CHAPTER 1 INTRODUCTION

1.1 Agency Theory and Managerial Ownership

Agency theory (Jensen and Meckling, 1976) assumes that the organizational form with the lowest agency costs is one in which the leader (chief executive officer [CEO] or president) owns 100% of the company; in this case, the top executive is also the principal (owner). When the top executive is not the sole owner, then that individual becomes an agent (employee) of the firm, at which point agency problems begin to arise. In other words, agency problems are said to occur when agents pursue individual goals that are not necessarily consistent with those of the organization.

Corporate governance is defined as "the set of mechanisms that induce the self-interested controllers of a company to make decisions that maximize the value of the company to its owners (Denis and McConnell, 2003, p. 2)." Corporate governance mechanisms can be broadly characterized as being either internal or external to the firm. The internal mechanisms of primary interest are the board of directors (Fama and Jensen, 1983), executive compensation (Lewellen and Huntsman, 1970), as well as managerial ownership (Jensen and Meckling, 1976). The external mechanisms are the threat of takeover (Jensen and Ruback, 1983), competition of products (Hart, 1983), institutional ownership (Brickley, Lease, and Smith, 1988), the market for managerial talent (Fama, 1980), and the legal system. However, emerging markets generally suffer from a lack of shareholder protection (Lins, 2003), and Taiwan is characterized by the absence of effective audit committee, low institutional ownership, and an inactive takeovers market (Chow, Chen, and Chen, 1996; Yeh, Lee, and Woidtke, 2001). These facts suggest that corporate governance in Taiwanese firms appears to rely principally on internal mechanisms rather than on external controls.

According to the 2000 Watson Wyatt report on U.S. executive pay trends, companies that offer more stock ownership to senior-level executives have better rates of return for their shareholders. Since the early 1990s, stock-based compensation plans have been adopted by many Taiwanese high-tech firms. It is often claimed that one of the major reasons for the success of Taiwan's information technology sector is due to the adoption of these unique employee financial participation scheme (often referred to as the "Taiwanese-style profit sharing and employee stock ownership plans") (Han, 2003). In August 2000, the Securities and Futures Commission in Ministry of Finance, R.O.C. further established the systems of "employee stock option" and "treasury stock" to allow Taiwanese firms to buy back their shares to be either transferred to employees or used for the issuance of employee stock options. Following the experience of U.S.[1], the stock-based compensation plans in Taiwan should also be mainly targeted toward management. In order to provide a valuable lesson for other developing economies, empirical evidence on whether managerial stock ownership affects agency cost in a country such as Taiwan (which has industrialized fairly rapidly) is worth exploring.

1.2 The Electronics Industry in Taiwan

During the past two decades, a great deal of attention regarding the performance of Taiwan's economy has been paid to the electronics industry. In 2000, the electronics industry alone accounted for 40% of the total sales and 72% of the total profits (before taxes) generated by all firms listed on the Taiwan Stock Exchange Corporation (TSEC). In addition, Taiwan's integrated circuit (IC), computers and peripherals, and telecommunication industries have also played prominent roles on the international platforms. For instance, the value of information hardware products of the major countries from around the world is summarized in Table 1.1. Notably, Taiwan ranked in the top four in both 1999 and 2000 in terms of domestic production. Since many Taiwanese businessmen have made vast amounts of investments in China during the past ten years, the aggregate value of the "Greater China" area should

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[1] American Compensation Association (now known as WorldatWork) surveyed 915 U.S. companies in August 2000, and reported that stock-based compensation plans were adopted among 51% of the sample companies and were available to 100% of upper management and 95% of middle management. However, no such study is currently available in Taiwan.

provide valuable information. By aggregating the Year 2000 outputs of Taiwan and China together, the Greater China area would be the second largest information hardware producer in the world, only next to the United States. Given the accelerative nature of technology development, high-tech firms are often characterized by rapid growth and abundant investment opportunities, and thus are expected to face a high degree of information asymmetry between managers and shareholders (Gaver and Gaver, 1995). This could lead to potential agency problems as the objectives of the principal (shareholders) and the agent (managers) are not always identical.

Table 1.1 Major Producers of Information Hardware Products

Country	Year 1999		Year 2000		Growth Rate (2000 over 1999)
	Value* (US$ 1 million)	Rank	Value* (US$ 1 million)	Rank	
U.S.	85,085	1	88,489	1	4%
Japan	44,051	2	45,468	2	3.2%
China	18,455	4	25,535	3	38.4%
Taiwan	21,023	3	23,081	4	9.8%
U.K	16,007	5	16,167	5	1%
Germany	10,910	6	12,001	6	10%

* Value includes only domestic products of information hardware.

Source: Information Technology Industry Yearbook, Industrial Economics & Knowledge Center, Industrial Technology Research Institute, Taiwan, R.O.C.

1.3 Firm Performance

Most prior studies in this area have merely documented the effects that managerial ownership has on financial performance measures such as accounting rate of return and Tobin's Q, with little attempt to assess its impact on economic performance measures such as productivity or efficiency. However, Kaplan and Norton (1992) devise a balanced scorecard because they believe the traditional financial performance measures are out of step with the skills and competencies that companies are trying to master today. Their balanced scorecard includes financial measures that tell the results of actions already taken but complements the financial measures with operational measures on internal processes, customer satisfaction, and the organization's innovation and improvement activities. In addition, the core of a business organization is its operational function – that is, the process of transforming inputs into outputs; and the importance of efficiency has been featured in many researches. For example, the pioneering work by Solow (1957) concludes that approximately 90% of the increase in real per capita output (and thus the standard of living) is attributable to efficiency growth. From an agency theory perspective, Hill and Snell (1989) also theorize that managerial stock ownership does affect a firm's posture toward strategies of diversification (either related or unrelated) and investment in R&D (product and process innovations), which in turn explain differences in productivity among firms. Therefore, the focus of this study is the empirical effect of managerial ownership on overall firm performance, including financial, economic, as well as time measures.

1.4 Objectives and Organization of this Study

This work attempts to bring together the literatures on corporate finance, productivity and survival analysis, and differs from prior studies in the following ways. First, it investigates the agency problem not only from traditional financial point of view, but also from economic and longitudinal perspectives. Tobin's Q and return on assets (ROA) are used as financial performance measures. Technical efficiency and total factor productivity are employed as economic performance measures. Survival time for initial public offerings (IPO) is taken as the duration measure for firm performance. Second, since there is a reason to believe that not all insiders have equal access to non-public information (Nunn, Madden, and Gombola, 1983), examining sub-group of insiders might provide additional insights into corporate governance structures. The insiders (a broad definition of management) are sub-classified into executives, board members, and large shareholders in order to allow for more in-depth analysis. Third, longitudinal models, instead of traditional cross-sectional analyses, are employed to control for any unobservable firm heterogeneity. Hill and Snell (1989) support the optimal use of panel data by stating the limitation of their cross-sectional analysis: "We use static data to test for what are undoubtably dynamic relationships. Longitudinal analysis would have been preferable … (p. 43)." Fourth, in order to ensure that our results are not affected by endogeneity of ownership, lagged insider ownership is employed as the independent variable. Last but not least, in addition to surveying the general situation in Taiwan, this study further investigates the electronics industry in terms of efficiency and productivity, because the high-tech sector is the first to adopt the stock-based compensation plans and is now the most important contributor to Taiwan's economy.

There are four more chapters besides this introductory one. The relation between managerial ownership and firm performance as well as the financial, economic, and duration measures of firm performance are reviewed in Chapter 2. Chapter 3 then describes the empirical models and the data. Chapter 4 presents the empirical results and the managerial implications. Finally, conclusive remarks are provided in the last chapter.

CHAPTER 2 LITERATURE REVIEW

Given the governance issues arising form the separation of ownership from control, the ability to align managerial and shareholder interests via insider ownership of equity is an important topic of inquiry. Despite the central importance of this issue to a corporate finance researcher, no theoretical or empirical consensus currently exists on whether managerial ownership affects firm performance. In this chapter, the relation between managerial ownership and firm performance are reviewed, and then the financial, economic, as well as duration measures of firm performance are introduced.

2.1 Managerial Ownership and Firm Performance

Three aspects of pertinent literature – i.e. the positive relation, irrelevancy or the negative relation, and the nonlinear relation between managerial ownership and firm performance, are reviewed to provide a thorough theoretical background for this work. The relation between managerial ownership and IPO survivability, as well as endogeneity and managerial ownership structure, are also discussed.

2.1.1 Positive Relation between Managerial Ownership and Performance

Jensen and Meckling (1976) suggest that insiders (management) deviate from the goal of shareholder wealth-maximization by consuming perquisites when they do not have an ownership stake in the firm. Accordingly, higher insider stockholding is hypothesized to align managerial interests with shareholders' interests. Leland and Pyle (1977) show that the entrepreneur's willingness to invest in his own project can serve as a signal of project quality, and that the value of the firm increases with the share of the firm held by the entrepreneur. Chung and Pruitt (1996) examine 404 publicly-held U.S. companies for the year of 1987 via a simultaneous equations model and find that executive (CEO) equity ownership positively influences Tobin's Q. Palia and Lichtenberg (1999) investigate 255 U.S. manufacturing firms between 1982 and 1993 and observe a positive relationship between managerial (top officers and board members) ownership and firm productivity. Core and Larcker (2002) analyze 195 U.S. firms that had adopted target ownership plans for top executives from 1991 to 1995 and find that excess accounting returns and stock returns were higher after the plans were adopted.

In Taiwan, Yeh and Chiu (1996) examine 137 TSEC listed companies from 1987 to 1991 and show that ownership concentration is positively related to a proxy of firm value generated by factor analysis. Yeh and Chiu also indicate that the lack of effective external corporate governance mechanism in Taiwan might induce significant equity agency costs.

2.1.2 Irrelevancy or Negative Relation between Managerial Ownership and Performance

In contrast, other investigators have proposed that the relation between managerial ownership and firm performance is unrelated or even negative. Demsetz (1983, p. 384) argues that the ownership structure of a firm that "emerges is an endogenous outcome of competitive selection in which various cost advantages and disadvantages are balanced to arrive at an equilibrium organization of the firm". Accordingly, Demsetz concludes that there is no relation between ownership structure and corporate performance. Demsetz and Lehn (1985) and Demsetz and Villalonga (2001) present evidences consistent with Demsetz's conclusions by examining cross-sectional data in 1980 and in the late 1970s, respectively. Agrawal and Knoeber (1996) investigate 383 Forbes-standing U.S. firms for the year of 1987 and find no effect of insider (officers and directors) shareholding on Tobin's Q. Cho (1998) uses cross-sectional data from 326 Fortune 500 firms in 1991 and finds, from the results of his simultaneous regression, that Tobin's Q affects ownership structure but not vice-versa. Himmelberg, Hubard, and Palia (1999) use panel data of 398 U.S. firms from 1982 to 1992 and control for firm fixed effects to re-examine the ownership-performance relationship.

Himmelberg et al. find no meaningful correlation between managerial (top managers and directors) ownership and Tobin's Q. However, Zhou (2001) criticizes the methodology of Himmelberg et al. (1999) by pointing out that fixed effects estimators may not be able to detect the effect that ownership has on firm performance even if such a relationship exists.

In Taiwan, Yu and Chou (1994) examine TSEC listed companies from 1987 to 1991 and classify insiders into seven groups.[2] Yu and Chou show that both total insider ownership and director ownership impact Tobin's Q negatively, whereas top officers' ownership has no effect on Tobin's Q. They propose a potential explanation for the monotonic negative relation between director ownership and Tobin's Q that board members might withhold the stock price of a firm because of their motives to repurchase stocks, to oppose takeovers, or to expropriate debt-holders. Wang (2001) investigates 133 Taiwanese publicly-held firms from 1989 to 1998 via a cross-sectional simultaneous equations model and find that insider ownership does not influence Tobin's Q.

2.1.3 Nonlinear Relation between Managerial Ownership and Performance

In a seminal study by Morck, Shleifer, and Vishny (1988), the existence of a nonlinear relationship between managerial ownership and firm performance was proposed. Morck et al. examine 371 Fortune 500 firms for the year of 1980 using piecewise linear regression and find a positive relationship between Tobin's Q and management ownership for the 0% to 5% board ownership range, a negative relationship in the 5% to 25% board ownership range (where managers are entrenched), and a positive relationship again for board ownership exceeding 25%. The same three-stage relationship as above is also observed by Morck et al. for top officer ownership and outside director ownership, respectively. McConnel and Servaes

[2] Yu and Chou (1994) divide insiders into (1) top officers, (2) directors, (3) supervisors, (4) related parties, (5) directors which is also a supervisor, (6) directors who is also a supervisor and an executive, and (7)large shareholders.

(1990) investigate 1173 NYSE/AMEX firms for the year 1976 and 1093 firms for the year 1986 and find an inverted U-shaped relation between Tobin's Q and insider (officers and directors) ownership, with the inflection point between 40% and 50%. Using ROA as the dependent variable, McConnel and Servaes obtain a similar inverted U-shaped relation between firm profitability and insider ownership. Short and Keasey (1999) use the ratio of market value to book value of equity and the return on shareholders' equity as measures of firm performance and find, in their sample of 255 U.K. firms from 1988 to 1992, a similar cubic relationship to the one found by Morck et al. (1988); the difference being that U.K. management becomes entrenched at higher levels of director ownership than their U.S. counterparts.[3]

In Taiwan, Yeh, Chiu, and Ho (1997) use the 5-year average number of 71 TSEC listed companies between 1987 and 1991 to test the relation between ownership structure and wealth exploitation from minority shareholders. Their empirical results show that the amount of wealth exploitation first rises and then falls with managerial stockholding, which has been defined as director, executive, and large shareholder ownership, respectively.

2.1.4 Managerial Ownership and IPO Survivability

Initial public offering (IPO) firms are organizations that offer their stock to the public market for the first time while moving from private to public ownership. An IPO firm undergoes numerous internal changes as it submits to the scrutiny of shareholders, investment bankers, and the Securities and Exchange Commission (Welbourne and Andrews, 1996). It then tries to acquire professional management, achieve a highly profitable business and provide transparency in organization and operations. The aftermarket performance of initial public offerings has received increased attention since Ritter's (1991) exposure of the potential wealth hazard of a buy-and-hold strategy toward investing in IPOs. The emphasis

[3] Short and Keasey (1999) state that ownership data in the U.K. are only available for directors of the firm, and not for other officers/managers.

thus far has been on the patterns in issuing activity, short-term underpricing, and long-run underperformance (Ritter and Welch, 2002). However, the question of survivability becomes especially important following periods of radical organizational transformations, and few events can compare with an IPO in terms of the fundamental change to strategy, structure, personnel, control process, and operating procedures of a firm. According to U.S. experience, approximately a third of IPO issuing firms either fail or are acquired within five years of going public (Jain and Kini, 1999). Additional information on the survival profile of an IPO can be very valuable to the security market as well as to the issuers. Investors could assess their portfolio returns/risks more properly, and issuing firms could make better decisions when proceeding with the IPO. Given the extent of research in corporate governance that has pointed to the potential role of managerial ownership in solving agency problem, an obvious question that arises is whether the insider stockholding improves the survival profile of IPO issuers.

For an IPO, failure to survive is defined as delisting from the trading exchange for negative reasons. The survival profile of IPO issuers can be accessed by evaluating the survival and the hazard functions. The survival function indicates the likelihood that a randomly selected IPO firm will survive longer than a specified period of time, while the hazard function describes the conditional probability that an IPO issuer will fail in the future given that it has survived up to the current time. Survival analysis techniques consider censored observations that arise when the duration of a study is limited, and thus avoid sampling bias (Shumway, 2001).

As to examining IPO survivability, two previous studies apply the identical log-logistic accelerated failure time (AFT) model but arrive at conflicting results. Hensler, Rutherford, and Springer (1997) investigate 741 IPOs on the NASDAQ between 1975 and 1984, and find that the survival time for IPOs increases with offer size, age of the firm at the offering, the initial return, IPO activity level in the market, and the percentage of insider ownership, while the survival time decreases upon increasing the general market level at the time of the offering and the number of risk characteristics. In a later paper, Jain and Kini (2000) analyze 877 IPO firms in the United States between 1977 and 1990, and find that the involvement of venture capitalists improves the survival profile of IPO firms, while managerial ownership retention and offer size are not significant at all.

2.1.5 Endogeneity and Managerial Ownership Structure

As mentioned earlier, several cross-sectional studies find either that there is no relation between managerial ownership and firm performance at all or that Tobin's Q affects ownership structure but not vice-versa. However, their results might be caused by measuring ownership and performance at the same time. Since top management are likely to have inside information about a firm's prospects, they have an incentive to adjust their portfolios based on their own estimates of future performance. Therefore, Jensen and Warner (1988) and Hermalin and Weisbach (1991) agree that cross-sectional regressions of Tobin's Q on ownership may be misleading as well as statistically incorrect because the results are contaminated by the effects of Tobin's Q on ownership. Hermalin and Weisbach (1991) further suggest the use of time-series data on ownership as a control for the possible simultaneity between ownership and Tobin's Q. To attenuate the potential spurious relation between ownership and performance caused by contemporaneous cross-sectional analysis, we have taken the 1-year lagged insider ownership as the independent variable to ensure that our 'cause' (ownership) precedes the 'consequence' (performance). This approach of lagging the endogenous variables by one-period is commonly used in longitudinal studies (such as Palia and Lichtenberg, 1999; and Han, 2003).

Following the lead of La Porta, Lopez-de-Silanes, and Shleifer (1999), some scholars began to identify the single ultimate controlling shareholders for corporations in East Asian countries (Claessens, Djankow, and Lang, 2000) and emerging markets (Lins, 2003). However, the process of constructing ultimate ownership requires data sources that capture the full breadth of any overlaps among family members, other companies, and other institutions. In the absence of detailed ownership data, Lins (2003) follows the convention of La Porta et al. (1999) by matching managers and families based on family surname, but this match is obviously imperfect when family members do not share the same surname (Lins, 2003, p. 180) or when non-family members share the same surname, which is often the case in Taiwan. This potential misclassification may cause a serious bias in the ownership measure. Therefore, given the lack of comprehensive pyramid structures and cross-holdings data up to now in Taiwan, we are precluded from conducting such an analysis of ultimate control in the present study. Instead, our attention is focused on another critical and largely ignored aspect of ownership structure – namely, the composition of insider ownership.

Nunn, Madden, and Gombola (1983) propose a hierarchy among the insiders regarding their functional roles within a firm. With direct responsibility for promoting all major corporate policies, top officers are expected to have the greatest access to non-public information. Directors, as members of the board, are responsible for advising top officers on all strategic decisions but have no day-to-day operational duties. Blockholders (i.e. those holding 10% or more of the outstanding shares) on the other hand, do not take part in the day-to-day operations of the firm and would not normally be consulted on most corporate decisions. Thus, in this study insiders are sub-classified into executives, board members, and large shareholders so as to examine the effect of insider ownership structure on firm performance.

Table 2.1 summarizes the empirical tests on the relation between ownership and performance discussed in this chapter. It can be observed that traditional studies have mostly focused on the effect of ownership on Tobin's Q (e.g., Morck, Shleifer, and Vishny, 1988; McConnel and Servaes, 1990; Agrawal and Knoeber, 1996; Chung and Pruitt, 1996; Cho, 1998; Himmelberg, Hubard, and Palia, 1999; Demsetz and Villalonga, 2001; in Taiwan, Yu and Chou, 1994, and also Wang, 2001). However, since Tobin's Q is buffeted by investor psychology pertaining to forecasts of a multitude of world events (Demsetz and Villalonga, 2001), caution is needed when viewing Q as a performance measure. In addition, since Tobin's Q incorporates only a single day's stock price information at the end of a year, the fact that the stock market of Taiwan is so volatile means that Tobin's Q might not be able to represent firm performance of an entire year adequately. Unlike prior research, this study attempts to measure firm performance based on a more comprehensive set of variables – Tobin's Q, ROA, technical efficiency, total factor productivity, and IPO survival time; and further aims to identify specific sub-group insider holding strategies that can improve overall performance for a firm.

Table 2.1 Summary of Prior Empirical Works on Ownership and Performance

Impact of Ownership on Performance	Author	Managerial Ownership Variable	Firm Performance Variable
Positive	Chung & Pruitt (1996)	CEO ownership	Tobin's Q
	Hensler, Rutherford, & Springer (1997)	Insider ownership	IPO survival time
	Palia & Lichtenberg (1999)	Managerial ownership	Total factor productivity
	Core & Larcker (2002)	Mandatory executive ownership	ROA, Excess stock return
	Yeh & Chiu (1996), Taiwan	Ownership concentration	Firm value
Irrelevant	Demsetz & Lehn (1985)	Ownership concentration	Accounting profit rates
	Agrawal & Knoeber (1996)	Insider ownership	Tobin's Q
	Cho (1998)	Insider ownership	Tobin's Q
	Himmelberg, Hubard, & Palia (1999)	Managerial (top officers & directors) ownership	Tobin's Q
	Jain & Kini (2000)	Managerial ownership	IPO survival time
	Demsetz & Villalonga (2001)	Management ownership	Tobin's Q, ROE
	Wang (2001), Taiwan	Insider ownership	Tobin's Q
Negative	Yu & Chou (1994), Taiwan	Total insider ownership, Director ownership	Tobin's Q
Nonlinear	Morck, Shleifer, & Vishny (1988)	Management (board) ownership, Top officer ownership, Outside director ownership	Tobin's Q
	McConnel & Servaes (1990)	Insider (officers & directors) ownership	Tobin's Q, ROA
	Short & Keasey (1999)	Managerial (directors) ownership	MVE/BVE, ROE
	Yeh, Chiu, & Ho (1997), Taiwan	Directors ownership, Executive ownership, Blockholder ownership	Wealth exploitation

2.2 Measures of Firm Performance

Three perspectives of firm performance measures, i.e. the financial measures such as Tobin's Q and ROA, the economic measures such as technical efficiency and total factor productivity, and the longitudinal measure of survival duration are introduced to provide an extensive technical background for this study.

2.2.1 Tobin's Q and ROA

Defined as the ratio of the market value of a firm to the replacement costs of its assets, Tobin's Q was first introduced as a predictor of a firm's future investments (Tobin and Brainard, 1968). Since then this measure has been used to explain a wide variety of corporate phenomena, including the relationship between managerial equity ownership and firm performance. A Tobin's Q above one indicates that the market views the firm's internal organization as exceptionally good or the expected agency costs as particularly low. Although multiple methods have been proposed for calculating the Q ratio, the different approaches tend to yield very similar values for Tobin's Q. Chung and Pruitt (1994) develop a simple formula for approximating Tobin's Q, which requires only basic financial and accounting information. Specifically in their method,

Approximate Q = (MVE + PS + D)/TA

where

MVE = (Closing price of share at the end of the financial year)*(Number of common shares outstanding);

PS = Liquidating value of the firm's outstanding preferred stock;

D = (Current liabilities − Current assets + Book value of long-term debt), and

TA = Book value of total assets.

Compared with the more theoretically correct model of Lindenberg and Ross (1981), at least 96.6% of the variability of Tobin's Q is explained by the approximate Q. In this study, Chung and Pruitt's method is employed to calculate Q.

As presented in Table 2.1, the earliest empirical study of Demsetz and Lehn (1985) used accounting profit rates to measure firm performance. Almost all of the studies that followed used Tobin's Q. However, caution is needed when employing Tobin's Q (Demsetz and Villalonga, 2001). Accounting profit rate is not affected by the psychology of investors, and only partially involves estimates of future events, mainly in the valuations it places on goodwill and depreciation. Therefore, although researchers in economics have long expressed concern over the use of accounting rates of return as proxies for the economic rate of return, ROA (generally derived as net income divided by value of assets) is still frequently used as the measure of firm profitability (Chen and Lee 1995).

2.2.2 Technical Efficiency and Stochastic Frontier

Production theory suggests a transformation process in which the firm employs and transforms different inputs, such as labor and capital, into outputs. With the production technology as given, technical efficiency pertains to getting the most out of a set of input resources. Farrel (1957) develops a method of measuring firm technical efficiency in a homogenous industry by estimating the production frontier, which represents the maximum output attainable at each input level. Firms that are technically efficient in their industry operate on the frontier, while technically inefficient firms operate beneath the frontier. Figure 2.1 shows a typical production frontier *f* with one input X and one output Y. Suppose the firm operates at point A with actual output of Y_1. According to the production frontier, the firm can increase its output level to that of point B, i.e. Y_1^{max}, using the same amount of input X_1. Hence, the distance AB can be regarded as technical inefficiency for the firm under consideration.

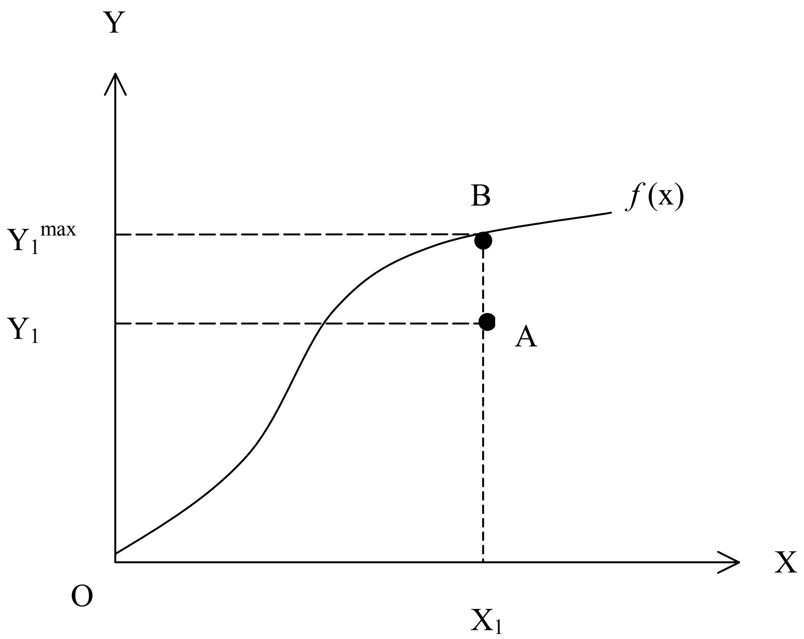

Figure 2.1 Production Frontier *f* (x) and Technical Efficiency

Aigner, Lovell and Schmit (1977) and Meeusen and van den Broeck (1977) independently propose the stochastic frontier production function, defined by:

$$Y_i = f(X_i;\beta)\cdot \exp(V_i - U_i) \qquad (2.1)$$

where Y_i denotes the output for the *i*-th firm; X_i represents a (1×K) vector of inputs; β is a (K×1) vector of unknown parameters to be estimated; V_i denotes the random error that accounts for measurement error and the effects of other random factors (e.g. weather, strikes, luck, and so on) not under the control of the firm, and U_i represents a non-negative random variable associated with technical inefficiency. Notably, Aigner et al. (1977) assume that the V_i's were independent and identically distributed (i.i.d.) normal random variables with zero mean and variance of σ_v^2, independent of the U_i's. The ratio of observed output for the *i*-th firm, relative to potential maximum output, given input vector X_i, is used to define the technical efficiency of the *i*-th firm (TE_i), which takes a value between zero and one:

$$TE_i = \frac{Y_i}{Y_i^{\max}} = \frac{f(X_i;\beta)\cdot \exp(V_i - U_i)}{f(X_i;\beta)\cdot \exp(V_i)} = \exp(-U_i) .$$

To investigate the determinants of technical inefficiency, Battese and Coelli (1995) propose a panel data model that specifies technical inefficiency effects as a function of some firm-specific factors:

$$U_{it} = Z_{it}\delta + W_{it}$$

where Z_{it} denotes a (1×M) vector of observable explanatory variables for the i-th firm at the t-th time period; δ represents a (M×1) vector of unknown parameters to be estimated, and W_{it} is an unobservable random error defined by the truncation of the normal distribution with zero mean and variance of σ^2. The truncation point of W_{it} is $-Z_{it}\delta$, that is, $W_{it} \geq -Z_{it}\delta$. Thus, the technical inefficiency effect U_{it} is obtained by the truncation (at zero) of the normal distribution with mean of $Z_{it}\delta$ and variance of σ^2. The maximum likelihood method is employed to estimate the parameters β and δ simultaneously, and variance parameters are expressed in terms of $\sigma_s^2 = \sigma_v^2 + \sigma^2$ and $\gamma = \sigma^2 / \sigma_s^2$.

2.2.3 Total Factor Productivity

As a relative concept, a natural measure of productivity is the ratio of outputs to inputs. Productivity in this work is referred to total factor productivity (TFP), which is defined as the "ratio of total output to the sum of associated labor and capital (factors) inputs" (Edosomwan, 1985, p. 3). Other traditional measures of productivity, such as labor productivity in a factory and land productivity in farming, are what is known as partial productivity. The partial productivity measure could provide a misleading indication of overall productivity because it overemphasizes one input and neglects others (Ghalayini and Noble, 1996). A good index of productivity must account for the services of all or at least most of the inputs employed by the firm – and the TFP is such an index. For simplicity, this study takes total value added as the aggregated measure of outputs for a firm. Let L denote labor input, and K denote capital input. TFP is thus defined as

$$TFP = \frac{VAD}{f(L,K)} \quad , \tag{2.2}$$

where VAD denotes total value added and $f(\bullet)$ denotes total input. Equation (2.2) could be rewritten in a form of production function:

$$VAD = TFP \cdot f(L,K) \, .$$

Without loss of generality, we take $f(\bullet)$ as a Cobb-Douglas function[4] and represent the output accordingly:

$$VAD = TFP \cdot L^{\alpha_L} \cdot K^{\alpha_K} \, , \tag{2.3}$$

where α_L and α_K represent how the output responds to changes in labor input and capital input respectively. In other words, they denote the technical parameters for factor elasticity. Taking the logarithm on both sides of Equation (2.3) for an individual firm i will result in:

$$\ln VAD_i = \ln(TFP_i) + \alpha_{L_i} \ln L_i + \alpha_{K_i} \ln K_i \, . \tag{2.4}$$

For a set of firms in a homogeneous industry, each firm's TFP can be inferred from regressing the above production function if the technical parameters α_{Li} and α_{Ki} are invariant across firms, i.e. $\alpha_{Li} = \alpha_L$ and $\alpha_{Ki} = \alpha_K$. Equation (2.4) for firm i could be rewritten as

$$\ln VAD_i = \alpha_L \ln L_i + \alpha_K \ln K_i + \ln(TFP_i) \, . \tag{2.5}$$

If we let $g(\bullet)$ be the effect of firm characteristics (including insider ownership or its

[4] Maddala (1979) shows that, at least within a limited class of functions such as Cobb-Douglas, generalized translog, and generalized Leontief, differences in the functional form produce a negligible difference in measures of multi-factor productivity.

composition) on the productivity of a firm within this industry, i.e. $\ln(TFP_i) = g(\cdot) + v_i$ with v_i as the error term, Equation (2.5) could be rewritten as

$$\ln VAD_i = \alpha_L \ln L_i + \alpha_K \ln K_i + g(\cdot) + v_i \,. \tag{2.6}$$

The functional form of $g(\bullet)$ will be detailed in Chapter 3. The production function will then be numerically estimated using regression techniques.

2.2.4 The Link between Financial and Economic Performance Measures

Several business and economic studies have demonstrated that productivity and efficiency growth do intrinsically determine the equilibrium values of a set of endogenous variables, such as profitability and stock price. Gordon and Parsons (1985) show that profit changes can be measured as a function of productivity plus changes in price recovery. Kumbhakar (1993), in his study of Utah dairy farmers, finds that smaller farms tend to be less technical efficient as well as less profitable. Grifell-Tatje and Lovell (1999) point out that profit change can be decomposed into three sources, namely, a productivity change effect (which includes a technical change effect and an operating efficiency effect), an activity effect, and a price effect. Summing up, these findings apparently suggest that efficiency gains have the potential to contribute to an increase in productivity, and thus in business profits. In addition, Alam and Sickles (1998) discover a positive correlation between the change in technical efficiency of a firm and its stock returns two month later. Palia and Lichtenberg (1999) also find a strong positive relationship between productivity and Tobin's Q. These results suggest that the stock market does reward firms when they increase their level of efficiency/productivity. Consequently, measuring firm performance by way of the economic measures (technical efficiency and total factor productivity) as opposed to the financial ones (profitability or Tobin's Q) might filter out noises such as price change or stock market volatility and allow us to better measure the true operating performance of a firm.

2.2.5 Survival Analysis

Survival analysis draws its origins from the bio-medical sciences and, in recent years, has found applications in business to predict events such as bank or corporate failure (Wheelock and Wilson, 1995) and bond default (Moeller and Molina, 2003). This statistical technique is capable of dealing with censored data that represents situations where the response of interest has not yet occurred. In the presence of this censored distribution, conventional econometric OLS procedures are ill-suited to duration analysis, because they would produce biased and inconsistent estimates (Cox and Oakes, 1984).

Let T be the length of the trading period. The probability of an IPO, offered for sale at $t = 0$, enduring longer than time t is a cumulative density function measured from t to infinity, i.e.,

$$S(t) = P(T > t) = \int_t^{\infty} F(u)du$$

where $S(t)$ is the survival function and $F(t)$ represents the probability density function. The hazard rate, $h(t)$, which measures the conditional probability that the IPO is delisted instantaneously given that it has survived up to time t, can be expressed as:

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \le T \le t + \Delta t | T \ge t)}{\Delta t} = \frac{F(t)}{S(t)} \quad .$$

The accelerated failure time (AFT) model is employed in this study to model time-to-failure for IPO firms. The AFT model states that the survival function of an individual with covariates Z at time t is the same as the survival function of an individual with a baseline survival function at a time $t \cdot \exp(\theta^{t} Z)$, where $\theta^t = (\theta_1,\ldots,\theta_p)$ is a vector of regression coefficient. In other words, the AFT model is defined by the relationship:

$$S(t|Z) = S_0\left[t \cdot \exp(\theta^t Z)\right] \tag{2.7}$$

where $S_0(t)$ denotes the baseline survival function when Z = 0. The factor $\exp(\theta^t Z)$ is called the acceleration factor telling the investigator how a change in covariate values changes the time scale from the baseline time scale. Another representation of the AFT model is the linear relationship between log time and the values of covariates:

$$\ln T = \lambda^t Z + \phi\varepsilon \tag{2.8}$$

where λ is a vector of unknown regression parameters, ϕ is an unknown scale parameter, and ε is a vector of errors assumed to come from a known distribution. The linear log-time model (equation 2.8) is equivalent to the AFT model (equation 2.7) with $-\theta = \lambda$ (Klein and Moeschberger, 1997). The inference for λ is based on a maximum likelihood approach.

CHAPTER 3 EMPIRICAL MODELS AND DATA

To examine the effects of managerial ownership and its composition on firm performance, this study follows the hierarchy of information asymmetry suggested by Nunn et al. (1983) and classifies insiders (the broad definition of management) into executives (top officers), non-executive directors, and large shareholders. Executives are responsible for the day-to-day management of the company. They are full-time employees and have direct responsibility for aspects of the business such as finance and marketing. They also help to formulate and implement corporate strategy. Their key strengths are that they bring specialized expertise and a wealth of knowledge to the business. However, non-executive directors are only consulted on a part-time basis and are likely to have other work commitments. They may therefore be unable to devote sufficient time to the company to be effective monitors, and may lack the expertise necessary to understand highly technical business issues or to make key decisions (Weir and Laing, 2001). This study considers not only total insider ownership but also its composition in an attempt to give a more accurate picture of the ownership-performance relation than most previous studies. The Securities and Exchange Law of Taiwan also defines insiders as board members, managers, and shareholders holding more than ten percent of total shares of a company. Specifically, "managers" are reported by the firm and usually comprise top officers such as CEO, vice-presidents, and other key executives. To avoid the possible effects of reverse causality from performance to ownership, the various variables of insider ownership take values at the beginning of the year under consideration.

Empirical test of this study is carried out in two stages. The first stage includes all industries in Taiwan. The second stage explores only the electronics industry. Five categories of empirical models are utilized to examine the effects of managerial ownership on different performance measures, i.e.: (1) Tobin's Q and ROA for all industries; (2) technical efficiency for each industry; (3) IPO survival time for all industries; (4) total factor productivity for electronics industry; and (5) technical efficiency for electronics industry.

3.1 Empirical Models for All Industries

3.1.1 Empirical Model on Tobin's Q and ROA for All Industries

The defining characteristic of a longitudinal study is that individuals are measured repeatedly through time. Panel data require special statistical methods because the set of observations on one subject tends to be inter-correlated. To control for firm-specific heterogeneity (i.e. corporate culture, good leadership, quality of workforce etc.) that are not measurable but have a significant impact on firm performance, a longitudinal mixed model is employed in this study to investigate the relationship between managerial ownership and financial performance measures. The mixed model incorporates problems relating to the estimation of both fixed effects and random effects in the same equation. Such model can be expressed in the following regression form:

$$y_{it} = \sum_{k=1}^{p} \omega_k x_{kit} + v_{it}$$

$$i = 1, \ldots, N \qquad t = 1, \ldots, T_i$$

$$v_{it} = u_i + \varepsilon_{it}$$

where subscript it refers to the i-th firm at the t-th time period, p is the number of independent variables, and $\omega_1, \ldots, \omega_p$ are unknown fixed-effect parameters to be estimated. v_{it} is the composite error term, where u_i is an unobservable individual firm effect and ε_{it} refers to the i.i.d. normal disturbance. u_i's are i.i.d. normal random variables with zero mean and variance of σ_u^2, independent of the ε_{it}'s. N is the number of firms and T_i is the number of periods for firm i. The panel of data is not required to be balanced, thus the number of periods for each firm does not have to be the same. An inferential method named Restricted (or Residual) Maximum Likelihood (REML) has been derived for the linear mixed models (McCulloch and Searle, 2000).

The dependent financial performance variable in this empirical model can be either Tobin's Q or ROA. Research and development (R&D), debt ratio, firm size and industry effects are included as control variables since Demsetz and Lehn (1985), Morck et al. (1988), McConnel and Servaes (1990) suggest that these variables have significant impact on both managerial ownership and firm performance. The following equations are thus constructed:

$$P_{it} = \omega_0 + \omega_1 RDS_{it} + \omega_2 DEBT_{it} + \omega_3 SIZE_{it} + \omega_{SIC} SIC + \omega_4 INS_{it} + \omega_5 (INS_{it})^2 + u_i + \varepsilon_{it} \tag{3.1}$$

$$P_{it} = \omega_0 + \omega_1 RDS_{it} + \omega_2 DEBT_{it} + \omega_3 SIZE_{it} + \omega_{SIC} SIC + \omega_6 EXE_{it} + \omega_7 (EXE_{it})^2 + \omega_8 BOD_{it} + \omega_9 (BOD_{it})^2 + u_i + \varepsilon_{it} \tag{3.2}$$

where P_{it} denotes financial firm performance, RDS_{it} denotes the ratio of R&D expenditure to sales, $SIZE_{it}$ represents firm size, SIC is the industry dummy, INS_{it} denotes the percentage of total outstanding shares owned by insiders, EXE_{it} denotes the percentage of total outstanding shares owned by top officers, and BOD_{it} represents the percentage of total outstanding shares owned by non-executive directors. The squared terms of ownership variables are employed to test the nonlinear effect. Multicollinearity might not be a problem since it is shown by Shieh (2001) that the expected relative coefficient of determination appears to be greater than 1 for all r_{12} (simple correlation coefficient between independent variables x_1 and x_2) $\neq 0$.

An unbalanced panel data set for 6 years (1996 to 2001) is employed for this model. The sample contains 717 Taiwanese companies listed on the Taiwan Stock Exchange Corporation (TSEC) and the GreTai Securities Market (GTSM), excluding those from the highly-regulated banking industry. The number of effective observations totals 3175. Despite our short panel may face the incidental parameters problem due to the initial values (Hsiao, Pesaran, and Tahmiscioglu, 2002)[5], Lindsey (1993) states that the number of observations per subject may

[5] Hsiao et al. (2002) state that in the case when the time dimension, T, is fixed, the introduction of

be constrained by practical considerations, and that for a given total cost, the investigator may be free to choose between a small value of T and a large sample size N, or vice versa.

3.1.2 Empirical Model on Technical Efficiency for Each Industry

For this empirical analysis, a Cobb-Douglas production function is assumed and longitudinal variables are substituted into Equation (2.1). Supposing that the technical parameters of input factors are invariant over time, after taking logarithm we get

$$\ln Y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_K \ln K_{it} + \beta_M \ln M_{it} + V_{it} - U_{it} \tag{3.3}$$

where ln represents natural logarithm, Y_{it} denotes output, L_{it} is labor input, K_{it} represents capital input, and M_{it} denotes materials input.

R&D, firm size, and firm age are included in the inefficiency regression as control variables. Economists recognize that R&D is crucial for productivity growth. Empirically, Huang and Liu (1994) apply the stochastic frontier production model to analyze Taiwan's electronics industry and find a positive relationship between R&D spending and technical efficiency. In an influential contribution, Jovanovic (1982) proposes a model of firm growth in which efficient firms grow and survive while inefficient firms stagnate or exit the industry as a result of a selection process. This leads to the conclusion that larger firms could be more efficient. Lundvall and Battese (2000) and Kim (2003) also support this positive correlation between firm size and technical efficiency for Kenyan and Korean manufacturing industries, respectively. Because of the time involved, larger firms are also more mature, implying a positive relationship between firm age and efficiency. Such a positive age-efficiency relationship could be reinforced by learning-by-doing effects that firms become more efficient

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"individual" specific, time-invariant effects increases the number of parameters to be estimated with the increase in the number of observations on the cross-sectional dimension, N. The random effects specification avoids the incidental parameter problem associated with the individual specific effects, but can still be subject to the incidental parameters problem due to the initial values when the model contains exogenous regressors.

as a result of their growing stock of experience (Malerba, 1992). The following equation of technical inefficiency is thus constructed,

$$U_{it} = \delta_0 + \delta_1 RD_{it} + \delta_2 SIZE_{it} + \delta_{31} AGE_{it} + \delta_{32}(AGE_{it})^2 + \delta_{41} EXE_{it} + \delta_{42}(EXE_{it})^2 + \delta_{51} BOD_{it} + \delta_{52}(BOD_{it})^2 + \delta_{61} BIG_{it} + W_{it} \quad (3.4)$$

where RD_{it} denotes R&D expenditure, $SIZE_{it}$ represents firm size, AGE_{it} is firm age in years, EXE_{it} denotes the percentage of total outstanding shares owned by top officers, BOD_{it} represents the percentage of total outstanding shares owned by non-executive directors, and BIG_{it} is the percentage of total outstanding shares owned by blockholders.

An unbalanced panel data set for 5 years (1996 to 2000) is employed in this model. The sample contains 628 Taiwanese companies listed either on TSEC or GTSM in 18 industries, excluding the highly-regulated banking industry. The number of effective observations totals 2420.

3.1.3 Empirical Model on IPO Survival for All Industries

Most AFT models assume that the hazard is a smooth, relatively simple function of time. However, in this study we employ the piecewise exponential model, a method that is widely used in several fields. The basic idea is to divide the time scale into intervals. Assume that the hazard is constant within each interval but can vary across intervals (Allison, 1995, p. 105). We define a set of J intervals with cut points $\psi_0, \psi_1, \ldots, \psi_J$, where $\psi_0 = 0$ and $\psi_J = \infty$. Thus, interval j is given by $[\psi_{j-1}, \psi_j]$. The hazard for individual i is assumed to have the form

$$h_i(t) = \tau_j e^{\rho Z_i} \qquad \text{for } \psi_{j-1} \le t < \psi_j \ .$$

There are several reasons for choosing the piecewise exponential hazards model (Li and Choe, 1997). First, this model is flexible. It dose not require us to make assumptions about the shape of the survival function as with parametric survival models. It can approximate any form of survival function closely as long as the period is divided into a sufficient number of segments.

Second, this model is computationally more efficient than Cox's proportional hazards model (Cox, 1972). The number of extra parameters that need to be estimated is not large because it is generally unnecessary to divide the time period into a very large number of segments.

The survival time of an IPO in this study is modeled as a function of various firm-specific characteristics at the time of offering. The explanatory variable of primary interest is managerial ownership retention. In addition, unlike prior works on IPO survival, we experiment with the square of managerial ownership since it seems reasonable to allow insider stockholding to have a nonlinear effect.

As for control variables, a considerable number of literatures have provided evidences of the significance of variables such as firm age, offer size, IPO activity, market level, and industry effect in explaining initial returns and long-run operating and investment performance. Ritter (1991) states firm age as a proxy for risk and finds that older firms performed better in the aftermarket than younger ones. Size of the offering has been considered as a proxy for the extent of information asymmetry regarding the prospects of the IPO issuer. IPO firms raising higher proceeds at the offering are presumed to have less uncertainty regarding their future prospects and, hence, are expected to perform better (Jain and Kini, 2000). Grinblatt and Hwang (1989) and Welch (1989) have suggested that IPO issuers use underpricing as a mechanism to signal their quality to the market. Thus, signaling models predict that initial return, i.e. the degree of underpricing, should be positively related to the firm's post-issue operating performance. IPO activity increases with the market level because firms will capitalize on "windows of opportunity" (Ritter, 1991). This lures additional firms of lower quality to the market of capital. Therefore, a negative relation between survival time and market level (or IPO activity) at the time of offering is expected.

The initial sample of IPO firms is compiled for the period 1992-2000, excluding highly-regulated financial institutions. Each firm is tracked until June 2003 to determine if it continues to trade or fails. Survivors are defined as firms that continue to operate independently as public corporations. Firms that are delisted from the trading exchange due to negative reasons are classified as non-survivors. The final sample consists of 560 firms listed originally on TSEC or GTSM, with 522 survivors and 38 non-survivors.

3.2 Empirical Models for Electronics Industry

3.2.1 Empirical Model on Total Factor Productivity for Electronics Industry

There are several reasons why we choose the electronics industry to study firm productivity rather than using data from a cross-section of industries. First, a production function can only be estimated for a set of firms within a *homogeneous* industry. Second, as stated in Chapter 1, the electronics industry of Taiwan plays a prominent role on the international platform and is one of the most important contributors to economic growth of Taiwan. For example, the electronics industry alone accounted for 52% (222 out of 423) of total IPOs issued in Taiwan during 1996-2000. Lastly, Taiwan has developed what is known as the 'Cluster Effect' – an effect characterized by the centralization of firms that facilitates the production of related products as a result of the close proximity of both suppliers and competitors. In fact, most of Taiwan's information technology products are made in the Hsinchu Science Park (HSP) area, which is touted as "the closest that Asia has come to replicating California's Silicon Valley (The Wall Street Journal, October 24, 1995)". Moreover, the Park Administration, the major authority of HSP, provides companies within the Park with a one-stop service in areas such as development planning, construction and landscaping, labor administration, information networks, and warehousing services etc. As a result, the parameters of factor elasticity, α_{Li} and α_{Ki}, can be taken as firm-invariant in our study.

Letting $g(\cdot)=\sum_{j=1}^{p}\alpha_j Z_{jit}$ and $v_{it}=u_i+\varepsilon_{it}$ and substituting longitudinal variables into Equation (2.6), it follows that

$$\ln VAD_{it} = \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + \sum_{j=1}^{p} \alpha_j Z_{jit} + u_i + \varepsilon_{it}\,, \qquad (3.5)$$

where ln represents the natural logarithm, subscript *it* refers to the *i*-th firm at the *t*-th time period, $Z_1, \ldots, Z_p$ are the observable firm characteristics, and $\alpha_1, \ldots, \alpha_p$ are unknown fixed-effect parameters to be estimated. v_{it} is the composite error term, i.e. $v_{it} = u_i + \varepsilon_{it}$ where u_i is an unobservable firm-specific effect and ε_{it} refers to the white-noise disturbance. u_i's are i.i.d. normal random variables with zero mean and a variance of σ_u^2 and are independent of the ε_{it}'s.

The relationship between firm characteristics and total factor productivity is then hypothesized as

$$\begin{aligned} \ln(TFP_{it}) &= u_i + \alpha_1 RD_{it} + \alpha_2 AGE_{it} + \alpha_3 (AGE_{it})^2 + \alpha_4 INS_{it} \\ &+ \alpha_5 (INS_{it})^2 + \alpha_t DUM_t + \varepsilon_{it}, \end{aligned} \qquad (3.6)$$

with RD_{it} being defined as R&D, AGE_{it} as firm age, INS_{it} as total insider holding ratio, and DUM_t as the year dummy. R&D and firm age are included as control variables since Hill and Snell (1989) and Huang and Liu (1994) have shown that these two variables have significant impact on productivity or efficiency. According to Palia and Lichtenberg (1999), the inclusion of the year effect eliminates the need to deflate any of the dollar-denominated variables.

To further examine the effect of managerial ownership structure on total factor productivity, the following equation is thus constructed:

$$\begin{aligned} \ln(TFP_{it}) &= u_i + \alpha_1 RD_{it} + \alpha_2 AGE_{it} + \alpha_3 (AGE_{it})^2 + \alpha_6 EXEP_{it} + \alpha_7 (EXEP_{it})^2 \\ &+ \alpha_8 BODP_{it} + \alpha_9 (BODP_{it})^2 + \alpha_t DUM_t + \varepsilon_{it}, \end{aligned} \qquad (3.7)$$

where $EXEP_{it}$ denotes the proportion of insider ownership attributable to executive stockholding, and $BODP_{it}$ denotes the proportion of insider ownership attributable to non-executive director stockholding.

After substituting Equations (3.6) and (3.7) into Equation (3.5) respectively, we obtain the following two mixed-model equations, where each firm is assigned its own random-effect intercept and each year is attributed a fixed-effect dummy variable.

$$\ln VAD_{it} = u_i + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + \alpha_1 RD_{it} + \alpha_2 AGE_{it} + \alpha_3 (AGE_{it})^2 + \alpha_4 INS_{it} + \alpha_5 (INS_{it})^2 + \alpha_t DUM_t + \varepsilon_{it} \quad (3.8)$$

$$\ln VAD_{it} = u_i + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + \alpha_1 RD_{it} + \alpha_2 AGE_{it} + \alpha_3 (AGE_{it})^2 + \alpha_6 EXEP_{it} + \alpha_7 (EXEP_{it})^2 + \alpha_8 BODP_{it} + \alpha_9 (BODP_{it})^2 + \alpha_t DUM_t + \varepsilon_{it} \quad (3.9)$$

$i = 1, \ldots, N; \qquad t = 1, \ldots, T_i$

with N as the number of firms and T_i as the number of periods for firm *i*. Since an unbalanced panel is allowed in the mixed model, the number of periods for each firm does not have to be the same.

A unbalanced panel data set for 5 years (1996 to 2000) is employed. The sample includes 333 Taiwanese electronics companies listed either on TSEC or GTSM. The number of effective observations totals 1113.

3.2.2 Empirical Model on Technical Efficiency for Electronics Industry

For this empirical test, a translog production function is assumed and longitudinal variables are substituted into Equation (2.1). Suppose that the technical parameters of input factors are invariant over time. Taking the logarithm on both side of Equation (2.1) will result in:

$$\ln Y^*_{it} = \beta_0 + \sum_{j=1}^{3} \beta_j \ln X_{jit} + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} \ln X_{jit} \ln X_{kit} + V_{it} - U_{it} \quad (3.10)$$

where ln represents natural logarithm, and subscript *it* refers to the *i*-th firm in the *t*-th time period. Y^*_{it} denotes adjusted output. The X_{it}'s are L^*_{it}, K^*_{it}, M^*_{it}, representing adjusted labor input, capital input, and materials input, respectively. To be net of price information, the input and output variables in value are converted into constant 1996 dollars using appropriate deflators from the Statistical Yearbook of the Republic of China, 2002. V_{it} is the i.i.d. normal random error, and U_{it} is the non-negative effect of technical inefficiency. R&D, firm size, and firm age are included in the technical inefficiency regression as control variables. The following specification of technical inefficiency is thus constructed,

$$U_{it} = \delta_0 + \sum_m \delta_m Z_{mit} + \sum_{t=1997}^{2001} \eta_t DUM_t + W_{it} \qquad (3.11)$$

$$i = 1,\ldots..,N \qquad t = 1996,\ldots..,2001$$

where the Z_{it}'s are ownership variables, i.e. INS_{it}, $EXEP_{it}$, $BODP_{it}$, $BIGP_{it}$ or their squares, and control variables such as RD_{it}, $SIZE_{it}$, AGE_{it}. INS_{it} denotes total insider holding ratio, $EXEP_{it}$ denotes the proportion of insider ownership attributable to executive stockholding, $BODP_{it}$ denotes the proportion of insider ownership attributable to director stockholding, and $BIGP_{it}$ denotes the proportion of insider ownership attributable to blockholder stockholding. RD_{it} denotes R&D, $SIZE_{it}$ denotes firm size, and AGE_{it} denotes firm age. DUM_t is a time dummy for period t to control for year effect, W_{it} is the random error defined by the truncation of the normal distribution with zero mean and variance of σ^2, and N is the number of firms. Since the model of Battese and Coelli (1995) does not require a balanced panel, the number of periods for each firm does not have to be the same.

An unbalanced firm-level panel data set for 6 years (1996 to 2001) is employed in this model. The sample contains 416 Taiwanese electronics companies listed on TSEC and GTSM. The number of effective observations totals 1612.

3.3 Operational Definition for Variables

The data are gathered from Taiwan Economic Journal (TEJ) Database. Variables of this study can be classified into four groups. Detailed definitions of the variables are given as follows:

(1) Performance Measures:

Tobin's Q (Q) = (share price * the number of common stock shares outstanding + market value of outstanding preferred stock + short-term liability – short-term assets + book value of long-term debt) ÷ (book value of total assets);

Return on assets (ROA) = (earnings before depreciation, interest and taxes) ÷ (book value of average total assets);

Time traded (TIME) = the number of months an IPO traded either on TSEC or GTSM, measured from the date of listing to the date of delisting or till the end of June 2003; and

Censor (CS) = a binary variable which is equal to 1 if the firm is delisted, or equal to zero if censored.

(2) Output and Input Measures:

Output (Y) = annual net sales of a firm;

Total value added (VAD) = annual net sales – total materials expenditure;

Labor input (L) = annual salary and wage expenditure;

Capital input (K) = book value of net property, plant, and equipment;

Materials input (M) = annual materials expenditure;

Adjusted output (Y*) = annual net sales of a firm, deflated by wholesale price index (WPI) of the electronics industry;

Adjusted labor input (L*) = the equivalent number of workers[6] = (annual salary and wage expenditure) ÷ (average annual earnings per employee on the payrolls of the electronics industry).

Adjusted capital input (K*) = value of net fixed assets computed based on the perpetual inventory method (Goldsmith, 1951)[7], with each level of the capital stock having been deflated by WPI of capital goods;

Adjusted materials input (M*) = annual materials expenditure, deflated by WPI of intermediate materials in the electronics industry.

(3) Managerial Ownership Variables:

Total insider holding ratio (INS) = (the number of shares owned by all insiders, including top officers, non-executive directors, and large shareholders who own more than 10% of total shares) ÷ (the number of total outstanding shares of the firm);

Executive holding ratio (EXE) = (the number of shares owned by top officers) ÷ (the number of total outstanding shares of the firm);

Board holding ratio (BOD) = (the number of shares owned by non-executive directors who are neither managers nor employees of the firm) ÷ (the number of total outstanding shares of the firm);

Blockholder holding ratio (BIG) = (the number of shares owned by large shareholders who own more than 10% of total shares, but are neither managers nor directors of the firm) ÷ (the number of total outstanding shares of the firm);

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[6] The actual number of workers for each electronics firm is not available from TEJ database. Therefore we imputed the equivalent number of workers.

[7] The perpetual inventory method is used to remove embedded inflation that would distort the measurement of capital. This method estimates the capital stock of a given year by cumulating past capital investment that has survived up to that year, and has recently been employed by Uri (2001) and Benfratello (2002) in analyzing technical efficiency.

Executive-to-insider holding ratio (EXEP) = (the number of shares owned by top officers) ÷ (the number of shares owned by all insiders);

Board-to-insider holding ratio (BODP) = (the number of shares owned by non-executive directors who are neither managers nor employees of the firm) ÷ (the number of shares owned by all insiders); and

Blockholder-to-insider holding ratio (BIGP) = (the number of shares owned by large shareholders who own more than 10% of total shares, but are neither managers nor directors of the firm) ÷ (the number of shares owned by all insiders).

(4) Control Variables:

Research and development ratio (RDS) = (annual R&D expenditure ÷ annual sales);

Research and development (RD) = annual R&D expenditure;

Adjusted research and development (RD*) =annual R&D expenditure, deflated by the general WPI;

Debt ratio (DEBT) = (book value of debts) ÷ (book value of total assets);

Firm size (SIZE) = book value of total assets;

Firm age (AGE) = the number of years passed since the firm has been established;

Size of IPO (SIZEO) = offering price × shares outstanding;

Firm age at offering (AGEO) = age of the firm (in years) at the offering date;

Initial return (IR) = (closing price at the day that market price did not reach the price fluctuation limit[8]– offering price) ÷ (offering price);

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[8] According to "Operating Rules of the Taiwan Stock Exchange Corporation", the daily fluctuation limit of a stock shall be seven percent of the closing price for the previous trading day, except for the

IPO activity (ACT) = dollar amount of total IPOs in a given quarter;

Market level (MKT) = Taiwan market index, excluding the financial stocks, at the end of IPO month;

Industry dummy (SIC) = two-digit industry classification code from Taiwan Economic Journal Database; and

Year dummy (D_t) = a time dummy for period *t* to control for year effect.

period of Nov. 21 to Dec. 31, 2000 when a 3.5% limit was imposed on the floor price.

CHAPTER 4 EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Descriptive Statistics

4.1.1 Descriptive Statistics of Managerial Ownership for All Industries

The descriptive statistics for the managerial ownership variables from 1996 to 2001 are presented in Table 4.1. For the total insider holding ratio (INS), the 6-year pooled mean is 28.77% and the median is 26.51%. As to its trend, both mean and median increase first and then decrease, but the mean keeps at about the same level as 6 years ago. From the mean-difference t test it can be found that the mean of INS in 2001 (27.41%) is not significantly different from that in 1996 (28.56%).

Regarding the executive holding ratio (EXE), the 6-year pooled mean is 7.94% and the median is 4.04%. Both mean and median of EXE have increased over the study period, and it can be observed from the mean-difference t test that the mean of EXE in 2001 (8.17%) is significantly larger than that in 1996 (6.62%).

For the board holding ratio (BOD), the 6-year pooled mean is 20.80% and the median is 17.17%. It can be observed that the mean of BOD has decreased significantly from 21.91% in 1996 to 19.20% in 2001.

Lastly, it should be noted that all of the third-quartile blockholder-to-insider holding ratios (BIG) are zero. In other words, 75% of our sample firms have no large shareholders that own more than 10% of the total shares but are neither executives nor directors of the firm. This may be due to the fact that non-management blockholders in Taiwan usually seek out voluntary anonymity by allocating their equity stakes to some nominal shareholder so that legal constraints on insider trading can be evaded.

Table 4.1 Descriptive Statistics of Managerial Ownership for All Industries

Year	1996	1997	1998	1999	2000	2001	Pooled
Sample Size	307	403	486	592	691	697	3175
Total Insider holding ratio (INS)							
Mean	28.56%	28.20%	29.24%	29.72%	29.48%	27.41%	28.77%
Median	26.14%	26.11%	26.37%	27.32%	27.09%	25.55%	26.51%
Std. Deviation	15.72%	15.01%	16.47%	16.39%	16.17%	14.72%	15.78%
Mean-difference t test for INS (1996 vs. 2001): t-statistic = 1.09, p-value = 0.2769							
Executive holding ratio (EXE)							
Mean	6.62%	7.75%	7.28%	8.40%	8.47%	8.17%	7.94%
Median	3.01%	3.49%	3.49%	4.37%	4.49%	4.28%	4.04%
Std. Deviation	9.92%	11.27%	10.19%	10.98%	10.76%	10.61%	10.68%
Mean-difference t test for EXE (1996 vs. 2001): t-statistic = −2.23, p-value = 0.0261							
Board holding ratio (BOD)							
Mean	21.91%	20.41%	21.94%	21.28%	20.97%	19.20%	20.80%
Median	18.43%	17.48%	17.54%	17.40%	16.95%	16.00%	17.17%
Std. Deviation	15.15%	13.99%	15.40%	14.99%	14.84%	13.30%	14.57%
Mean-difference t test for BOD (1996 vs. 2001): t-statistic = 2.71, p-value = 0.0069							
Blockholder holding ratio (BIG)							
Mean	2.45%	3.51%	3.06%	3.48%	3.36%	3.80%	3.37%
Median	0%	0%	0%	0%	0%	0%	0%
Third Quartile	0%	0%	0%	0%	0%	0%	0%
Std. Deviation	6.54%	9.06%	7.54%	8.29%	8.03%	8.14%	8.05%

# of Firms: 717

# of Observations: 3175

The descriptive statistics of managerial ownership structure by industry are presented in Table 4.2. For the executive holding ratio (EXE), the 5-year pooled mean of all industries is 8.38%, with the highest value of 18.13% for the automobile industry and the lowest value of 4.56% for the cement industry.

For the board holding ratio (BOD), the 5-year pooled mean of all industries is 23.22%, with the highest value of 28.41% for the electric and machinery industry and the lowest value of 16.83% for the transportation industry.

Furthermore, the 5-year pooled mean of blockholder holding ratio (BIG) for all industries is 3.16%, with a high of 6.61% for the construction industry and a low of 1.27% for the electric appliance and cable industry. However, the median of BIG for each industry is zero (though not shown in Table 4.2), indicating that most firms in our sample have no large shareholders who own more than 10% of total shares,

Table 4.2 Descriptive Statistics of Managerial Ownership Structure by Industry

Industry	SIC	# of Firms	# of Observations	5-year Pooled Mean		
				Executive Ownership (EXE)	Board Ownership (BOD)	Blockholder Ownership (BIG)
Cement	11	8	39	4.56%	20.31%	5.60%
Foods	12	27	126	6.49%	17.92%	2.46%
Plastics	13	26	108	11.26%	18.80%	3.90%
Textiles	14	66	286	7.34%	19.01%	2.02%
Electric & Machinery	15	45	179	10.59%	28.41%	4.63%
Electric Appliance & Cable	16	17	78	7.33%	19.45%	1.27%
Chemicals	17	46	161	9.23%	20.90%	4.96%
Glass & Ceramics	18	6	28	8.56%	20.31%	5.79%
Paper & Pulp	19	7	33	4.61%	18.53%	4.05%
Iron & Steel	20	36	154	10.98%	18.38%	2.93%
Rubber	21	10	47	10.19%	19.25%	4.04%
Automobile	22	5	23	18.13%	20.78%	1.32%
Electronics	**23**	**261**	**916**	**7.41%**	**27.40%**	**2.22%**
Construction	25	14	33	7.95%	18.39%	6.61%
Transportation	26	9	37	7.75%	16.83%	5.60%
Others	27, 29, 99	45	172	9.93%	23.58%	5.01%
All industries	—	628	2420	8.38%	23.22%	3.16%

Time period: 1996-2000.

4.1.2 Distribution and Survival of IPOs for All Industries

Table 4.3 shows the distribution of IPOs in Taiwan from 1992 to 2000, classified by issuing year and by industry. The number of IPOs increased notably in 1995 and kept an ascending trend afterwards, mainly contributed by the electronics industry. The last column reveals that the electronics industry alone accounted for almost half of total IPOs (44.5%) in the sample period, which is consistent with the notion that Taiwan's economy has been focusing on the high-tech sector for the past few years.

The survival curve, which is a time-series portrayal of the sample IPOs' endurance, plots the survival probabilities over time (also called the survival function). There are several ways to calculate the survival function. The Kaplan-Meier product-limit method, which provides a non-parametric consistent estimate of the survival function, is used in this study. Specifically, the Kaplan-Meier estimator is defined as

$$\hat{S}(t) = \prod_{j:t_j \le t} \left[1 - \frac{d_j}{n_j} \right]$$

where n_j is the number of IPOs surviving and uncensored at time t_j , and d_j is the number of IPO firms being delisted at t_j. Figure 4.1 presents the estimated survival curve of our sample IPO firms for each trading month. Since $S(t)$ denotes an IPO's probability of enduring past time t, it starts with 1.00 at month 0 and moves downward as more and more IPO firms are delisted. In Figure 4.1 the sharpest drop occurred after 100 months of trading, and the survival curve seems to level off at about the probability of 0.75.

Table 4.3 Distribution of IPOs by Year and by Industry

Industry	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**# IPO** (% of total)
Cement	0	0	1	0	0	0	0	0	0	1 (0.2%)
Foods	2	2	2	3	1	1	1	2	1	15 (2.7%)
Plastics	3	0	1	0	2	1	1	3	3	14 (2.5%)
Textiles	6	4	2	1	3	4	4	12	3	39 (7.0%)
Electric & Machinery	1	0	3	4	1	7	7	7	5	35 (6.3%)
Electric Cable	0	1	0	2	0	1	3	0	1	8 (1.4%)
Chemicals	1	2	1	3	2	0	5	6	6	26 (4.6%)
Glass & Ceramics	2	0	1	0	1	0	0	0	0	4 (0.7%)
Iron & Steel	5	3	0	4	6	4	4	2	2	30 (5.4%)
Rubber	1	0	0	0	0	0	1	0	1	3 (0.5%)
Automobile	0	0	0	0	2	1	0	0	0	3 (0.5%)
Electronics	**3**	**2**	**6**	**16**	**28**	**23**	**48**	**54**	**69**	**249 (44.5%)**
Construction	2	6	5	9	6	4	10	11	7	60 (10.7%)
Transportation	1	2	2	2	2	4	1	2	0	16 (2.9%)
Tourism	0	0	0	0	0	0	3	2	0	5 (0.9%)
Retailing	0	1	0	0	1	3	1	0	0	6 (1.1%)
Others	7	4	4	4	4	3	3	9	8	46 (8.2%)
# IPO (% of total)	**34** (6.1%)	**27** (4.8%)	**28** (5.0%)	**48** (8.6%)	**59** (10.5%)	**56** (10.0%)	**92** (16.4%)	**110** (19.6%)	**106** (18.9%)	**560** (100%)
# non-survivor till June 2003	4	4	2	6	6	7	4	1	4	38

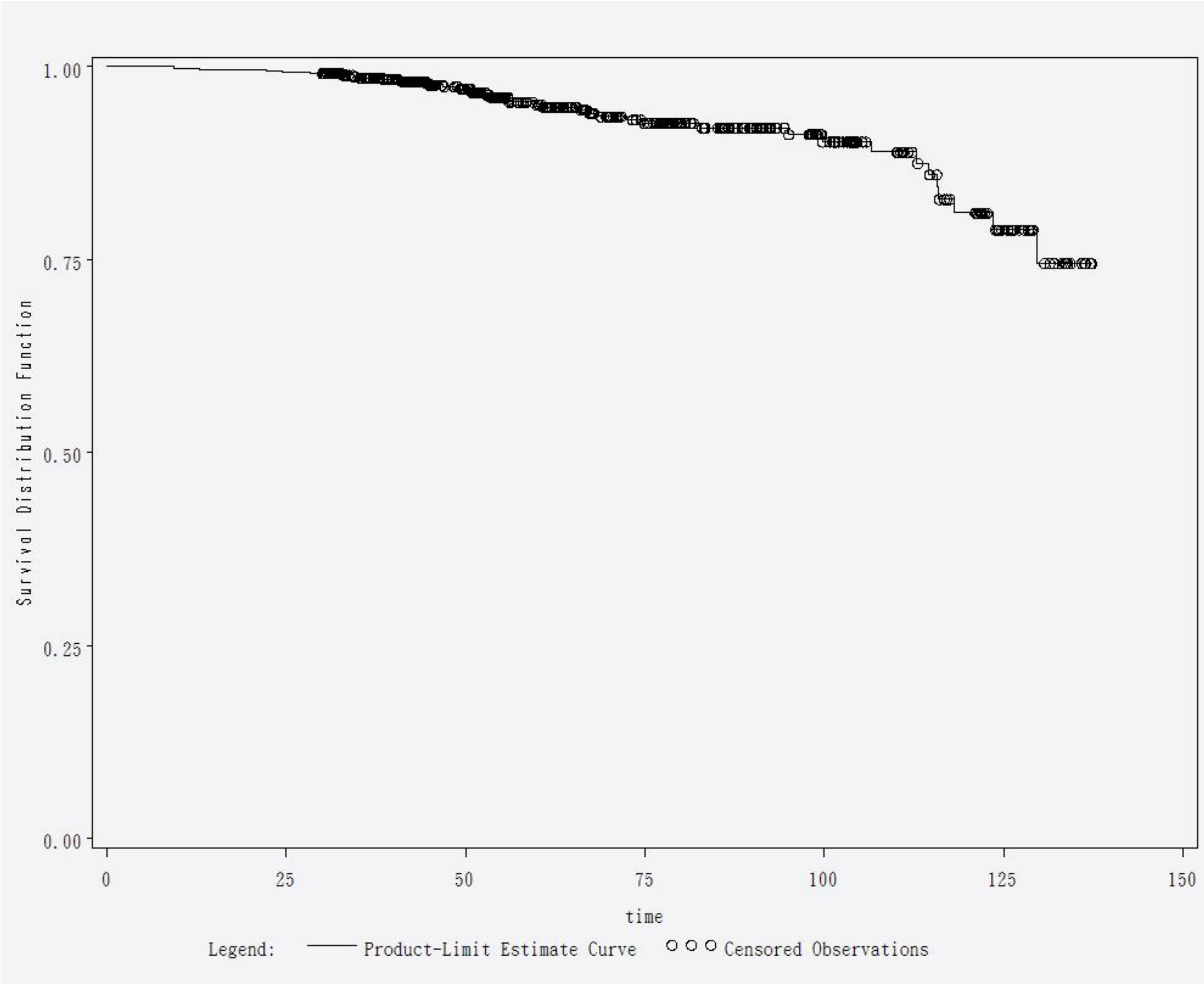

Figure 4.1 Survival Curve for IPOs in Taiwan (N=560)

4.1.3 Descriptive Statistics for Electronics Industry

The descriptive statistics for Taiwan's electronics industry from 1996 to 2001 are presented in Table 4.4. It could be noticed that the listed electronics firms in Taiwan vary in size and in age. Annual sales ranges from over 200 billion NT dollars to 77 million NT dollars[9]. The average annual sales is at 7467 million NT dollars. The average firm age is 15.46 years, with a maximum of 52 years and a minimum of 2 years.

For the ownership variables of Taiwan's electronics industry, the 6-year pooled mean for the total insider holding ratio (INS) in Table 4.4 is 38.80%, higher than the average (28.77%) of all industries in Table 4.1. In terms of the compositions of insider ownership, on average the executive holdings account for 22.26% of total insider ownership in the electronics industry, and the director holdings account for 72.40% of total insider ownership, respectively. However, compared with the average of all industries in Table 4.2, the executive ownership (EXE) for the electronics industry is below average (7.41% < 8.38%) while the board ownership (BOD) for the electronics industry is above average (27.40% > 23.22%). The above results demonstrate that although the stock-based compensation plans were first adopted in the electronics industry and not available to board members, the executive ownership in the electronics industry is not particularly higher than in the other industries.

[9] In 1996, one U.S. dollar is about equal to 27.5 NT dollars.

Table 4.4 Descriptive Statistics for Taiwan's Electronics Industry

Variable	Mean	Median	Std. Dev.	Min.	Max.	Unit of Variable
Y*	7467	2333	16213	77	212977	NT$ millions
L*	697	312	1266	2.12	13855	No. of workers
K*	2344	452	9223	3.83	214281	NT$ millions
M*	3027	599	9010	0.10	116780	NT$ millions
RD*	197	44	615	0	11090	NT$ millions
SIZE	7001	1934	18474	140	340972	NT$ millions
AGE	15.46	14.00	7.58	2	52	No. of years
INS	38.80%	36.05%	19.13%	1.01%	100%	Percentage of total outstanding shares
EXEP	22.26%	15.36%	22.53%	0%	100%	Percentage of insider ownership
BODP	72.40%	79.55%	24.95%	0%	100%	Percentage of insider ownership
BIGP	5.33%	0%	13.33%	0%	76.94%	Percentage of insider ownership

Time period: 1996-2001

# of firms: 416

# of observations: 1612

* : in constant 1996 dollar

4.2 Effect of Managerial Ownership for All Industries

4.2.1 Effect of Managerial Ownership on Tobin's Q for All Industries

The estimation results of Equation (3.1) and Equation (3.2) with Tobin's Q as the dependent performance variable for all industries are listed in Table 4.5, while the coefficient estimates of industry dummies are omitted.

The estimation results of Equation (3.1) with total insider ownership as the explanatory ownership variable is given in Model 1. In Model 1A it is observed that the coefficient estimate for $(INS)^2$ is not statistically significant (t-statistic= −0.45, p-value>0.10), suggesting no quadratic relationship between total insider ownership and Tobin's Q. Then in Model 1B we re-estimate Equation (3.1) after eliminating the insignificant independent variable $(INS)^2$. The estimate for INS is now statistically significant (t-statistic=10.34, p-value<0.01), indicating a monotonically positive relation between total insider ownership and Tobin's Q.

The estimation result of Equation (3.2) with executive and board holding ratios as the explanatory ownership variables is given in Model 2. In Model 2A it can be observed that the coefficient estimate for $(EXE)^2$ is not statistically significant (t-statistic= −0.24, p-value>0.10), showing no quadratic relationship between executive ownership and Tobin's Q. Consequently, in Model 2B the insignificant explanatory variables $(EXE)^2$ is eliminated, and it is found that the coefficient estimate for EXE is significantly positive (t-statistic=7.54, p-value<0.01), indicating a positive relationship between executive ownership and Tobin's Q. The coefficient estimate for $(BOD)^2$ is still significantly negative (t-statistic= −2.61, p-value<0.01), showing an inverted U-shaped relationship between board member ownership and Tobin's Q.

As to model selection, since the value of the likelihood-ratio test statistics (=7555.6−7554.1=1.5) did not exceed the critical value (3.84), we can not reject the hypothesis that Model 2B better captures the relation between managerial ownership structure and firm value than Model 2A. The null model likelihood ratio (LR) test is highly significant, indicating that the null model with only the fixed effects should be rejected. Hense, it is necessary to include the random effect in our estimation.

Table 4.5 Effect of Managerial Ownership on Tobin's Q for All Industries

Explanatory Variable	Dependent Variable: Tobin's Q			
	Model 1A	Model 1B	Model 2A	Model 2B
Intercept	0.7815	0.8062	0.7126	0.7179
	(6.12)***	(6.97)***	(5.82)***	(5.97)***
INS	1.4260	1.2675	—	—
	(3.81)***	(10.34)***		
$(INS)^2$	−0.2145	—	—	—
	(−0.45)			
EXE	—	—	1.4034	1.3244
			(3.72)***	(7.54)***
$(EXE)^2$	—	—	−0.1917	—
			(−0.24)	
BOD	—	—	2.0744	2.0659
			(6.16)***	(6.17)***
$(BOD)^2$	—	—	−1.3442	−1.3364
			(−2.62)***	(−2.61)***
RDS	2.5141	2.5118	2.5206	2.5193
	(4.64)***	(4.63)***	(4.65)***	(4.65)***
DEBT	−0.7821	−0.7866	−0.7742	−0.7756
	(−7.81)***	(−7.89)***	(−7.76)***	(−7.79)***
SIZE	0.2385	0.2158	0.3864	0.3672
	(0.29)	(0.26)	(0.47)	(0.45)
SIC	YES***	YES***	YES***	YES***
# of Firms	717		717	
# of Observations	3175		3175	
−2 Res Log Likelihood	7560.5	7561.1	7554.1	7555.6
Null Model LR Test (Chi-Square)	(1170.03)***	(1171.74)***	(1171.09)***	(1171.30)***

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

Numbers in parentheses are t-statistics.

YES: The industry effects are estimated but not reported.

4.2.2 Effect of Managerial Ownership on ROA for All Industries

The estimation results of Equation (3.1) and Equation (3.2) with ROA as the dependent performance variable for all industries are listed in Table 4.6, while the coefficient estimates of industry dummies are omitted.

The estimation results of Equation (3.1) with total insider ownership as the explanatory ownership variable is given in Model 3. It is observed that the coefficient estimate for $(INS)^2$ is statistically significant (t-statistic= −2.23, p-value<0.05), suggesting an inverted U-shaped relationship between total insider ownership and ROA.

The estimation result of Equation (3.2) with executive and board holding ratios as the explanatory ownership variables is given in Model 4. In Model 4A it can be observed that the coefficient estimate for $(EXE)^2$ is not statistically significant (t-statistic= −1.00, p-value>0.10), showing no quadratic relationship between executive ownership and ROA. Consequently, in Model 4B the insignificant explanatory variable $(EXE)^2$ is eliminated, and it is found that the coefficient estimate for EXE is significantly positive (t-statistic=8.59, p-value<0.01), indicating a monotonically positive relationship between executive ownership and ROA. The coefficient estimate for $(BOD)^2$ is still significantly negative (t-statistic= −1.73, p-value<0.10), showing an inverted U-shaped relationship between board member ownership and ROA.

With regard to model fitting, since the value of the likelihood-ratio test statistics (= −7517.4− [−7515.2]= −2.2) did not exceed the critical value (3.84), we can not reject the hypothesis that Model 4B better captures the relation between insider ownership composition and firm profitability than Model 4A. The null model likelihood ratio (LR) test is highly significant, indicating that the null model with only the fixed effects should be rejected. Therefore, it is appropriate to include random effect in our estimation.

Table 4.6 Effect of Managerial Ownership on ROA for All Industries

Explanatory Variable	Dependent Variable: ROA		
	Model 3	Model 4A	Model 4B
Intercept	0.0964 (7.85)***	0.1004 (8.48)***	0.1027 (8.83)***
INS	0.2336 (6.30)***	—	—
$(INS)^2$	–0.1048 (–2.23)**	—	—
EXE	—	0.1803 (4.88)***	0.1476 (8.59)***
$(EXE)^2$	—	–0.0780 (–1.00)	—
BOD	—	0.2143 (6.47)***	0.2113 (6.41)***
$(BOD)^2$	—	–0.0878 (–1.77)*	–0.0857 (–1.73)*
RDS	–0.5219 (–8.93)***	–0.5215 (–8.92)***	–0.5231 (–8.94)***
DEBT	–0.1939 (–19.51)***	–0.19481 (–19.62)***	–0.1952 (–19.69)***
SIZE	0.2462 (2.85)***	0.2544 (2.93)***	0.2453 (2.84)***
SIC	YES***	YES***	YES***
# of Firms	717	717	
# of Observations	3175	3175	
–2 Res Log Likelihood	–7525.4	–7515.2	–7517.4
Null Model LR Test (Chi-Square)	(704.43)***	(694.98)***	(697.87)***

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

Numbers in parentheses are t-statistics.

YES: The industry effects are estimated but not reported.

4.2.3 Effect of Managerial Ownership on Technical Efficiency for Each Industry

In terms of the effect of insider ownership composition on technical efficiency, Table 4.7 lists the estimation result of technical inefficiency regression (Equation 3.4) for each industry in Taiwan, while omitting the intercept and the control variables. Model selection tests are used to choose the specifications which best fit the data and only those results are reported. It needs to be kept in mind when looking at the coefficient of the explanatory variable in the inefficiency function that a positive coefficient implies a decrease in technical efficiency.

Regarding executive ownership, the coefficient estimates of $(EXE)^2$ for the cement, food, textiles, and electronics industries are significantly negative, indicating a U-shaped relationship between executive stockholding and technical efficiency. For the electric and machinery industry the coefficient estimate of $(EXE)^2$ is significantly positive, indicating an inverted U-shaped relationship between executive stockholding and technical efficiency. Meanwhile, for the plastics industry the coefficient estimate of EXE is significantly negative, indicating that executive stockholding positively influences technical efficiency. Finally, for the paper and construction industries, the coefficient estimates of EXE are significantly positive, indicating that executive stockholding negatively impacts technical efficiency.

Concerning board ownership, the coefficient estimate of $(BOD)^2$ for the food industry is significantly negative, indicating a U-shaped relationship between board stockholding and technical efficiency. Meanwhile, for the electric and machinery industry the coefficient estimate of $(BOD)^2$ is significantly positive, indicating an inverted U-shaped relationship between board stockholding and technical efficiency. Moreover, for the cement and iron industries the coefficient estimates of BOD are significantly negative, indicating that board stockholding positively impacts technical efficiency. Finally, for the rubber and electronics industries the coefficient estimates of BOD are significantly positive, indicating that board stockholding negatively influences technical efficiency.

As for blockholder ownership, the coefficient estimates of BIG for the glass and paper industries are significantly negative, indicating blockholder stockholding positively impacts technical efficiency. Finally, for the automobile industry the coefficient estimate of BIG is significantly positive, indicating blockholder stockholding negatively influences technical efficiency.

The estimated variance ratio γ is significantly different from zero for most industries, suggesting that this study makes an adequate specification of the stochastic frontier and inefficiency effects. Mean technical efficiencies differ substantially among the sample industries, ranging between 20.21% and 95.52%.

Table 4.7 Effect of Managerial Ownership on Technical Efficiency for Each Industry

Variable \ Industry	Cement	Foods	Plastics	Textiles	Electric & Machinery	Electric Appliance & Cable	Chemicals	Glass & Ceramics
EXE	0.0879	0.0255	−0.0055	0.0061	−0.0200	0.0022	0.0019	−0.0020
	(2.14)**	(2.18)**	(−3.50)***	(0.80)	(−3.19)***	(0.43)	(0.40)	(−0.38)
$(EXE)^2$	−0.0083	−0.0008	—	−0.0005	0.0003	—	—	—
	(−4.29)***	(−2.35)**		(−2.05)**	(3.27)***			
BOD	−0.0128	0.0275	−0.0014	−0.0017	−0.0187	−0.0008	−0.0044	−0.0059
	(−2.49)**	(3.40)***	(−0.82)	(−0.83)	(−3.56)***	(−0.31)	(−0.92)	(−1.54)
$(BOD)^2$	—	−0.0005	—	—	0.0001	—	—	—
		(−3.74)***			(2.42)**			
BIG	0.0001	−0.0056	0.0005	0.0054	−0.0026	0.0144	0.0055	−0.0286
	(0.01)	(−0.84)	(0.24)	(1.32)	(−0.90)	(1.36)	(1.12)	(−3.56)***
# of Firms	8	27	26	66	45	17	46	6
γ	0.7908***	0.4510***	0.3290	0.3119***	0.9741***	0.6680***	0.2459**	0.2524***
Mean TE	56.38%	70.31%	37.10%	78.51%	44.70%	56.16%	56.32%	76.40%

Variable \ Industry	Paper & Pulp	Iron & Steel	Rubber	Auto-mobile	Electronics	Construction	Trans-portation	Others
EXE	0.0174	0.0002	0.0062	0.0183	0.9093	0.0251	0.0006	0.0018
	(1.88)*	(1.14)	(1.40)	(1.12)	(1.75)*	(1.74)*	(0.04)	(0.55)
$(EXE)^2$	—	—	—	—	−3.0359	—	—	—
					(−2.20)**			
BOD	0.0029	−0.0089	0.0096	0.0083	0.2085	−0.0020	−0.0135	−0.0011
	(0.80)	(−9.27)***	(2.68)***	(0.48)	(1.65)*	(−0.13)	(−1.47)	(−0.43)
$(BOD)^2$	—	—	—	—	—	—	—	—
BIG	−0.0314	0.0044	0.0041	0.0797	0.0048	−0.0051	−0.0120	0.0036
	(−3.90)***	(0.49)	(0.95)	(2.11)**	(0.01)	(−0.23)	(−0.42)	(1.16)
# of Firms	7	36	10	5	261	14	9	45
γ	0.2956*	0.0539	0.0408	0.9993***	0.4912***	0.9999***	0.0344	0.9999***
Mean TE	77.40%	95.52%	92.93%	73.74%	20.21%	56.61%	91.44%	29.40%

The values in parentheses are t-statistics.

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

4.2.4 Effect of Managerial Ownership on IPO Survival for All Industries

Table 4.8 presents the estimation results of the piecewise exponential AFT model with total insider ownership as the independent ownership variable. The time scale was divided into 6 intervals, i.e. 24 months as an interval. Two models are reported: Model 5A contains the quadratic term of total insider ownership while model 5B does not.

The coefficient for $(INS)^2$ is significantly positive (χ^2-statistic = 3.95, p-value<0.05) for Model 5A, suggesting a U-shaped relation between total insider ownership and survival time. In Model 5B, the INS term is not significantly different from zero (χ^2-statistic=0.01, p-value>0.10). This reduced model (Model 5B) is rejected by the likelihood-ratio test where the value of test statistics –2[(-211.27)-(-208.76)]=5.02 is greater than the critical value (3.84), indicating that the model specification using the quadratic term of total insider ownership is more appropriate.

In terms of control variables, the coefficients on AGEO and IR have the expected signs and are statistically significant (p-value<0.10). However, SIZEO, ACT, or MKT are not significant in either Model 5A or 5B.

Evidence in Table 4.8 shows that the survival time of an IPO firm in Taiwan first decreases and then increases with total insider ownership. The survival time also increases with firm age and level of initial return monotonically, consistent with the IPO literature. No significant effect has been found for the variables of offer size, IPO activity, or market level, which is different from the results of Hensler, Rutherford, and Springer (1997).

Table 4.8 Effect of Total Insider Ownership on IPO Survival for All Industries

Independent Variable	Expected Sign	Model 5A		Model 5B	
		Estimate	(χ^2-statistic)	Estimate	(χ^2-statistic)
Intercept		8.0638	(21.44)***	5.2788	(26.25)***
INS		−13.9016	(3.90)**	0.0928	(0.01)
$(INS)^2$		15.3679	(3.95)**	—	—
AGEO	+	0.0450	(4.18)**	0.0464	(4.58)**
SIZEO	+	0.0135	(0.31)	0.0194	(0.55)
IR	+	0.9522	(3.12)*	0.9683	(3.16)*
ACT	−	−0.0035	(0.07)	−0.0036	(0.07)
MKT	−	−0.0781	(0.28)	−0.0840	(0.33)
J=1		2.6285	(7.26) ***	2.5407	(6.81) ***
J=2		1.4067	(2.76)*	1.3219	(2.45)
J=3		0.8110	(1.00)	0.7217	(0.79)
J=4		1.0808	(1.53)	1.0223	(1.36)
J=5		−0.2194	(0.07)	−0.2756	(0.11)
J=6		0	.	0	.
# of IPOs		560		560	
Log Likelihood		−208.76		−211.27	

The dependent variable is ln(TIME).

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

This study continues to carry out a detailed analysis for the structure of managerial ownership. Table 4.9 presents the estimation results for the piecewise exponential AFT model with the executive-to-insider and the board-to-insider holding ratios as independent ownership variables. Three models are reported: the first two contain the quadratic term while the third does not.

The results of Model 6A or Model 6B show that the coefficient for $(EXEP)^2$ or $(BODP)^2$ is not significantly different from zero p-value>0.10), showing no curvilinear correlation between the compositions of insider ownership and IPO survival time.

In Model 6C, the term of EXEP is significantly positive (χ^2-statistic=3.42, p-value<0.10), suggesting a positive relation between the executive-to-insider holding ratio and IPO survival time. The coefficient estimate for BODP is still not significantly different from zero (χ^2-statistic = 2.06, *p*-value>0.10), indicating no correlation between the board-to-insider holding ratio and IPO survival time. This reduced model is not rejected by the likelihood-ratio test, indicating that Model 6C has better specification than the other two models.

Table 4.9 Effect of Insider Ownership Structure on IPO Survival for All Industries

Independent Variable	Model 6A		Model 6B		Model 6C	
	Estimate	(χ^2-statistic)	Estimate	(χ^2-statistic)	Estimate	(χ^2-statistic)
Intercept	4.2822	(13.37)***	3.7004	(6.70)***	4.1747	(12.97)***
EXEP	0.0019	(0.00)	0.0218	(3.24)*	0.0225	(3.42)*
$(EXEP)^2$	0.0004	(0.54)	—	—	—	—
BODP	0.0121	(2.20)	0.0298	(0.78)	0.0117	(2.06)
$(BODP)^2$	—	—	–0.0001	(0.30)	—	—
AGEO	0.0468	(4.70)**	0.0468	(4.73)**	0.0468	(4.70)**
SIZEO	0.0217	(0.65)	0.0238	(0.76)	0.0234	(0.74)
IR	0.9051	(2.71)*	0.8939	(2.68)	0.9037	(2.73)*
ACT	–0.0039	(0.08)	–0.0042	(0.10)	–0.0037	(0.08)
MKT	–0.1129	(0.61)	–0.1112	(0.59)	–0.1130	(0.61)
J=1	2.5766	(7.00) ***	2.6170	(7.23) ***	2.6015	(7.14) ***
J=2	1.3578	(2.58)	1.4000	(2.74)*	1.3823	(2.68)
J=3	0.7537	(0.87)	0.7955	(0.96)	0.7783	(0.92)
J=4	1.0724	(1.50)	1.1216	(1.64)	1.1005	(1.58)
J=5	–0.2927	(0.13)	–0.2648	(0.11)	–0.2809	(0.12)
J=6	0	.	0	.	0	.
# of IPOs	560		560		560	
Log Likelihood	–209.19		–209.37		–209.52	

The dependent variable is ln(TIME).

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

4.3 Effect of Managerial Ownership for Electronics Industry

Because the electronics industry is the first to adopt the "Taiwanese-style profit sharing and employee stock ownership plans", and because this industry alone makes major contribution to Taiwan's economy, this study will further investigate the influence of managerial ownership on productivity and efficiency among Taiwanese electronics firms.

4.3.1 Effect of Managerial Ownership on Total Factor Productivity for Electronics Industry

The results of estimating Equation (3.8) with total insider ownership as the ownership variable are listed in Table 4.10, while the year effects and the random intercepts are omitted. In Model 7A, it is observed that the coefficient estimate for $(INS)^2$ is not statistically significant (t-statistic = –0.56, p-value>0.10), suggesting no quadratic relation between total insider ownership and productivity. In Model 7B we re-estimate Equation (3.8) after eliminating the insignificant independent variable $(INS)^2$. The coefficient estimate for (INS) is still not significantly different from zero (t-statistic= –0.58, p-value>0.10), indicating no correlation between total insider ownership and total factor productivity at all.

Table 4.10 Effect of Total Insider Ownership on TFP for Electronics Industry

Independent Variable	Coefficient	Model 7A		Model 7B	
		Estimate	(*t*-statistic)	Estimate	(*t*-statistic)
Mean Intercept	E(u_i)	6.4978	(14.61)***	6.6583	(15.76)***
lnL	α_L	0.5878	(13.96)***	0.5884	(13.98)***
lnK	α_K	0.0387	(1.43)	0.0384	(1.42)
RD	α_1	0.2883	(5.65)***	0.2873	(5.64)***
AGE	α_2	0.0192	(1.19)	0.0031	(0.52)
(AGE)^2	α_3	−0.0005	(−1.07)	—	—
INS	α_4	0.1504	(0.37)	−0.0797	(−0.58)
(INS)^2	α_5	−0.2151	(−0.56)	—	—
YEAR	α_t	YES	YES***	YES	YES***
# of Firms		333		333	
# of Observations		1113		1113	
AICC		1852		1840	

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

YES: The year effects are estimated, but not reported.

This research continues to carry out an in-depth analysis for the structure of managerial ownership. The results of estimating Equation (3.9) with the executive-to-insider and the board-to-insider holding ratios as the ownership variables are presented in Table 4.11, while the year effects and the random intercepts are omitted.

In Model 8A, it is observed that the coefficient estimate for $(\mathrm{BODP})^2$ is not significantly different from zero (t-statistic=0.50, p-value>0.10), showing no quadratic relationship between board-to-insider holding ratio and productivity. Consequently, in Model 8B we re-estimate Equation (3.9) after eliminating the insignificant independent variables $(\mathrm{BODP})^2$ and $(\mathrm{AGE})^2$, and observe that the coefficient estimate for $(\mathrm{EXEP})^2$ is still significantly positive (t-statistic=3.22, p-value<0.01), indicating a U-shaped relation between executive-to-insider holding ratio and productivity. However, the coefficient estimate for BODP is not significantly different from zero (t-statistic= −0.25, p-value>0.10), showing no correlation between board-to-insider holding ratio and productivity. Finally, in Model 8C we replace the board-to-insider holding ratio (BODP) with the blockholder-to-insider holding ratio (BIGP) and find a similar result as in Model 8B, in that large shareholder ownership does not affect productivity. As for the goodness of fit, both Model 8B and Model 8C demonstrate the same lower AICC (=1832) than the other three models, suggesting that the quadratic specification of the executive-to-insider holding ratio did better capture the relationship between managerial ownership and firm productivity.

In terms of control variables, Model 8B and Model 8C report the same positive effect of R&D expenditure on productivity ($\alpha_1 = 0.2810$, p-value<0.01), consistent with the findings of Hill and Snell (1989) and Huang and Liu (1994). However, there exists no significant contribution of firm age on productivity ($\alpha_2 = 0.0026$, p-value>0.10); therefore, we cannot conclude that there is learning effect for older firms in Taiwan's electronics industry.

Table 4.11 Effect of Insider Ownership Structure on TFP for Electronics Industry

Independent Variable	Coefficient	Model 8A		Model 8B		Model 8C	
		Estimate	(*t*-statistic)	Estimate	(*t*-statistic)	Estimate	(*t*-statistic)
Mean Intercept	$E(u_i)$	6.5449	(15.01)***	6.6198	(15.78)***	6.5887	(16.20)***
lnL	α_L	0.5903	(14.07)***	0.5914	(14.10)***	0.5914	(14.10)***
lnK	α_K	0.0424	(1.58)	0.0418	(1.56)	0.0418	(1.56)
RD	α_1	0.2806	(5.53)***	0.2810	(5.54)***	0.2810	(5.54)***
AGE	α_2	0.0208	(1.31)	0.0026	(0.43)	0.0026	(0.43)
$(AGE)^2$	α_3	−0.0005	(−1.24)	—	—	—	—
EXEP	α_6	−0.5421	(−1.51)	−0.6407	(−2.33)**	−0.6096	(−2.50)**
$(EXEP)^2$	α_7	0.8808	(1.98)**	1.0218	(3.22)***	1.0218	(3.22)***
BODP	α_8	−0.2633	(−0.55)	−0.0311	(−0.25)	—	—
$(BODP)^2$	α_9	0.1879	(0.50)	—	—	—	—
BIGP		—	—	—	—	0.0311	(0.25)
YEAR	α_t	YES	YES***	YES	YES***	YES	YES***
# of Firms		333		333		333	
# of Observations		1113		1113		1113	
AICC		1844		1832		1832	

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

YES: The year effects are estimated, but not reported.

4.3.2 Effect of Managerial Ownership on Technical Efficiency for Electronics Industry

The results of estimating stochastic frontier production function (Equation 3.10) and technical inefficiency regression (Equation 3.11) with total insider ownership as the explanatory variable are listed in Table 4.12. Model 9A includes both INS and its square in the inefficiency function whereas Model 9B includes INS only. It needs to be kept in mind when looking at the coefficient of the explanatory variable in the inefficiency function that a positive coefficient implies a decrease in technical efficiency.

In Model 9A, it is observed that the coefficient for $(INS)^2$ is not significantly different from zero (t-statistic = 0.17, p-value>0.10), suggesting no quadratic relation between total insider ownership and technical efficiency. In Model 9B, the square of total insider holding ratio is eliminated from Equation (3.11), and it is found the coefficient for INS is now significantly positive (t-statistic=3.29, p-value<0.01), indicating a negative correlation between total insider ownership and technical efficiency.

Table 4.12 Effect of Total Insider Ownership on TE for Electronics Industry

Independent Variable	Model 9A		Model 9B	
	Coefficient	(t-statistics)	Coefficient	(t-statistics)
Stochastic Frontier Production Function (Equation 3.10)				
Intercept	11.4174	(17.98)***	12.2431	(15.58)***
lnL*	2.6802	(14.75)***	2.4181	(12.89)***
lnK*	−0.6227	(−4.76)***	−0.9294	(−5.54)***
lnM*	−0.2501	(−5.92)***	−0.2226	(−4.84)***
lnL* lnL*	0.0235	(6.39)***	0.0229	(5.89)***
lnK* lnK*	0.0439	(6.33)***	0.0553	(6.53)***
lnM* lnM	0.0524	(31.14)***	0.0534	(31.85)***
lnL* lnK*	−0.1456	(−10.27)***	−0.1257	(−8.60)***
lnL* lnM*	−0.0597	(−8.32)***	−0.0586	(−7.78)***
lnK* lnM*	−0.0040	(−0.84)	−0.0073	(−1.43)
Technical Inefficiency Regression (Equation 3.11)				
Constant	3.6671	(24.07)***	2.3737	(8.58)***
INS	0.1858	(0.58)	0.2697	(3.29)***
$(INS)^2$	0.0597	(0.17)	—	—
RD*	−0.0271	(−6.77)***	−0.0336	(−6.52)***
SIZE	−0.0015	(−10.00)***	−0.0043	(−2.07)**
AGE	−0.0044	(−2.01)**	−0.0056	(−2.62)***
DUM_{1997}	−0.0609	(−0.69)	−0.0570	(−0.58)
DUM_{1998}	−0.1062	(−1.25)	−0.1040	(−1.06)
DUM_{1999}	−0.2661	(−3.36)***	−0.2610	(−2.75)***
DUM_{2000}	−0.4095	(−5.11)***	−0.4140	(−4.40)***
DUM_{2001}	−0.4078	(−5.27)***	−0.3853	(−4.21)***
σ_s^2	0.3343	(25.59)***	0.3327	(24.37)***
γ	0.9999	(10E+7)***	0.2668	(13.37)***
# of Firms	416		416	
# of Observations	1612		1612	
Log-likelihood	−1371		−1393	

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

Our research continues with a detailed analysis of the effects that managerial ownership structure may have on technical efficiency. The results of estimating stochastic frontier production function (Equation 3.10) and technical inefficiency regression (Equation 3.11) with the executive-to-insider and the board-to-insider holding ratios as the ownership variables are presented in Table 4.13. Model selection tests are used to choose the specifications which best fit the data and only those results are reported. Model 10A includes both EXEP and its square in the inefficiency function, Model 10B includes BODP only, and Model 10C includes all the three variables.

In Model 10A, it is observed that the coefficient for $(EXEP)^2$ is significantly negative (t-statistic = –2.13, p-value<0.05), showing a U-shaped relation between executive ownership and technical efficiency. Consequently, in Model 10B it is found that the coefficient for BODP is significantly positive (t-statistic = 1.74, p-value<0.10), indicating a monotonically negative relationship between board ownership and technical efficiency. Finally in Model 10C, despite the possible collinearity among the variables of $(EXEP)^2$, EXEP and BODP, the coefficient for $(EXEP)^2$ is still significantly negative (t-statistic= –2.57, p-value<0.05), and the coefficient for BODP is still significantly positive (t-statistic = 2.02, p-value<0.05), consistent with the results from Model 10A and 10B. Summing up, it is found that the executive-to-insider holding ratio first decreases and then increases technical efficiency, whereas the board-to-insider holding ratio negatively impacts technical efficiency.

In terms of control variables, the coefficient estimates for RD*, SIZE, and AGE are all significantly negative, indicating that R&D, firm size, and firm age positively influence technical efficiency, consistent with the findings of Huang and Liu (1994), etc.. As to year dummies, the coefficient estimates for DUM_{1999}, DUM_{2000}, and DUM_{2001} are significantly negative, showing an overall increasing trend for technical efficiency over the observed period.

Table 4.13 Effect of Insider Ownership Structure on TE for Electronics Industry

Independent Variable	Model 10A		Model 10B		Model 10C	
	Coefficient	(t-statistics)	Coefficient	(t-statistics)	Coefficient	(t-statistics)
Stochastic Frontier Production Function (Equation 3.10)						
Intercept	11.4540	(14.82)***	11.7633	(13.06)***	10.7275	(13.73)***
lnL*	2.4303	(13.02)***	2.4370	(12.63)***	2.4499	(14.40)***
lnK*	−0.7937	(−5.12)***	−0.9270	(−5.27)***	−0.8301	(−5.44)***
lnM*	−0.2301	(−4.95)***	−0.2305	(−4.81)***	−0.2531	(−5.42)***
lnL* lnL*	0.0228	(5.85)***	0.0223	(5.87)***	0.0219	(5.90)***
lnK* lnK*	0.0496	(6.28)***	0.0557	(6.39)***	0.0513	(6.89)***
lnM* lnM*	0.0528	(32.11)***	0.0539	(31.99)***	0.0534	(32.21)***
lnL* lnK*	−0.1267	(−8.72)***	−0.1273	(−8.49)***	−0.1293	(−9.77)***
lnL* lnM*	−0.0581	(−7.73)***	−0.0572	(−7.64)***	−0.0569	(−7.80)***
lnK* lnM*	−0.0060	(−1.17)	−0.0072	(−1.37)	−0.0049	(−0.95)
Technical Inefficiency Regression (Equation 3.11)						
Constant	2.4780	(9.99)***	2.0098	(7.74)***	1.3036	(5.80)***
EXEP	0.3228	(1.56)	—	—	0.6863	(2.77)***
$(EXEP)^2$	−0.5826	(−2.13)**	—	—	−0.7926	(−2.57)**
BODP	—	—	0.1153	(1.74)*	0.2524	(2.02)**
RD*	−0.0257	(−6.30)***	−0.0288	(−4.96)***	−0.0101	(−2.17)**
SIZE	−0.0090	(−7.54)***	−0.0042	(−2.00)**	−0.0110	(−5.13)***
AGE	−0.0051	(−2.08)**	−0.0057	(−2.54)**	−0.0056	(−2.34)**
DUM_{1997}	−0.0197	(−0.23)	−0.0293	(−0.35)	−0.0292	(−0.33)
DUM_{1998}	−0.0772	(−0.95)	−0.0878	(−1.08)	−0.0818	(−0.96)
DUM_{1999}	−0.2450	(−3.05)***	−0.2536	(−3.10)***	−0.2569	(−3.12)***
DUM_{2000}	−0.4029	(−5.17)***	−0.4052	(−5.14)***	−0.4170	(−4.99)***
DUM_{2001}	−0.3794	(−4.86)***	−0.3849	(−4.81)***	−0.3810	(−4.60)***
σ_s^2	0.3331	(25.90)***	0.3353	(24.15)***	0.3356	(23.72)***
γ	0.4173	(7.24)***	0.0733	(1.79)*	0.0328	(2.28)**
# of Firms	416		416		416	
# of Observations	1612		1612		1612	
Log-likelihood	−1395		−1404		−1402	

***, **, *: Significant at the 1%, 5%, and 10% level, respectively.

Formal tests of hypotheses associated with Model 10C are given in Table 4.14. The first null hypothesis of a Cobb-Douglas frontier is strongly rejected. The second hypothesis, H_0: $\gamma = 0$, all δs =0, and all ηs=0, which specifies that the sample electronics firms are full technical efficient, is also rejected. Again, the third hypothesis that technical efficiency is time-invariant is rejected. In sum, the above test results support our employment of a translog production frontier with time-varying inefficiency specification in this study.

Table 4.14 Likelihood Ratio Test for Model 10C

Restriction	Null Hypothesis	Degrees of freedom	Test statistics	Critical Value at 1%
Cobb-Douglas vs. Translog production function	H_0: $\beta_{jk} = 0$ $j \leq k$ =1,2,3	6	−2{−1920−(−1402)} = 1036	16.81
No technical inefficiency effect	H_0: $\gamma = 0$, all δs =0, & all ηs=0	12	230	27.62*
No year effect for time dummies	H_0: all ηs=0	5	−2{−1479−(−1402)} =154	15.09

* The critical value for the test of no technical inefficiency effect is obtained from Table 1 of Kodde and Palm (1986).

4.4 Summary and Discussions

This study documents the vital importance of executive stock ownership to overall performance for firms in Taiwan. Table 4.15 summarizes the empirical findings of this study. It should be noted that the results for the traditional "total insider ownership" variable are promiscuous and confusing, similar to those from prior empirical works (Table 2.1). However, executive ownership, either as a percentage of total outstanding shares or as a proportion of insider stockholdings, plays a consistent role in advancing firm performance in terms of all the measures, regardless of which industry the firm belongs to. Board ownership, either as a ratio of total outstanding shares or of insider stockholdings, might not contribute to firm performance at all.

Table 4.15 Summary of Empirical Results in This Study

Managerial Ownership Variable	Firm Performance Variable				
	For All Industries			For Electronics Industry	
	Tobin's Q	ROA	IPO Survival time	Technical Efficiency	Total Factor Productivity
Total Insider holding ratio (INS)	Positive	Inverted U-shaped	U-shaped	Negative	Irrelevant
Executive holding ratio (EXE)	Positive	Positive	—	U-shaped	—
Board holding ratio (BOD)	Inverted U-shaped	Inverted U-shaped	—	Negative	—
Executive-to-insider holding ratio (EXEP)	—	—	Positive	U-shaped	U-shaped
Board-to-insider holding ratio (BODP)	—	—	Irrelevant	Negative	Irrelevant

4.4.1 Implications of Managerial Ownership Structure to All Industries

In terms of the impact of managerial ownership on performance, it is observed in Figure 4.2 that total insider ownership positively influences Tobin's Q, but first increases and then decreases ROA. For an IPO issuer, total insider ownership first decreases and then increases it survival time. In other words, increasing total insider ownership above a certain level might enhance firm value as well as survivability, but not necessarily firm profitability. However, different results are reached if insiders are classified into sub-groups. Executive ownership is positively related with all the three measure of Tobin's Q, ROA, and IPO survival time. In contrast, board ownership forms the inverted U-shaped relationship with both Tobin's Q and ROA, and is unrelated to IPO survival.

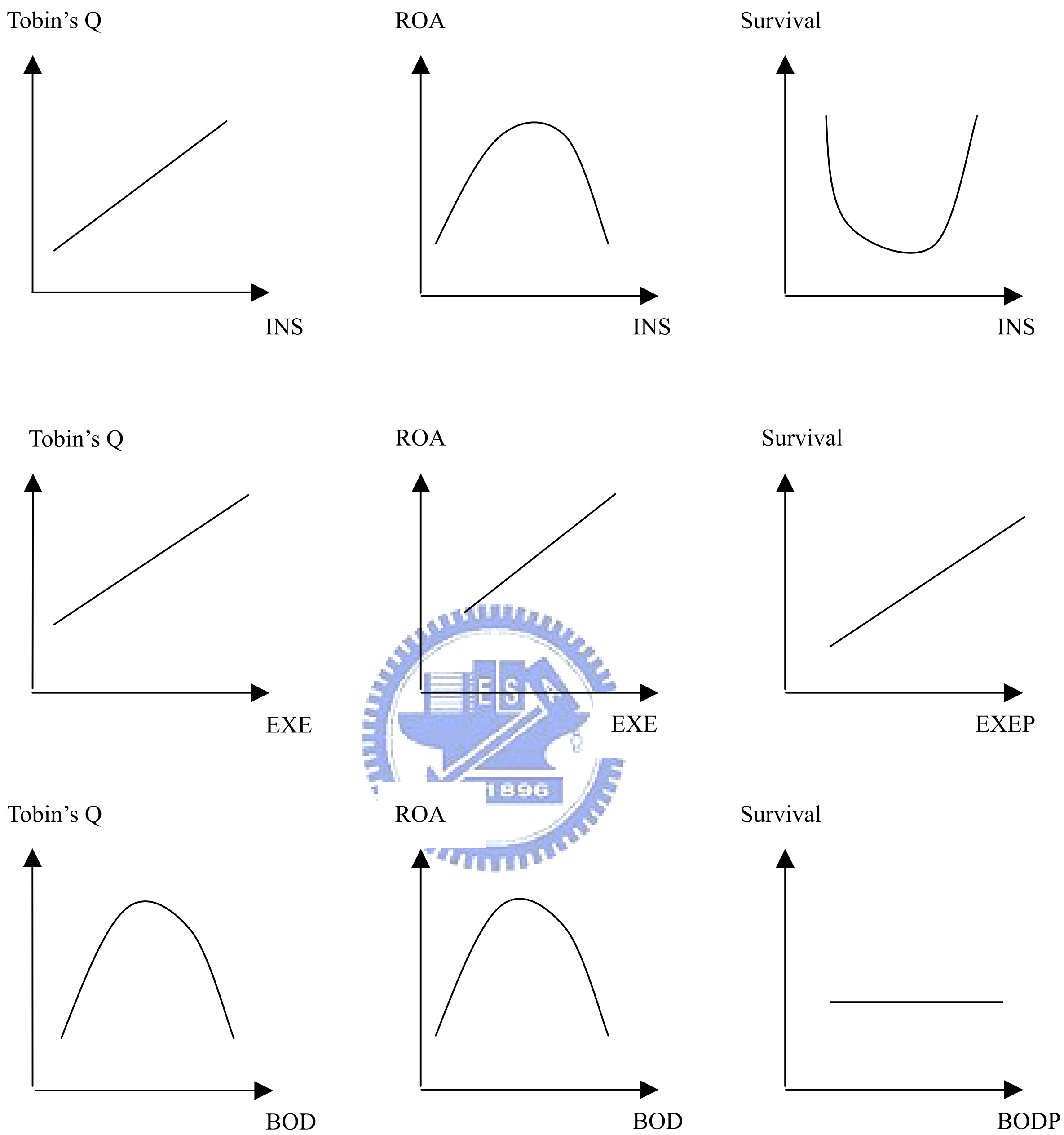

Figure 4.2 Effect of Managerial Ownership on Firm Performance for All Industries

As to the congruent results of executive ownership on Tobin's Q, ROA and IPO survival, it might indicate the significance of top officers' commitment to the performance of Taiwanese listed firms. Hsu (1997) finds that family control through family members serving as board members and senior managers has been gradually decreasing in Taiwan, while the incidence of professional managers serving as board members and senior managers has been increasing. For example, it is regulated in the "Standards for Determining Unsuitability for OTC Listing" that at least one-third of the directors of the applicant company should not be mutually related in any of the following ways: (i) spouses; (ii) lineal relatives within the second degree of kinship; (iii) collateral relatives within the third degree of kinship; (iv) representatives of the same juristic person; or (v) related parties. Furthermore, Securities & Futures Commission (Taiwan's securities regulator) has recently pushed the listed firms to adopt the system of independent directors and independent supervisor. Therefore, the increasing presence of non-family professionals may have important implications for corporate governance. With heavier ownership and stronger control, these top officers might be able to exert their professional knowledge in making strategic decisions concerning firm survival and development. Thus, firm performance is likely to improve and agency costs to reduce. This supports the convergence-of-interest hypothesis of Jensen and Meckling (1976).

The inverted U-shaped relation between board ownership and firm performance suggests that "management entrenchment" (Morck et al., 1988) or some other mitigating factor, such as the inability of the market to discipline the board of directors, may be the dominant factor influencing firm performance. That is, as board ownership increases beyond a certain point, the possibility for outsiders to take over the company may decline, and thus the probability of the market to discipline the board also declines. After this point, the non-executive directors might get entrenched and may seek to maximize his or her personal utility instead of focusing on shareholder wealth.

Results of this study also demonstrate that the effect of managerial ownership structure on technical efficiency in Taiwan differs among different industries. Technical efficiency in Taiwan could be enhanced by increasing executive ownership in the cement, food, plastics, textiles, and electronics industries, and by decreasing executive ownership in the electric and machinery, paper and construction industries. For the cement, food, and iron industries, technical efficiency can be improved by encouraging board ownership, while the opposite effect would be induced for the electric and machinery, rubber, and electronics industries. As to the blockholder ownership, technical efficiency is positively related for the glass and paper industries, while negative relationship exists for the automobile industry. One possible explanation for this phenomenon is that the magnitude of information asymmetry between distinct insiders and shareholders differs substantially among industries. Consequently the agency problems among industries are not identical and cannot be remedied by a universal ownership scheme. Therefore, specific insider holding policy should be developed for different industries to maximize firm efficiency.

4.4.2 Implications of Managerial Ownership Structure to Electronics Industry

Empirical results also suggest that executive stock ownership is essential to productivity and efficiency for Taiwanese electronics firms. As shown in Figure 4.3, although a negative correlation is initially observed between the total insider ownership and technical efficiency, critical resolutions are unveiled after we decompose managerial ownership.

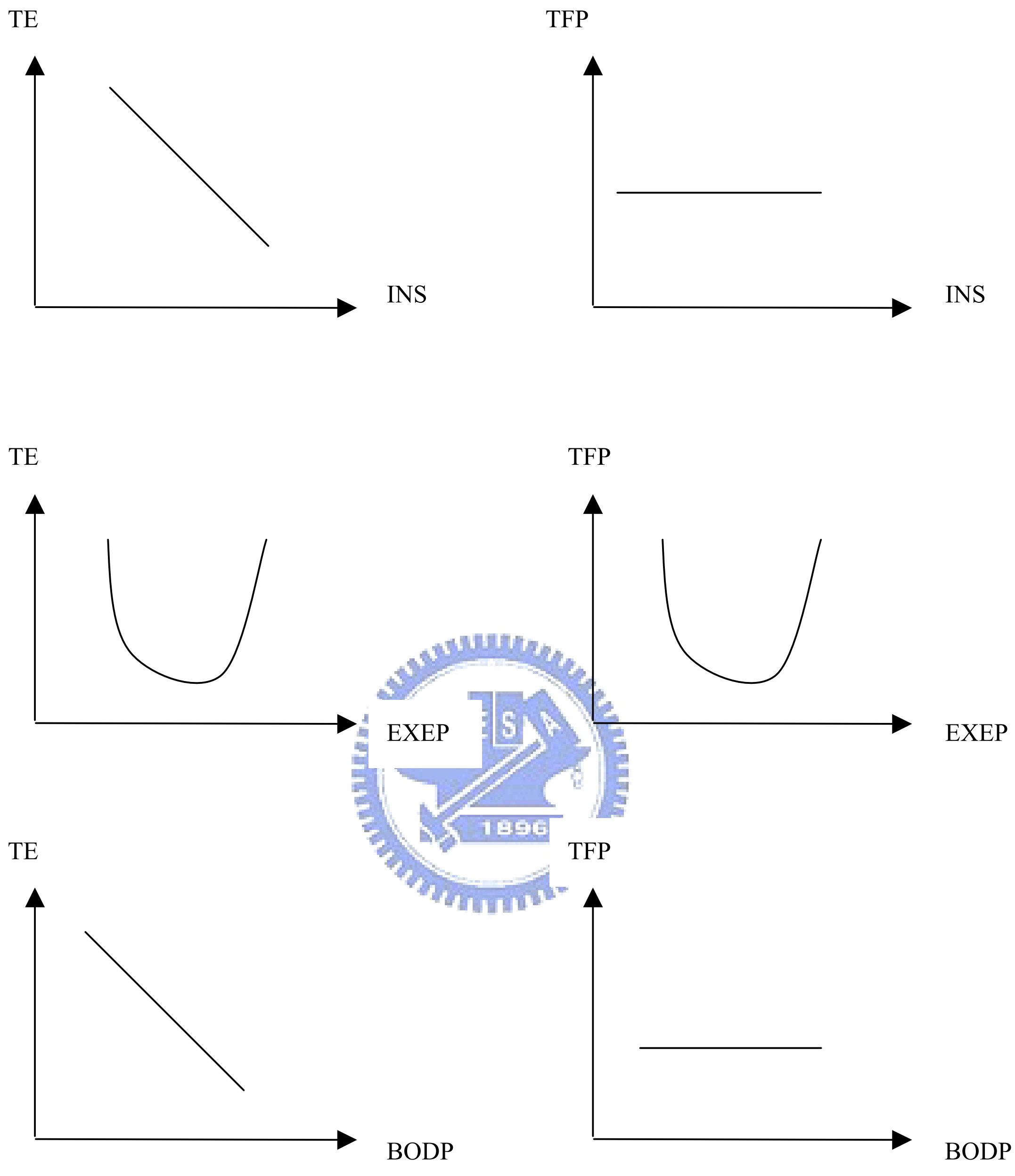

Figure 4.3 Effect of Managerial Ownership on Firm Performance for Electronics Industry

Regarding executive ownership, the U-shaped influences of the executive-to-insider holding ratio on technical efficiency and total factor productivity indicate that increasing executive ownership beyond a certain percentage will somewhat relieve the agency problem, which is consistent with the result of Yeh, Chiu, and Ho (1997). One possible explanation for this phenomenon might be the fact that the magnitude of information asymmetry between shareholders and managers in the electronics industry is enhanced, because most top officers own proprietary high-tech expertise. Raising the executive-to-insider holing ratio might enable these top officers to exert their particular know-how in directing the strategic development of the firm and in supervising an efficient utilization of firm resources. Thus, firm efficiency and productivity are likely to be improved and thus agency problem be relieved. This again supports the convergence-of-interest hypothesis of Jensen and Meckling (1976).

With regards to board member ownership, a negative relation or irrelevancy is observed between the board-to-insider holding ratio and technical efficiency or total factor productivity. A potential reason might be the fact that individuals or institutions are not necessarily endowed with both managerial talent and financial capital (Denis and McConnell, 2003). In particular, outside investors are less likely to possess the professional skills needed to run a high-tech company. Even if they were elected as board members, they probably do not have the ability to assume responsibilities typical of management. That is to say, non-executive directors in Taiwanese electronics firms probably behave more like an ordinary investor. Therefore, increasing the board-to-insider holding ratio might not be beneficial to firm efficiency or productivity.

CHAPTER 5　CONCLUSIONS

Agency theory and some previous investigations suggest that managerial equity ownership may influence firm performance, but the empirical tests mainly focus on financial measures such as Tobin's Q and ROA. On the other hand, although productivity and efficiency are also important indicators of firm performance, few production-function studies have ever taken managerial ownership into account, let alone its composition. This study brings together various aspects of corporate finance and productivity literature and examines the impact of managerial ownership structure on overall firm performance in Taiwan, from the perspectives of financial measures (Tobin's Q and ROA), economic measures (total factor productivity and technical efficiency) and IPO survival duration. Insiders, the broad definition of management, have been sub-classified into executives, board members, and large shareholders to carry out a systematic analysis on managerial ownership structure that has not been done before.

Empirical results demonstrate that for the study period 1996-2001, although increasing at first and then later decreasing, total insider ownership has remained at about 30% of total outstanding shares of a firm on average. However, in terms of managerial ownership structure, executive ownership has grown significantly, whereas board ownership has demonstrated a declining trend. Large shareholders do not exist among most of the sample firms.

As for the impact of managerial ownership on firm performance, the results for the traditional "total insider ownership" variable are still mixed and contradictory, resembling those in traditional works. However, critical resolutions are unveiled after "total insider ownership" is decomposed. Evidence shows that executive ownership consistently improves performance measures for Taiwanese firms in different industries. In contrast, board ownership might not contribute to firm performance at all.

These results seem to reflect the reality in Taiwan's economic development during the last decade. Under circumstances characterized by rapid growth of high-tech sector in the 1990s, Taiwan-style profit sharing and employee stock ownership plans have been often used as a strategic scheme to attract and to retain talented knowledge workers. The important implication of this study is that for Taiwanese listed firms increasing executive stock ownership among insiders will improve overall firm performance and thus reduce the agency cost. The recent legislation of "employee stock option" system in Taiwan should also be considered as a positive factor in terms of aligning managerial and shareholders' interests. From a corporate governance perspective, stock ownership of top officers, especially in high-tech firms, should be encouraged to enhance firm performance.

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附 錄：相 關 證 期 法 令

一、 內部人之相關規定

法規名稱：公開發行公司應公告或向財政部證券暨期貨管理委員會申報事項一覽表 (民國 93 年 02 月 10 日修正)

公告或申報項目 9：股權、質權變動

內容摘要：公司董監事、經理人及持股超過百分之十股東(簡稱公司內部人) 之持股變動情形與股票質之資權之設定及解除情形。 (申報對象包括：董事、監察人、經理人及持股超過百分之十之股東，包括其配偶、未成年子女及利用他人名義持有者；另政府或法人股東指派之代表人及金控子公司內部人，包括其配偶、未成年子女及利用他人名義持有者；另政府或法人股東指派之代表人及金控子公司內部人，包括其配偶、未成年子女及利用他人名義持有股票者亦適用。)

公告或申報期限：

1. 公司應於每月十五日以前彙總向本會指定之資訊申報網站傳輸公司內部人上月持有股數變動情形，視為已依規定完成公告申報。
2. 質權設定者，應於質權設定後五日內向本會指定之資訊申報網站傳輸，並應於每月十五日前彙總向本會指定之資訊申報網站傳輸，視為已依規定完成公告申報；質權解除者亦同。

公告或申報項目 12：公司內部人持股轉讓事前申報

1 公司內部人申報持股轉讓時應將申報書送達所屬公司並傳真證交所或櫃買中心。

2 公司於收到內部人之申報書後應即上網申報。

法規名稱：上市上櫃公司治理實務守則 第 10 條 (民國 92 年 12 月 31 日修正)

上市上櫃公司應重視股東知的權利，並確實遵守資訊公開之相關規定，將公司財務、業務、內部人持股及公司治理情形，經常且即時利用公開資訊觀測站或公司設置之網站提供訊息予股東。

二、 經理人之相關規定

法規名稱：公司法 (民國 90 年 11 月 12 日修正)

第 8 條 本法所稱公司負責人：在無限公司、兩合公司為執行業務或代表公司之股東；在有限公司、股份有限公司為董事。

公司之經理人或清算人，股份有限公司之發起人、監察人、檢查人、重整人或重整監督人，在執行職務範圍內，亦為公司負責人。

第 29 條 公司得依章程規定置經理人，其委任、解任及報酬，依左列規定定之。但公司章程有較高規定者，從其規定：

(一) 無限公司、兩合公司須有全體無限責任股東過半數同意。

(二) 有限公司須有全體股東過半數同意。

(三) 股份有限公司應由董事會以董事過半數之出席，及出席董事過半數同意之決議行之。

經理人應在國內有住所或居所。

法規名稱：證券交易法 (民國 93 年 04 月 28 日修正)

第 22-2 條 （董事、監察人等股票之轉讓方式）

已依本法發行股票公司之董事、監察人、經理人或持有公司股份超過股份總額百分之十之股東，其股票之轉讓，應依左列方式之一為之：

(一) 經主管機關核准或自申報主管機關生效日後，向非特定人為之。

(二) 依主管機關所定持有期間及每一交易日得轉讓數量比例，於向主管機關申報之日起三日後，在集中交易市場或證券商營業處所為之。但每一交易日轉讓股數未超過一萬股者，免予申報。

(三) 於向主管機關申報之日起三日內，向符合主管機關所定條件之特定人為之。

經由前項第三款受讓之股票，受讓人在一年內欲轉讓其股票，仍須依前項各款所列方式之一為之。

第一項之人持有之股票，包括其配偶、未成年子女及利用他人名義持有者。

第 25 條 公開發行股票之公司於登記後，應即將其董事、監察人、經理人及持有股份超過股份總額百分之十之股東，所持有之本公司股票種類及股數，向主管機關申報並公告之。

前項股票持有人，應於每月五日以前將上月份持有股數變動之情形，向公司申報，公司應於每月十五日以前，彙總向主管機關申報。必要時，主管機關得命令其公告之。

第二十二條之二第三項之規定，於計算前二項持有股數準用之。

第一項之股票經設定質權者，出質人應即通知公司；公司應於其質權設定後五日內，將其出質情形，向主管機關申報並公告之。

第 157 條 發行股票公司董事、監察人、經理人或持有公司股份超過百分之十之股東，對公司之上市股票，於取得後六個月內再行賣出，或於賣出後六個月內再行買進，因而獲得利益者，公司應請求將其利益歸於公司。

第 157-1 條 左列各款之人，獲悉發行股票公司有重大影響其股票價格之消息時，在該消息未公開前，不得對該公司之上市或在證券商營業處所買賣之股票或其他具有股權性質之有價證券，買入或賣出：

(一) 該公司之董事、監察人及經理人。

(二) 持有該公司股份超過百分之十之股東。

(三) 基於職業或控制關係獲悉消息之人。

(四) 從前三款所列之人獲悉消息者。

違反前項規定者，應就消息未公開前其買入或賣出該證券之價格，與消息公開後十個營業日收盤平均價格之差額限度內，對善意從事相反買賣之人負損害賠償責任；其情節重大者，法院得依善意從事相反買賣之人之請求，將責任限額提高至三倍。

第一項所稱有重大影響其股票價格之消息，指涉及公司之財務、業務或該證券之市場供求、公開收購，對其股票價格有重大影響，或對正當投資人之投資決定有重要影響之消息。

三、 庫藏股之相關規定

法規名稱： 證券交易法第 28-2 條 (民國 91 年 06 月 12 日修正)

股票已在證券交易所上市或於證券商營業處所買賣之公司，有左列情事之一者，得經董事會三分之二以上董事之出席及出席董事超過二分之一同意，於有價證券集中交易市場或證券商營業處所或依第四十三條之一第二項規定買回其股份，不受公司法第一百六十七條第一項規定之限制：

(一) 轉讓股份予員工。

(二) 配合附認股權公司債、附認股權特別股、可轉換公司債、可轉換特別 股或認股權憑證之發行，作爲股權轉換之用。

(三) 爲維護公司信用及股東權益所必要而買回，並辦理銷除股份者。

前項公司買回股份之數量比例，不得超過該公司已發行股份總數百分之十；收買股份之總金額，不得逾保留盈餘加發行股份溢價及已實現之資本公積之金額。

公司依第一項規定買回其股份之程序、價格、數量、方式、轉讓方法及應申報公告事項，由主管機關以命令定之。

公司依第一項規定買回之股份，除第三款部分應於買回之日起六個月內辦理變更登記外，應於買回之日起三年內將其轉讓；逾期未轉讓者，視爲公司未發行股份，並應辦理變更登記。

公司依第一項規定買回之股份，不得質押；於未轉讓前，不得享有股東權利。

公司於有價證券集中交易市場或證券商營業處所買回其股份者，該公司其依公司法第三百六十九條之一規定之關係企業或董事、監察人、經理人之本人及其配偶、未成年子女或利用他人名義所持有之股份，於該公司買回之期間內不得賣出。

第一項董事會之決議及執行情形，應於最近一次之股東會報告；其因故未買回股份者，亦同。

四、 員工認股權憑證之相關規定

法規名稱：公司法第 167-2 條 (民國 90 年 11 月 12 日 修正)

公司除法律或章程另有規定者外，得經董事會以董事三分之二以上之出席及出席董事過半數同意之決議，與員工簽訂認股權契約，約定於一定期間內，員工得依約定價格認購特定數量之公司股份，訂約後由公司發給員工認股權憑證。

法規名稱：發行人募集與發行有價證券處理準則 (民國 91 年 05 月 22 日修正)

第 52 條　發行人申報發行員工認股權憑證，如有下列情形之一者，本會得退回其案件：

(一) 最近連續二年有虧損者。但依其事業性質，須有較長準備期間或具有健全之營業計畫，確能改善營利能力者，不在此限。

(二) 資產不足抵償債務者。

(三) 重大喪失債信情事，尚未了結或了結後尚未逾三年者。

(四) 對已發行員工認股權憑證而有未履行發行及認股辦法約定事項之情事，迄未改善或經改善後尚未滿三年者。

(五) 其他本會為保護公益認為有必要者。

第 53 條　發行人申報發行員工認股權憑證，其每次發行得認購股份數額，不得超過已發行股份總數之百分之十，且加計前各次員工認股權憑證流通在外餘額，不得超過已發行股份總數之百分之十五。

發行人發行員工認股權憑證，給予單一認股權人之認股權數量，不得超過每次發行員工認股權憑證總數之百分之十，且單一認股權人每一會計年度得認購股數不得超過年度結束日已發行股份總數之百分之一。

第 54 條　員工認股權憑證不得轉讓。但因繼承者不在此限。

第 55 條　上市或上櫃公司申報發行員工認股權憑證，其認股價格不得低於發行日標的股票之收盤價。

興櫃股票、未上市或未在證券商營業處所買賣之公司發行員工認股權憑證，其認股價格不得低於申報日最近期經會計師查核簽證之財務報告每股淨值。

第 56 條　員工認股權憑證自發行日起屆滿二年後，持有人除依法暫停過戶期間外，得依發行人所定之認股辦法請求履約。

員工認股權憑證之存續期間不得超過十年。

第 58 條　發行人申報發行員工認股權憑證，應經董事會三分之二以上董事出席及出席董事超過二分之一之同意，並於發行及認股辦法中訂定下列有關事項：

(一) 發行期間。

(二) 認股權人資格條件。

(三) 員工認股權憑證之發行單位總數、每單位認股權憑證得認購之股數及因認股權行使而須發行之新股總數或依本法第二十八條之二規定須買回之股數。

(四) 認股條件 (含認股價格、權利期間、認購股份之種類及員工離職或發生繼承時之處理方式等) 之決定方式。

(五) 履約方式；上市或上櫃公司應以發行新股或交付已發行股份擇一爲之。但興櫃股票、未上市或未於證券商營業處所買賣之公司，應以發行新股爲之。

(六) 認股價格之調整。

(七) 盈餘轉增資及資本公積轉增資時，得增發員工認股權憑證或調整認股股數。但以認股時公司章程載明有足以供認購股份數額者爲限。

(八) 行使認股權之程序。

(九) 認股後之權利義務。

(一〇) 其他重要約定事項。

前項第一款所稱發行期間，自申報生效通知到達之日起不得超過一年。超過發行期間，其未發行之餘額仍須發行時，應重行申報。

第一項各款事項之變更，應經董事會三分之二以上董事出席及出席董事超過二分之一之同意。

第一項各款事項有變更時，發行人應即檢具董事會議事錄及修正後相關資料，列爲補正書件，並準用第十三條第四項規定。

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