incentive alignment (CEO delta) and convexity (CEO vega) on inducing managerial risk-taking vary with outsourcing intensity. In addition to the whole sample, I sort the sample into four subsamples based on outsourcing intensity; the group of firms without purchase contracts, the groups of firms with the low, medium, and high outsourcing intensity. Then, I repeat the delta and vega regression analysis for each sample.

In the previous literature, the relation between CEO delta and risk-taking is

[12] I avoid using firm assets to scale R&D, because outsourcing firms, by definition, have fewer fixed assets, and thus fewer total assets than comparable non-outsourcing firms.

unclear, while the positive relation between CEO vega and risk-taking is relatively robust (Coles, Daniel, and Naveen 2006). This is because CEO delta has two different effects on managerial risk-taking. First, the firm can induce optimal managerial risk-taking, by aligning the manager's incentives to shareholders' value through high CEO delta. Second, high CEO delta makes the manager to be more exposed to the firm's risks, so the manager's incentives to take risks will also decrease. In Table 3.6, I find that the effect of delta is unclear in the group of non-outsourcing firms and the group of firms with greater shares of outsourcing. However, the effect of delta is significant in (2), the mild outsourcing group. Also, the magnitude of the effect in (2) is nearly twice as much as that in the whole sample. This indicates that the incentive alignment scheme by increasing CEO delta functions well in the mild outsourcing firms. This effect decreases as the intensity of outsourcing increases, possibly because idiosyncratic risk rises with outsourcing intensity.

Regardless of outsourcing intensity, the effect of convexity on inducing R&D investment appears to be strong and significant in all specifications. I find that the effectiveness of convexity for increasing R&D investment is higher in the group of non-outsourcing firms or intensive outsourcing firms. In contrast with the result of CEO delta, the vega effectiveness increases as outsourcing intensity increases.

3.4.4 The Optimal Proportion of Equity-Based Compensation

Outsourcing has two effect on the proportional usage of equity-based compensation. First, it increases firm-specific risk that managers can not completely diversify away. Therefore, if outsourcing firms grant equity-based compensation to their CEOs, they need to pay more to compensate the increased risk. This may justify the relatively higher CEO compensation in outsourcing firms than in non-outsourcing firms. According to this argument, outsourcing firms may not prefer equity-based compensation due to the possibly significant deadweight loss. Second, outsourcing improves firm flexibility that enables the firm to increase the investment level of R&D. Therefore, outsourcing firms are more likely to use equity-based compensation so that they can reach higher levels of R&D investment more effectively. Based on these two different effects of outsourcing, I examine how outsourcing firms determine their compensation structure in this section.

I first examine whether the CEOs of the firms that increasingly use outsourcing are more likely to diversify their risks by selling their equity shares granted. In (1) of Table 3.7, I use probit models to test how an increase in outsourcing intensity changes the probability that CEOs sell their equity shares. I control for the lagged variables of stock returns, CEO delta, and CEO vega. The estimates show that CEOs with high delta or high vega are more likely to sell their shares, and the relation appears to be stronger for delta than vega. Even after controlling for stock returns, CEO delta, and CEO vega, the estimated coefficient of $\Delta PO1year/COGS$ is still large and significant. An outsourcing firm's CEO is more likely to sell her shares with a 4 percentage point increased probability, when the firm increases its share of outsourcing by 0.1. This association is as much strong as the association between stock returns and the probability that CEOs sell their equity shares.

[INSERT TABLE 3.7 HERE]

The specification (2) in Table 3.7 presents the results for the effect of outsourcing on the compensation structure. Firms use more equity-based compensation, as their outsourcing intensity increases. A 0.1 increase in *PO1year/COGS* increases the proportion of equity-based compensation in total compensation by about 1 percent. It indicates that CEOs of the firms without purchase contracts receive about 10 percent lower compensation in the form of equity-based compensation than all-outsourcing firms. In addition, I include a dummy variable of whether the firm's CEO has sold her shares in the previous fiscal year. I find that firms tend to grant 3 percentage point more equity-based compensation, when their CEOs sold their shares in the previous year. This suggest that firms have an optimal compensation structure, and re-adjust the proportion of equity-based compensation to their CEOs' diversification behaviors.

In Table 3.8, I test the optimal trade-off between the benefits and costs of granting equity-based compensation, by sorting my sample into four subsamples based on CEO delta and vega; (1) low delta & low vega, (2) low delta & high vega, (3) high delta & low vega, (4) high delta & high vega. High and low represents below and above the median of each variable. The numbers of observations of two low-high pairs among the four subsamples are much lower than that of the high-high or low-low pair. This indicates that firms with high CEO delta are more likely to have high CEO vega as well. Based on the previous literature, I conjecture that CEOs in high delta groups are less diversified than those in low delta groups. Also, CEOs in high vega groups are less risk-averse than those in low vega groups, because their wealth increases with higher stock return volatility. According to these arguments, the costs of granting equity-based compensation will be the highest for the firms in the high delta & low vega group (the specification (3)) among the four subsamples. In contrast, the costs of granting such compensation will be lowest for the firms with low delta & high vega (the specification (2)). Therefore, I expect that the effect of outsourcing on the proportional usage of equity-based compensation will be larger in the low delta & high vega group than in the high delta & low vega group.

[INSERT TABLE 3.8 HERE]

In Table 3.8, all the estimated coefficients of *PO1year/COGS* are positive, but those are significant only in high CEO vega groups. Outsourcing has the most significant impact (0.187) on the proportional usage of equity-based compensation, when the firm's CEO is in the low delta & high vega group. The effect decreases to almost one third (0.0571) and becomes insignificant, when the firm's CEO is in the high delta & low vega group. These results are consistent with Hypothesis 3.3 that outsourcing firms use proportionally more equity-based compensation, and this preference is pronounced when managers are more diversified and less risk-averse.

3.5 Conclusion

Using a new dataset of purchase obligations from firm 10-Ks to measure firm-level outsourcing activity, I analyze CEO compensation in outsourcing firms. I first document that outsourcing intensity plays an important role in explaining the cross-sectional variations in CEO compensation. Outsourcing firms pay higher compensation to their CEOs than do non-outsourcing firms. Also, the higher compensation mostly arises from the greater use of equity-based compensation. This paper explains how the relatively high level of CEO compensation and the greater use of equity-based compensation in outsourcing firms can be justified.

Outsourcing firms are a special sample to examine compensation policies, because outsourcing has two different effects on the use of equity-based compensation. First, outsourcing improves firm flexibility which enable the firm to increase their risk tolerance and capacity in spendings. I find that outsourcing firms invest more heavily in R&D, and thus they are more likely to depend on equity-based compensation to induce more R&D investment from their managers.

Second, outsourcing increases the costs of granting equity-based compensation at the same time. Outsourcing activity inevitably leads to making business relationships with other firms, so they are more seriously exposed to other firm-specific risks or international risks. I find that a firm's idiosyncratic risk increases with the firm's outsourcing intensity. Therefore, outsourcing firm CEOs will require additional premiums to compensate their increased risks, which may justify the higher level of CEO compensation in outsourcing firms. The additional compensation is, in other words, additional costs to the firm. Therefore, firms are more likely to refrain from using equity-based compensation due to the additional costs.

Based on the above two effects of outsourcing, I show that the positive association between outsourcing intensity and the use of equity-based compensation depends on the relative costs of granting such compensation. I find that the positive impact of outsourcing on the use of equity-based compensation diminishes in the firms with less diversified and more risk-averse CEOs. In contrast, the firms with relatively diversified and less risk-averse CEOs use proportionally more equity-based compensation in the total compensation package than do other firms.

Overall, my findings are consistent with outsourcing firms determining their compensation level and structure based on the optimal trade-off between the increased benefits and costs of granting equity-based compensation. My results also provide new evidence that the dramatic executive pay rise in the manufacturing sector might result from the sharp rise in outsourcing activity and the following increase in firm risk-taking in the sector.

Appendix C

C.1 Variable Definitions

- *PO1year/COGS* is the total amount of purchase obligations due within 1 year, scaled by costs of good sold.
- Δ *PO1year/COGS* is the difference between *PO1year/COGS* and the value in the prior year.
- *Log(sales)* is the log of sales.
- *Log(1+age)* is the log of one plus firm age, defined as a given year minus the year when the firm first appeared in Compustat.
- *NYSE size* is the percentile of the firm's market cap, based on Fama-French's NYSE breakpoints.
- *M/B* is market value of assets divided by book value of assets. Market value of assets is market value of common equity plus book value of preferred stock plus debt (long-term debt + debt in current liabilities) plus book value of minority interest.
- *ROA* is net operating income divided by total assets in the prior year.
- *R&D/sales* is R&D expenditures divided by sales in the prior year.
- *Book leverage* are the ratio of total debt to the book value of assets.
- *Stock return* is annual stock returns calculated using 12 monthly stock returns between June to May in the next year.
- *Log(total risks)* is the log of standard deviation of the firm's daily stock returns over the 252 trading days starting from June to May in the next year.
- *Log(idiosyncratic risks)* is the log of standard deviation of residuals from a regression of the firm's daily excess stock returns (raw returns less the riskless rate) on the Fama-French 3 factors. The regression uses daily stock returns of a firm over the one year period from June to May in the next year and yield one firm-year observation.
- *Log(cash comp)* is the log of dollar value of salary plus bonus.

- *Log(equity comp)* is the log of dollar value of equity-based compensation including restricted stock grants and stock option grants. I use recalculated option value (OPTION_AWARDS_BLK_VALUE_adusted) following Coles, Daniel, and Naveen (2010). They find that firms report their own valuation of option grants in the post-FAS 123R period in OPTION_AWARDS_BLK_VALUE. By using the exact assumptions of the ExecuComp in the pre-FAS 123R period on the Black-Sholes model parameters, the recalculated value of options awards post-FAS 123R is comparable to that pre-FAS 123R. The assumptions of the ExecuComp are available at the Wharton Data Research Services website or Coles, Daniel, and Naveen (2010). They find the method of adjustment for pre-FAS 123R option value yields about 0.99 correlation with the OPTION_AWARDS_BLK_VALUE reported by the ExecuComp.

- *Log(total comp)* is the log of dollar value of total direct compensation (TDC1). TDC1 is recalculated for the post-FAS 123R value following Coles, Daniel, and Naveen (2010). The redefined TDC1 post-FAS 123R is SALARY + BONUS + NONEQ_INCENT + OTHCOMP + STOCK_AWARDS_FV + "OPTION_AWARDS_BLK_VALUE_adusted" + DEFER_RPT_AS_COMP_TOT, while TDC1 pre-FAS 123R is SALARY + BONUS + OTHANN + ALLOTHTOT + RSTKGRNT + OPTION_AWARDS_BLK_VALUE + LTIP.

- *% Equity comp* is the percentage point of dollar value of equity-based compensation in dollar value of total direct compensation. $\in(0,1)$

- *CEO delta* is the delta of current grants plus the delta of prior outstanding grants. The delta of current grants is (Black-Sholes Delta of all current option grants + number of shares of current restricted stock grants) $\times$ fiscal year-end price $\times$ 0.01. The delta of prior grants is (Black-Sholes Delta of all prior option grants + number of outstanding shares of prior restricted stock grants) $\times$ fiscal year-end price $\times$ 0.01.

- *CEO vega* is the vega of current option grants plus the vega of prior outstanding option grants. The vega of current option grants is Black-Sholes Vega of all current option grants $\times$ fiscal year-end price $\times$ 0.01. The vega of prior option grants is Black-Sholes Vega of all prior option grants $\times$ 0.01.

- *the number of current restricted stock grants* is RSTKGRNT(STOCK_AWARDS_FV) divided by the fiscal year-end stock price in the pre-FAS 123R period (post-FAS 123R period).

- *the number of prior restricted stock grants* is SHROWN_EXCL_OPTS.

- *the number of current option grants* is NUMSECUR from the Stock Option Grants - 1992 format Table for the pre-FAS 123R period, and OPTS_GRT from the Plan-Based Awards Table for the post-FAS 123R period. The detailed reference under the old and new SEC reporting requirement is in Hayes, Lemmon, and Qiu (2012).

- *the number of prior outstanding option grants* is OPT_UNEX_UNEXER_NUM plus OPT_UNEX_EXER_NUM.

- *Black-Sholes Delta* is the first partial derivative of the option value with respect to stock price. I follow Core and Guay (2002) method.

- *Black-Sholes Vega* is the first partial derivative of the option value with respect to stock price volatility. I follow Guay (1999) method.

- *Log(CEO age)* is the log of executive age.

- *Log(1+tenure)* is the log of 1 plus the years between the given fiscal year and the year that the executive became chief executive officer (becameceo).

- *CEO sells share* is a dummy variable that equals 1 if the CEO sold shares of her firm in the given fiscal year. Data on managers' sale of shares are obtained from Thomson Financial's compilation of insider trades that are filed with the Securities and Exchange Commission (SEC).

C.2 The U.S. Leading Seaports with Importing Trade

The Maritime Administration at the U.S. Department of Transportation provides the data for the U.S. waterborne custom ports.[1] I use the trade statistics data on U.S. waterborne foreign container trade by U.S. custom ports. The statistics include both government and non-government shipments by vessel into and out of U.S. foreign trade zones, the 50 states, District of Columbia, and Puerto Rico. The statistics exclude shipments between the 50 states and Guam, Puerto Rico, the U.S. Virgin Islands, American Samoa and the Trust Territories of the Pacific Islands. Among 90 ports with non-zero importing trade in 2010, I exclude the ports with imports less than 500 TEUs. This gives 40 large seaports with significant importing trade.[2] The following figure plots locations of these seaports based on the latitudinal and longitudinal positions. Also, Table C.1 provides the complete list of the 40 seaports.

Figure C.1: Map of 40 U.S. Leading Seaports with Importing Trade

[1]Fort (2011) has detailed description about this data. The data are available at http://www.marad.dot.gov/.

[2]A TEU is a nominal unit of measure equivalent to a 20 x 8 x 8 shipping container. The cutoff point in TEUs is not critical. In unreported tests, I use 50, 100 or 300 TEUs as a cutoff point and find the similar results.

Table C.1: 40 Leading U.S. Seaports for Importing Trade

Port Name	**State**	**Imports (TEUs)**	**Latitude**	**Longitude**
LOS ANGELES	CA	3877969	33.72	-118.27
LONG BEACH	CA	3048538	33.75	-118.20
NEW YORK	NY	2622795	40.70	-74.02
SAVANNAH	GA	1055195	32.08	-81.10
SEATTLE	WA	888147	47.65	-122.33
OAKLAND	CA	739542	37.83	-122.30
NORFOLK	VA	721259	36.85	-76.32
CHARLESTON	SC	548392	32.78	-79.93
HOUSTON	TX	520881	29.75	-95.33
TACOMA	WA	495755	47.25	-122.42
MIAMI	FL	309201	25.77	-80.17
BALTIMORE	MD	280097	39.28	-76.58
EVERGLADES	FL	246083	26.08	-80.07
PHILADELPHIA	PA	143631	39.95	-75.17
WILMINGTON DE	DE	132495	39.75	-75.50
WILMINGTON NC	NC	115011	34.23	-77.95
GULFPORT	MS	104830	30.35	-89.08
JACKSONVILLE	FL	93356	30.40	-81.38
BOSTON	MA	79863	42.35	-71.08
NEW ORLEANS	LA	78511	29.95	-90.07
PORTLAND OR	OR	68597	45.53	-122.72
SAN DIEGO	CA	49931	32.70	-117.17
CHESTER	PA	45781	39.87	-75.43
MOBILE	AL	35267	30.67	-88.03
FREEPORT	TX	31092	28.95	-95.27
PALM BEACH	FL	24148	26.77	-80.05
TAMPA	FL	23090	27.92	-82.45
HUENEME	CA	18272	34.15	-119.20
PANAMA CITY	FL	14624	30.13	-85.67
MANATEE	FL	11709	27.63	-82.55
GALVESTON	TX	8135	29.28	-94.83
GLOUCESTER	NJ	5249	42.62	-70.67
FORT PIERCE	FL	3062	27.47	-80.32
EVERETT WA	WA	2610	47.98	-122.25
RICHMOND VA	VA	1801	37.45	-77.42
FERNANDINA BEACH	FL	829	30.68	-81.47
BEAUMONT	TX	674	30.08	-94.08
SOUTH LOUISIANA	LA	647	30.00	-90.50
VANCOUVER	WA	569	45.60	-122.67
LAKE CHARLES	LA	557	30.22	-93.22

C.3 Distance to Port and First-stage Regressions

The following table presents summary statistics of distance between a firm and the closest port by firm outsourcing intensity. In the table, *PO1year/COGS=0* is the group of firms without purchase contracts. *Low*, *Medium*, and *High* are the three quantile groups with *High* being the most intense outsourcing activity. *Distance to port* (in 100 miles) is calculated as the great-circle distance between firm and port location using latitude and longitude.

Table C.2: Distance between a firm and the closest port (in 100 miles)

Quantile(PO1year/COGS)	Mean	Std. Dev.	Min.	Max.	N
Distance to closest any port					
PO1year/COGS=0	0.538	0.712	0.015	3.187	
Low	0.566	0.738	0.003	4.001	
Medium	0.47	0.681	0.004	3.324	
High	0.43	0.614	0.002	2.923	
Distance to closest seaport					
PO1year/COGS=0	2.405	2.863	0.015	9.890	
Low	2.526	2.754	0.004	9.928	
Medium	2.095	2.662	0.004	9.458	
High	1.778	2.661	0.002	11.478	
Distance to closest airport					
PO1year/COGS=0	0.635	0.748	0.016	3.337	
Low	0.684	0.772	0.013	4.001	
Medium	0.599	0.743	0.013	3.324	
High	0.556	0.655	0.003	2.923	
Distance to closest border					
PO1year/COGS=0	2.925	2.07	0.182	10.746	
Low	2.877	1.713	0.056	10.758	
Medium	3.052	1.516	0.247	10.749	
High	2.955	1.64	0.188	10.63	

Table C.3 reports the first-stage regression results. Excluded instruments are *Distance to closest seaport*, *Distance to closest airport*, *Distance to closest border*, and *PO1year/COGS (lagged)*. *close to port* is a dummy variable that equals 1, if the distance to port is less than the mean distance to the port in the sample.

Table C.3: First-Stage Regressions

	Dependent variable: PO1year/COGS (1)	(2)	(3)
Distance to closest seaport	-0.00183*	-0.00133**	
	(-1.95)	(-2.16)	
Distance to closest airport	-0.000271	0.0000793	
	(-0.12)	(0.04)	
Distance to closest border	0.00106	0.000521	
	(1.07)	(0.56)	
Close to seaport (dummy)			0.0122**
			(2.14)
Close to airport (dummy)			-0.00148
			(-0.40)
Close to border (dummy)			-0.00569
			(-1.46)
PO1year/COGS (lagged)	0.793***	0.794***	0.793***
	(30.15)	(30.38)	(29.97)
Log(sales)	0.000512	0.000527	0.000622
	(0.30)	(0.31)	(0.36)
Log(1+age)	-0.00377	-0.00310	-0.00393
	(-1.52)	(-1.27)	(-1.58)
M/B	0.00822**	0.00799**	0.00796**
	(2.52)	(2.46)	(2.44)
ROA	-0.0288	-0.0298	-0.0289
	(-1.06)	(-1.09)	(-1.06)
Stock return (lagged)	0.00183	0.00192	0.00163
	(0.40)	(0.42)	(0.35)
Log(CEO age)	-0.0149	-0.0155	-0.0140
	(-1.01)	(-1.04)	(-0.95)
Log(1+tenure)	-0.000633	-0.000388	-0.000712
	(-0.28)	(-0.17)	(-0.32)
Log(CEO delta) (lagged)	-0.00156	-0.00162	-0.00142
	(-0.86)	(-0.89)	(-0.78)
Log(CEO vega) (lagged)	0.000948	0.00101	0.000828
	(0.83)	(0.88)	(0.73)
Observations	3604	3604	3604
Adjusted R^2	0.670	0.670	0.670
Year dummy	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes
Coastal Region dummy	Yes	No	Yes

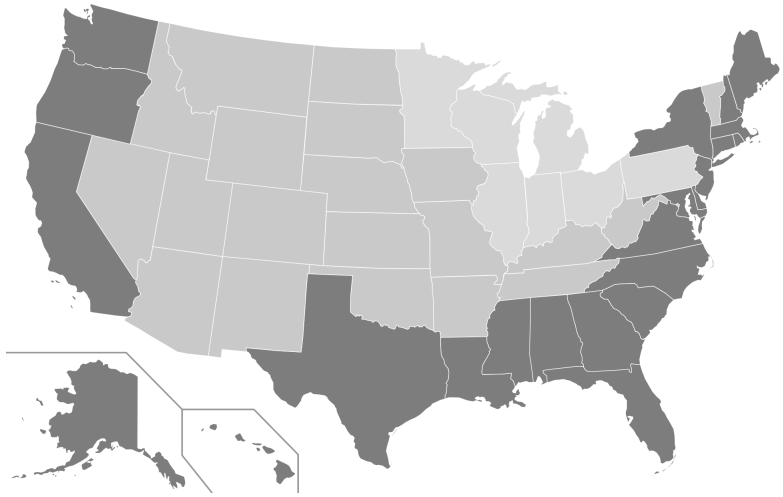


Figure C.2: U.S. Coastal States

There are 4 coastal state regions in the United States. (1) Atlantic Ocean states: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, New York, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida (2) Pacific Ocean states: California, Oregon, Washington, Alaska, Hawaii (3) Gulf of Mexico states: Florida, Alabama, Mississippi, Louisiana, Texas (4) Great Lake states: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota. I exclude Great Lake states dummy, because this region is not relevant with deep water ports.

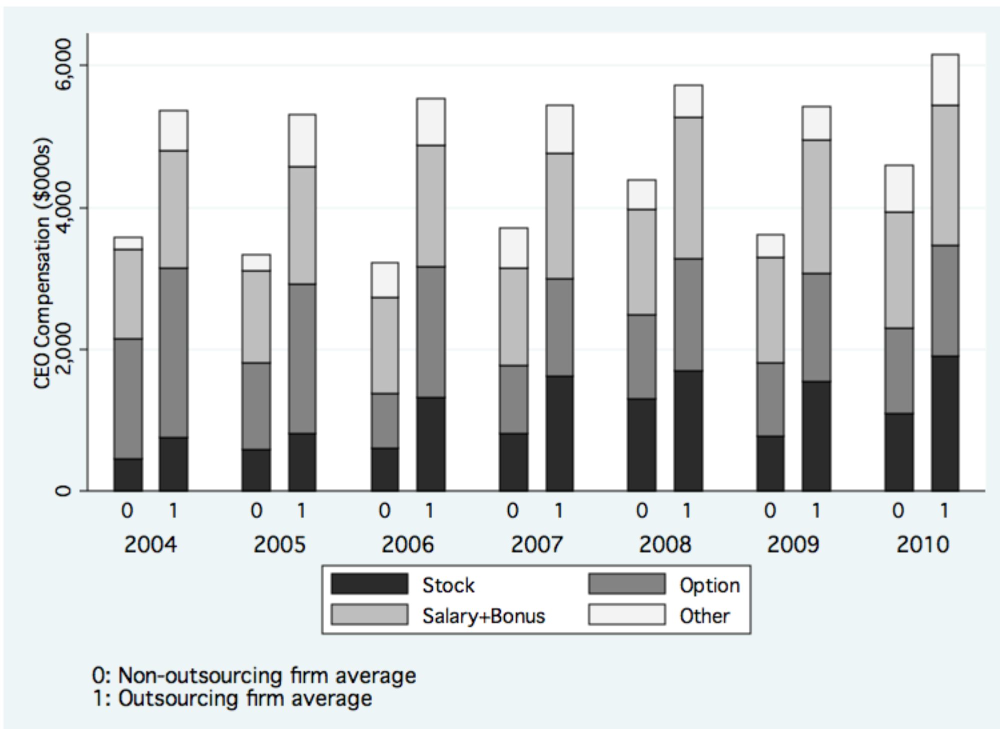


Figure 3.1: CEO Compensation Level and Structure: Outsourcing Firms versus Non-outsourcing Firms

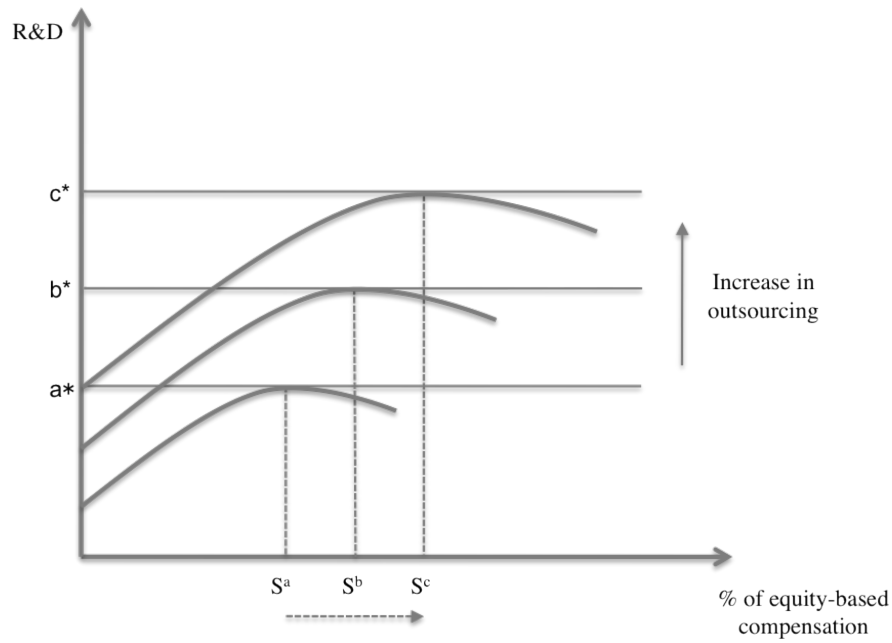
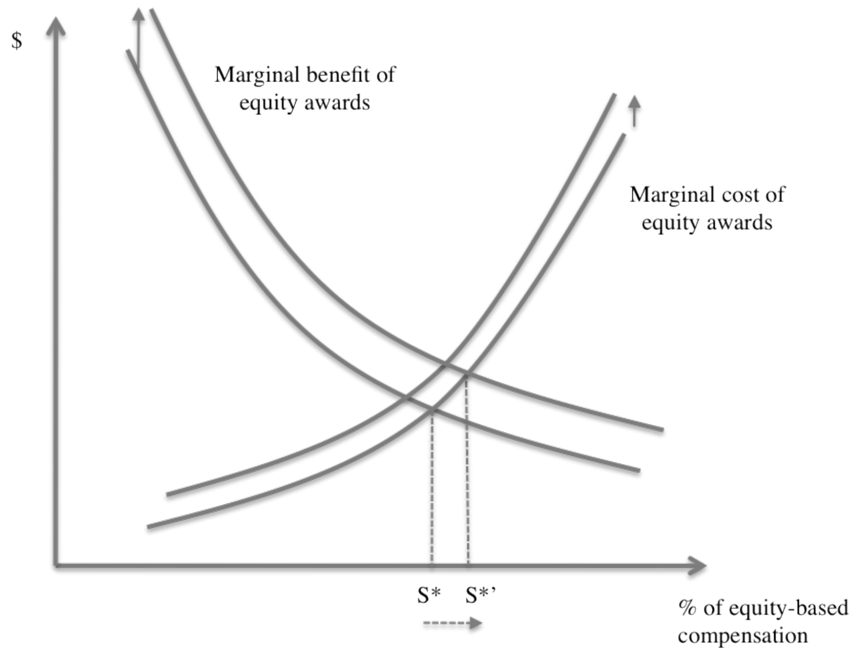
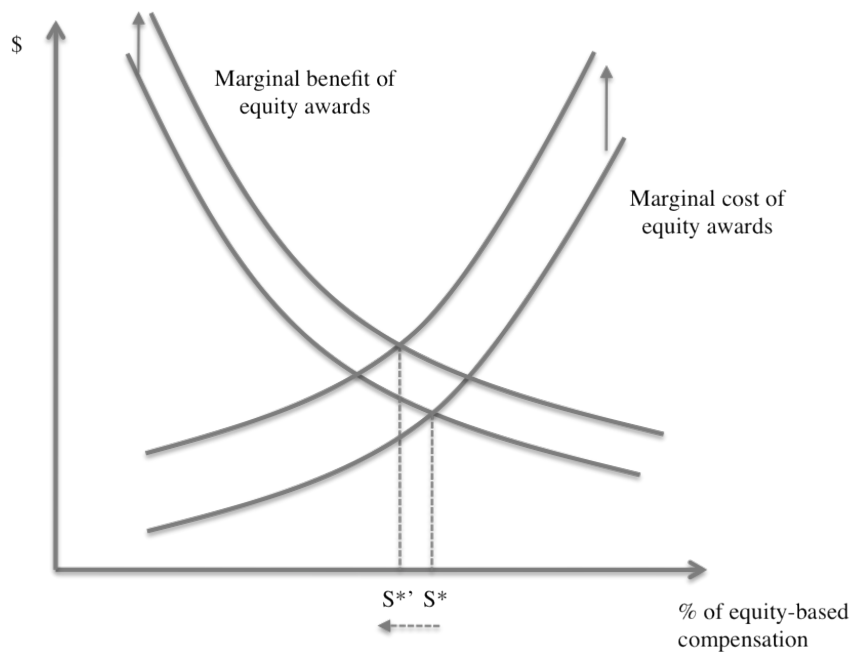


Figure 3.2: Outsourcing Intensity and R&D Investment

The figure illustrates the relations between outsourcing intensity and R&D investment. In the case depicted, the optimal R&D level changes, as firms differ in outsourcing intensity. The firm with intense outsourcing uses more equity-based compensation to reach the higher level of R&D investment than the firm with mild outsourcing.



(a)



(b)

Figure 3.3: Marginal Benefits and Costs of Granting Equity-based Compensation

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The figure shows the relation between the marginal benefit and cost of using equity-based compensation. S^* is the optimal proportion of equity-based compensation in total compensation of a non-outsourcing firm. (a) depicts the case of an outsourcing firm with a relatively diversified or less risk-averse manager. The shift of marginal benefit curve exceeds the shift of marginal cost curve. Thus, the firm use proportionally more equity-based compensation. (b) depicts the case of an outsourcing firm with a less diversified or more risk-averse manager. The shift of marginal cost curve exceeds the shift of marginal benefit curve. The firm uses less equity-based compensation.

	Total	Payments Due in Less Than 1 year	Payments Due in 1-3 years	Payments Due in 4-5 years	Payments Due in More Than 5 years
Operating Leases	$ 865	$ 108	$ 211	$ 192	$ 354
Purchase Obligations	1,994	1,994	—	—	—
Asset Retirement Obligations	14	—	2	2	10
Other Obligations	4	4	—	—	—
Total	$ 2,877	$ 2,106	$ 213	$ 194	$ 364

(a) In the Apple Inc.'s 10-K for the fiscal year 2005

	Total	Payments Due in Less Than 1 Year	Payments Due in 1-3 Years	Payments Due in 4-5 Years	Payments Due in More Than 5 Years
Operating leases	$ 1,760	$ 195	$ 409	$ 368	$ 788
Purchase obligations	5,378	5,378	—	—	—
Asset retirement obligations	28	—	8	7	13
Other obligations	471	242	124	105	—
Total	$ 7,637	$ 5,815	$ 541	$ 480	$ 801

(b) In the Apple Inc.'s 10-K for the fiscal year 2008

Figure 3.4: Examples of Purchase Obligations Disclosures

Description of purchase obligations excerpted from the footnotes of the Apple Inc.'s 2008 10-K: "The Company utilizes several contract manufacturers to manufacture sub-assemblies for the Companys products and to perform final assembly and test of finished products. These contract manufacturers acquire components and build product based on demand information supplied by the Company, which typically covers periods ranging from 30 to 150 days. The Company also obtains individual components for its products from a wide variety of individual suppliers. Consistent with industry practice, the Company acquires components through a combination of purchase orders, supplier contracts, and open orders based on projected demand information. Such purchase commitments typically cover the Companys forecasted component and manufacturing requirements for periods ranging from 30 to 150 days. In addition, the Company has an off-balance sheet warranty obligation for products accounted for under subscription accounting pursuant to SOP No. 97-2 whereby the Company recognizes warranty expense as incurred. As of September 27, 2008, the Company had outstanding off-balance sheet third-party manufacturing commitments, component purchase commitments, and estimated warranty commitments of $5.4 billion. During 2006, the Company entered into long-term supply agreements with Hynix Semiconductor, Inc., Intel Corporation, Micron Technology, Inc., Samsung Electronics Co., Ltd., and Toshiba Corporation to secure supply of NAND flash memory through calendar year 2010. As part of these agreements, the Company prepaid $1.25 billion for flash memory components during 2006, which will be applied to certain inventory purchases made over the life of each respective agreement. The Company utilized $567 million of the prepayment as of September 27, 2008."

Table 3.1: Summary Statistics on Firm Characteristics

The table reports the summary statistics on the selected firm characteristics. The sample consists of 822 manufacturing firms with the firm-level averages on each variable in the fiscal year period of 2004-2010. The sample is sorted by outsourcing intensity into four subsamples; firms without purchase contracts and the three quantile groups based on *PO1year/COGS* (Low, Medium, and High). Variables definitions are available in Appendix.

Quantile(PO1year/COGS)	Mean	Std. Dev.	Min.	Max.	N
NYSE size (%)					
PO1year/COGS=0	39.343	25.978	5	100	164
Low	45.784	27.152	5	100	215
Medium	49.608	28.068	5	100	215
High	51.345	30.492	5	100	215
Book leverage					
PO1year/COGS=0	0.201	0.163	0	0.729	164
Low	0.217	0.148	0	0.679	215
Medium	0.187	0.15	0	0.699	215
High	0.158	0.157	0	0.729	215
M/B					
PO1year/COGS=0	1.664	1.054	0.414	5.985	164
Low	1.504	0.820	0.494	5.412	215
Medium	1.694	0.91	0.46	5.659	215
High	2.051	1.215	0.601	6.843	215
Sales growth					
PO1year/COGS=0	0.104	0.128	-0.123	0.734	164
Low	0.093	0.121	-0.267	0.558	215
Medium	0.104	0.121	-0.321	0.618	215
High	0.139	0.131	-0.211	0.769	215
R&D/sales					
PO1year/COGS=0	0.066	0.114	0	0.657	166
Low	0.058	0.106	0	0.706	219
Medium	0.076	0.103	0	0.625	219
High	0.11	0.125	0	0.706	218

Table 3.2: Summary Statistics on Compensation Characteristics

The table reports the summary statistics on the selected compensation variables. The sample consists of 822 manufacturing firms with the firm-level averages on each variables in the fiscal year period of 2004-2010. The sample is sorted by outsourcing intensity into four subsamples; firms without purchase contracts and the three quantile groups based on *PO1year/COGS* (Low, Medium, and High). Variables definitions are available in Appendix.

Quantile(PO1year/COGS)	Mean	Std. Dev.	Min.	Max.	N
Log(total comp)					
PO1year/COGS=0	7.702	0.8	5.624	9.906	166
Low	7.983	0.867	6.055	10.017	219
Medium	8.106	0.84	5.614	9.612	219
High	8.045	0.989	5.614	10.07	218
Log(cash comp)					
PO1year/COGS=0	6.651	0.477	5.451	8.093	166
Low	6.793	0.522	5.552	8.532	219
Medium	6.815	0.545	5.39	8.297	219
High	6.767	0.627	5.39	8.508	218
Log(equity comp)					
PO1year/COGS=0	7.095	1.029	3.875	9.096	157
Low	7.248	1.145	4.411	9.724	214
Medium	7.534	0.976	4.604	9.388	213
High	7.504	1.173	3.783	9.817	213
% Equity comp					
PO1year/COGS=0	39.562	19.287	0	91.288	166
Low	41.885	18.361	0	87.34	219
Medium	45.322	18.734	0	87.489	219
High	46.916	20.334	0	85.358	218
CEO delta ($000s)					
PO1year/COGS=0	481.314	708.16	0	4669.464	163
Low	736.622	2501.219	2.006	33922.605	215
Medium	606.497	882.025	5.547	6697.142	215
High	947.730	2041.406	15.306	20928.076	215
CEO vega ($000s)					
PO1year/COGS=0	112.643	191.749	0	1475.132	164
Low	154.451	216.418	0	1485.971	215
Medium	166.430	223.716	0	1371.888	215
High	217.627	366.096	0	3363.412	215
CEO sells share (dummy)					
PO1year/COGS=0	0.34	0.316	0	1	166
Low	0.357	0.32	0	1	219
Medium	0.393	0.334	0	1	219
High	0.398	0.328	0	1	218

Table 3.3: Outsourcing Intensity and CEO Pay

The table displays the effects of outsourcing intensity (*PO1year/COGS*) on the level of CEO compensation. The dependent variables, (1) *Log(total comp*, (2) *Log(cash comp*, and (3) *Log(equity comp* are the logs of total direct compensation, salary plus bonus, and equity-based compensation including restricted stocks and stock options grants, respectively. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1) Log(total comp)		(2) Log(cash comp)		(3) Log(equity comp)	
PO1year/COGS	0.226**	0.279**	0.0581	-0.00126	0.328**	0.354*
	(2.07)	(2.07)	(0.67)	(-0.01)	(2.24)	(1.89)
Log(sales)	0.384***	0.384***	0.300***	0.301***	0.414***	0.413***
	(17.07)	(17.04)	(17.40)	(17.44)	(17.97)	(17.91)
Log(1+age)	-0.0386	-0.0379	-0.00150	-0.00229	-0.0865**	-0.0861**
	(-1.38)	(-1.36)	(-0.07)	(-0.10)	(-2.32)	(-2.31)
M/B	0.0747***	0.0738***	-0.0132	-0.0122	0.166***	0.165***
	(2.93)	(2.88)	(-0.79)	(-0.74)	(6.01)	(5.97)
ROA	0.0334	0.0353	0.0125	0.0105	-0.447*	-0.446*
	(0.17)	(0.18)	(0.11)	(0.09)	(-1.86)	(-1.86)
Stock return (lagged)	0.118***	0.118***	0.0468***	0.0473***	0.0764*	0.0761*
	(4.40)	(4.38)	(2.71)	(2.74)	(1.80)	(1.79)
Log(CEO age)	0.0479	0.0479	0.321***	0.321***	-0.369*	-0.369*
	(0.31)	(0.31)	(2.73)	(2.73)	(-1.81)	(-1.81)
Log(1+tenure)	-0.0545**	-0.0543**	0.0135	0.0133	-0.114***	-0.114***
	(-2.53)	(-2.52)	(0.79)	(0.78)	(-3.88)	(-3.88)
Log(CEO delta) (lagged)	-0.0336	-0.0335	-0.0463***	-0.0465***	0.0868***	0.0869***
	(-1.56)	(-1.55)	(-2.96)	(-2.97)	(3.12)	(3.13)
Log(CEO vega) (lagged)	0.163***	0.162***	0.0889***	0.0892***	0.149***	0.149***
	(5.90)	(5.89)	(4.74)	(4.75)	(6.19)	(6.19)
Observations	3584	3584	3588	3588	3118	3118
Adjusted R^2	0.649	0.649	0.631	0.631	0.598	0.598
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Coastal region dummy	Yes	Yes	Yes	Yes	Yes	Yes
Estimation Method	OLS	IV	OLS	IV	OLS	IV

Table 3.4: Outsourcing Intensity and Total/Idiosyncratic Risks

The table displays the effects of outsourcing intensity (*PO1year/COGS*) on the risks of the firms. The dependent variable, (1) *Log(total risks* is the log of standard deviation of daily stock returns over the 252 trading days starting from June to May in the next year. The dependent variable, (2) *Log(idiosyncratic risks* is the log of standard deviation of residuals from a regression of the firms daily excess stock returns on the Fama-French 3 factors, using daily stock returns of a firm over the one year period from June to May in the next year. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1) Log(total risks)			(2) Log(idiosyncratic risks)		
PO1year/COGS	0.112**	0.0902**	0.132**	0.143**	0.106**	0.174***
	(2.17)	(2.46)	(2.57)	(2.44)	(2.43)	(2.74)
Log(sales)	-0.0876***	-0.0953***	-0.0923***	-0.106***	-0.114***	-0.112***
	(-15.14)	(-20.18)	(-18.60)	(-15.65)	(-19.37)	(-17.78)
Log(1+age)	-0.0536***	-0.0371***	-0.0331***	-0.0698***	-0.0562***	-0.0541***
	(-4.99)	(-3.73)	(-3.15)	(-5.84)	(-4.85)	(-4.33)
M/B	-0.0230***	-0.0160***	-0.0247***	-0.0241**	-0.0242***	-0.0346***
	(-2.74)	(-2.59)	(-3.58)	(-2.49)	(-3.43)	(-4.31)
ROA	-0.695***	-0.293***	-0.276***	-0.796***	-0.362***	-0.355***
	(-6.16)	(-5.72)	(-5.13)	(-5.87)	(-5.92)	(-5.39)
Stock return	0.201***	0.0537***	0.0771***	0.145***	0.0454***	0.0621***
	(5.86)	(7.13)	(9.80)	(3.63)	(5.21)	(6.75)
Book leverage	-0.0301	0.0945**	0.101**	0.0419	0.145***	0.157***
	(-0.53)	(2.33)	(2.38)	(0.65)	(3.00)	(3.05)
Observations	754	4321	3583	758	4351	3609
Adjusted R^2	0.637	0.703	0.724	0.633	0.623	0.630
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Coastal region dummy	Yes	Yes	Yes	Yes	Yes	Yes
Estimation Method	OLS-Between	OLS	IV	OLS-Between	OLS	IV

Table 3.5: Outsourcing Intensity and R&D

The table displays the effects of outsourcing intensity (*PO1year/COGS*) on R&D investment. The dependent variable is *R&D/sales* which is R&D expenditures divided by sales in the prior year. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	Dependent variable: R&D/sales				
PO1year/COGS	0.0463*	0.0410**	0.0496**	0.0684***	0.0959***
	(1.66)	(1.96)	(2.37)	(2.88)	(3.74)
Log(sales)		-0.00776***	-0.0160***	-0.0175***	-0.0176***
		(-2.74)	(-3.98)	(-3.81)	(-4.46)
Log(1+age)		-0.00259	-0.00125	-0.000880	-0.00206
		(-0.63)	(-0.30)	(-0.19)	(-0.53)
M/B		0.0246***	0.0220***	0.0246***	0.0224***
		(5.00)	(3.86)	(3.94)	(4.11)
ROA		-0.394***	-0.385***	-0.397***	-0.388***
		(-7.04)	(-5.96)	(-5.44)	(-5.79)
Stock return (lagged)		0.0148***	0.0145***	0.0152***	0.0149***
		(4.19)	(3.30)	(3.09)	(3.35)
Log(CEO age)			-0.0247	-0.00781	-0.0288
			(-0.98)	(-0.28)	(-1.20)
Log(1+tenure)			-0.00356	-0.00121	-0.00324
			(-0.85)	(-0.25)	(-0.78)
Log(CEO delta) (lagged)			0.00508**	0.00640**	0.00596**
			(2.16)	(2.44)	(2.56)
Log(CEO vega) (lagged)			0.00899***	0.00982***	0.0103***
			(5.69)	(6.28)	(6.75)
Observations	4656	4604	3604	3580	3604
Adjusted R^2	0.457	0.563	0.579		0.530
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes
Coastal region dummy	Yes	Yes	Yes	Yes	Yes
Estimation Method	OLS	OLS	OLS	Heckman	IV

Table 3.6: R&D and Risk-Taking Incentives

The table displays the effects of risk-taking incentives (*Log(CEO delta)* and *Log(CEO vega)*) on R&D investment. The dependent variable is *R&D/sales* which is R&D expenditures divided by sales in the prior year. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. In addition to the whole sample, the sample is sorted by outsourcing intensity into four subsamples; firms without purchase contracts and the three quantile groups based on *PO1year/COGS* (Low, Medium, and High). Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	Dependent variable: R&D/sales				
		Quantile(PO1year/COGS):			
	Whole Sample	(1) PO1year/COGS=0	(2) Low	(3) Medium	(4) High
Log(CEO delta) (lagged)	0.00570**	-0.00318	0.00932**	0.00754	0.00482
	(2.39)	(-0.57)	(2.04)	(1.49)	(0.94)
Log(CEO vega) (lagged)	0.0108***	0.0139***	0.0101***	0.0109***	0.0125***
	(7.02)	(3.74)	(3.24)	(3.22)	(4.65)
Log(sales)	-0.0171***	-0.0193**	-0.0137*	-0.0203*	-0.0208***
	(-4.25)	(-2.37)	(-1.70)	(-1.89)	(-3.21)
Log(1+age)	-0.00334	-0.00579	-0.0147**	0.00247	0.00244
	(-0.83)	(-0.49)	(-2.22)	(0.32)	(0.28)
M/B	0.0239***	0.0134*	0.0441***	0.0103	0.0181**
	(4.59)	(1.83)	(3.41)	(1.48)	(2.49)
ROA	-0.392***	-0.349***	-0.431***	-0.352***	-0.404***
	(-6.01)	(-3.07)	(-3.36)	(-2.78)	(-4.67)
stock return (lagged)	0.0159***	0.0169**	0.00904	0.0141	0.0225**
	(3.55)	(2.12)	(1.10)	(1.62)	(2.07)
Log(CEO age)	-0.0288	-0.125**	-0.00474	-0.0493	0.00130
	(-1.20)	(-2.21)	(-0.08)	(-1.26)	(0.03)
Log(1+tenure)	-0.00367	-0.00434	-0.00334	-0.00166	0.00257
	(-0.88)	(-0.61)	(-0.35)	(-0.25)	(0.31)
Observations	3604	692	949	966	997
Adjusted R^2	0.525	0.476	0.565	0.452	0.556
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes
Coastal region dummy	Yes	Yes	Yes	Yes	Yes

Table 3.7: CEO Diversification and Equity-Based Compensation

The specification (1) examines the effect of an increase in outsourcing intensity (Δ*PO1year/COGS*) on the probability that CEOs sell their shares, using profit estimations. The dependent variable, *CEO sells share* is a dummy variable that equals 1 if the CEO sold shares of her firm in the given fiscal year. The specification (2) presents the effects of outsourcing intensity *PO1year/COGS* and diversifying action of the CEO in the prior year (*CEO sells share - lagged*) on the proportional use of equity-based compensation. The dependent variable is *% Equity Comp* which the proportion of dollar value of equity-based compensation in dollar value of total direct compensation. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. In addition to the whole sample, the sample is sorted by outsourcing intensity into four subsamples; firms without purchase contracts and the three quantile groups based on *PO1year/COGS* (Low, Medium, and High). Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	(1) Dependent var: CEO sells share?		(2) Dependent var: % Equity Comp		
	Whole Sample	PO ever exists			
PO1year/COGS			0.0728**	0.0932**	0.0920**
			(2.16)	(2.21)	(2.19)
CEO sells share (dummy-lagged)					0.0304***
					(3.21)
Δ PO1year/COGS	0.394*	0.385*			
	(1.87)	(1.79)			
Log(sales)	0.00362	0.0467	0.0185***	0.0183***	0.0188***
	(0.11)	(1.19)	(3.10)	(3.08)	(3.18)
Log(1+age)	-0.136**	-0.175**	-0.0136	-0.0133	-0.0123
	(-2.21)	(-2.57)	(-1.42)	(-1.39)	(-1.29)
M/B (lagged)	0.0395	0.0213	0.0134***	0.0131***	0.0122***
	(1.51)	(0.75)	(3.16)	(3.07)	(2.89)
ROA (lagged)	0.302	0.190	0.0539	0.0544	0.0417
	(1.26)	(0.70)	(1.22)	(1.23)	(0.97)
Stock return (lagged)	0.376***	0.398***	-0.00922	-0.00939	-0.0121
	(6.90)	(6.38)	(-1.07)	(-1.09)	(-1.42)
Log(CEO age)	-0.465	-0.501	-0.151***	-0.151***	-0.147***
	(-1.62)	(-1.57)	(-3.00)	(-3.00)	(-2.94)
Log(1+tenure)	0.248***	0.303***	-0.0409***	-0.0408***	-0.0425***
	(5.88)	(6.43)	(-6.19)	(-6.18)	(-6.39)
Log(CEO delta) (lagged)	0.0948***	0.0894**	0.0000791	0.000142	-0.00116
	(2.68)	(2.12)	(0.01)	(0.02)	(-0.19)
Log(CEO vega) (lagged)	0.0784***	0.0522*	0.0465***	0.0464***	0.0459***
	(3.03)	(1.65)	(8.59)	(8.56)	(8.69)
Observations	3520	2812	3564	3564	3564
Pseudo / Adjusted R^2	0.126	0.131	0.261	0.261	0.264
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes
Coastal Region dummy	Yes	Yes	Yes	Yes	Yes
Estimation Method	Probit	Probit	OLS	IV	IV

Table 3.8: Outsourcing and % of Equity-Based Compensation over Different CEO Delta-Vega

The table displays the effects of outsourcing intensity (*PO1year/COGS*) on the proportional usage of equity-based compensation. The dependent variable is *% Equity Comp* which the proportion of dollar value of equity-based compensation in dollar value of total direct compensation. Other variables are defined in Appendix. The sample consists of 822 manufacturing firms with available firm-years data in the period of 2004-2010. In addition to the whole sample, the sample is sorted by CEO delta and CEO vega into four subsamples; Low-Low, Low-High, High-Low and High-High groups of CEO delta-vage. Year, industry (in each three-digit SIC code), and coastal region fixed effects are included in all specifications. *t-statistics* (in parenthesis) are robust and adjusted for clustering at the firm level. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

	Dependent variable: % Equity Comp				
	Whole Sample	(1) Low Delta Low Vega	(2) Low Delta High Vega	(3) High Delta Low Vega	(4) High Delta High Vega
PO1year/COGS	0.108***	0.118	0.187*	0.0571	0.114*
	(2.59)	(1.46)	(1.89)	(0.47)	(1.86)
Log(sales)	0.0219***	0.0374***	0.0264*	0.0443**	0.00907
	(3.75)	(4.15)	(1.77)	(2.23)	(0.95)
Log(1+age)	-0.0153	-0.0144	-0.00546	-0.0498	-0.00709
	(-1.64)	(-0.95)	(-0.26)	(-1.50)	(-0.46)
M/B	0.0215***	0.0216*	0.0304	0.0201	0.0272***
	(3.32)	(1.88)	(1.61)	(1.03)	(3.07)
ROA	-0.149***	-0.0608	-0.200	-0.265	-0.348***
	(-3.06)	(-0.84)	(-1.51)	(-1.32)	(-4.75)
Stock return (lagged)	-0.0177*	-0.0383***	-0.0441	-0.00323	-0.0331
	(-1.72)	(-2.61)	(-1.45)	(-0.11)	(-1.36)
Log(CEO age)	-0.155***	-0.127	-0.382***	-0.123	-0.0912
	(-3.10)	(-1.65)	(-3.28)	(-0.83)	(-1.08)
Log(1+tenure)	-0.0401***	-0.0524***	-0.0113	-0.0648***	-0.0348***
	(-6.09)	(-4.64)	(-0.48)	(-2.74)	(-3.68)
Log(CEO delta) (lagged)	0.00294	0.0344***	-0.0547	-0.0418	0.0191
	(0.51)	(2.82)	(-1.00)	(-1.64)	(1.34)
Log(CEO vega) (lagged)	0.0447***	0.0258***	0.0857*	0.0507***	0.0122
	(8.36)	(2.73)	(1.74)	(4.56)	(0.84)
Observations	3584	1353	433	402	1396
Adjusted R^2	0.261	0.185	0.145	0.327	0.157
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes
Coastal region dummy	Yes	Yes	Yes	Yes	Yes
Estimation Method	IV	IV	IV	IV	IV

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