Effects of Employee Stock Bonuses on Technical Efficiency: Evidence from Taiwan's Electronic Industry

員工分紅配股對生產效率的影響：以台灣電子產業爲例

doi:10.6226/NTURM2009.20.1.331

臺大管理論叢, 20(1), 2009

NTU Management Review, 20(1), 2009

作者/Author： 鄭士卿(Vivian Jeng);霍熾榮(Robert C. W. Fok);張元晨(Yuan-Chen Chang)

頁數/Page： 331-354

出版日期/Publication Date：2009/12

臺大管理論叢 2009/12
第20卷第1期 331-354

員工分紅配股對生產效率的影響：以台灣電子產業爲例

Effects of Employee Stock Bonuses on Technical Efficiency: Evidence from Taiwan's Electronic Industry

鄭士卿／國立政治大學風險管理與保險學系副教授
Vivian Jeng, Associate Professor, Department of Risk Management and Insurance, National Chengchi University

霍熾榮／威斯康辛大學 Parkside 分校商學院副教授
Robert C.W. Fok, Associate Professor, School of Business and Technology, University of Wisconsin-Parkside

張元晨／國立政治大學財務管理學系教授
Yuanchen Chang, Professor, Department of Finance, National Chengchi University

Received 2006/6, Final revision received 2008/6

摘要

本文採用資料包絡分析法 (DEA)，計算出國內電子產業廠商的生產效率指標，並利用企業分紅配股金額資料，探討員工分紅配股制度對電子業廠商生產效率的影響。本文的實證結果顯示在國內電子業廠商中實施員工分紅配股公司的效率值較未實施公司的效率值為高，且國內大部分電子業公司規模效率上的表現較純技術效率的表現為佳。另外，在控制其他變數對生產效率值的影響之後，本文發現國內電子業廠商實施員工分紅配股制度，對其生產效率有進一步提昇的作用。

【關鍵字】資料包絡分析法、員工分紅配股、生產效率

Abstract

This paper examines the role of employee stock bonuses on the technical efficiency of Taiwan's electronic manufacturers. Using data envelopment analysis (DEA), we show that the majority of Taiwan's electronic manufacturers have better performance in their scale efficiency than pure technical efficiency, and their efficiency scores are higher for firms that distribute bonus to their employees. Moreover, we use Tobit regression analysis to determine what characteristics influence the efficiency measures obtained. Our results show that higher levels of employee stock bonuses are positively related to efficiency scores, which suggests that employee stock bonuses improve the performance of Taiwan's electronic firms.

【Keywords】data envelopment analysis, stock bonuses, technical efficiency

1. Introduction

Increased equity sharing by employees has received a lot of attention from academics as well as management practitioners for its potential to affect both firm's productivity and financial performance. The scheme of profit sharing with employees has been established in the 19th century and subsequent concept has mostly been expansion of the original definitions.[1] In recent years, several papers have documented the adoptions of similar profit sharing plans of companies around the world (Sesil, Kruse, & Blasi, 2001; D'Art & Turner, 2004; Jones & Kato, 1995).

Apart from employee stock-ownership plan (ESOP's), companies in the USA have established pension saving schemes that allow employees to invest their money with tax incentives in a basket of mutual funds for use in their retirement. Sesil et al. (2001) show that for fiscal year 1994, there are over 8 million participants in non-ESOP defined contribution pension plans in the USA that hold employer stock (over 80 per cent in 401(k) plans). D'Art and Turner (2004) use the 1999 Cranfield survey to compare the profit sharing plans and unionization in eleven European countries. Jones and Kato (1995) report that 91 percent of all firms listed on Japanese stock markets had an ESOP with individual ownership stakes amounting to about $14,000 per non-executive participant in 1989. Employee profit sharing plans has been practiced in Taiwan by United Microelectronics Corp. (UMC) since 1983. Following UMC's practice, the percentage of Taiwan's high technology firms adopted similar plans increases from 12 percent in 1991 to 73 percent in 2002 according to data in Taiwan Economic Journal.

A number of recent studies have attempted to evaluate the effects of employee stock sharing schemes on company productivity and profitability. Many advocates of employee stock ownership have focused on how they can serve as collective incentives to improve workplace co-operation and performance. Some studies examine profitability among companies with or without profit sharing plans. The evidence in the literature for the link between company performance and these schemes is inconclusive (Poole, 1989; Kruse, 1993; Jones & Kato, 1995; Kim, 1998; D'Art & Turner, 2004). Jones and Kato (1995) use OLS regression and find that there is a modest gain of company's output from the introduction of an ESOP in Japan. D'Art and Turner (2004) find weak evidence among eleven European firms for the link between profit sharing plan and firm productivity. These results could be due to different measures of firm performance.

[1] This has been documented most recently in the paper by D'Art and Turner, 2004.

Another strand of literature gauges the efficiency of companies using data envelopment analysis (DEA), a nonlinear programming technique (Charnes & Cooper, 1985; Seiford & Thrall, 1990; Thore, Phillips, Rueflis, & Yue, 1996; Wang, Gopal, & Zionts, 1997). Thore et al. (1996) examine the productivity efficiency of U.S. computer companies using DEA technique. They show that a few companies, including Apple computer and Compaq computer, were able to stay at the productivity efficiency frontier in their sample period. Wang et al. (1997) use DEA to measure the effect of information technology on firm's performance and conclude that it has a significant impact on firm profitability.

Our paper tries to fill the void in the literature by studying the relationship between employee incentive mechanism and technical efficiency. We believe our findings can shed light on issues related to profit sharing plans of companies. First, different from other profit sharing plans around the world, companies adopting employee stock bonus scheme in Taiwan pay bonus to employees through stock dividends rather than cash. In addition, firms are not allowed to issue stock options in Taiwan during our sample period. Therefore, managers in Taiwan tend to believe that distributing stock bonus to employees is important to retain valuable employees despite its disadvantage of diluting stock price. Such environment provides a unique feature for researchers to examine the effectiveness of employee incentive scheme. In addition, though voluminous studies in the literature have examined the link between profit sharing plans and firm performance, they focus mostly on financial performance using ratios such as return on equity or return on asset. Thore et al. (1996) and Wang et al. (1997) apply the DEA methodology to examine the efficiency performance of U.S. manufacturing industries in the 1980. By applying the DEA methodology to the Taiwanese electronic industries, our paper facilitates the multiple inputs and outputs and evaluates employee incentive scheme with a more recent data.

While advocates of employee stock bonus in Taiwan often claim that this scheme is one of the key successful factors for the competitiveness of Taiwanese electronic industry, it is often criticized with possible dilution effects on stockholders of the firm. Our paper provides important empirical evidence to directors and CEOs in electronic firms as whether they should distribute stock bonus to their employees. Moreover, while government regulation and accounting rules have been changing in recent years, regulators in Taiwan can evaluate the effectiveness of profit sharing plans using our methods. It is also important from the viewpoint of policy implementation to consider potential threat to the competitiveness of electronic industry in Taiwan once stock bonus scheme is no longer an

option for companies to attract employees. Finally, if the stock bonus plan is effective, we intend to know how long its effect lasts and if it is indeed an incentive-enhancing tool for multiple years. By examining the lagged effect of stock bonus to firm efficiency, our results could provide an answer to evaluate the necessity for continuous bonus distribution.

We measure firm technical efficiency by using data envelopment analysis and examine the relationship between employee stock bonuses and firm's efficiency measures. Our results are briefly discussed as below. First, our results show that efficiency scores are higher for firms that distribute bonus to their employees than non-bonus firms. In addition, after considering the impact of firms operating at decreasing return to scale (DRS), higher levels of employee stock bonuses are positively related to efficiency scores, suggesting that employee stock bonuses improve firm efficiency. Finally, we also show that stock bonus schemes have lagged impact on the efficiency measures.

The remainder of the paper is organized as follows: Section 2 describes the special features of employee stock bonus scheme in Taiwan. Section 3 introduces the DEA technique. Section 4 describes the data. Section 5 presents and discusses the empirical results on the determinants of DEA efficiency scores. Section 6 concludes the paper.

2. Employee Stock Bonus Scheme in Taiwan

Employee profit sharing plan was first adopted by the United Microelectronics Corp. (UMC) in Taiwan in 1983. One of the special features of the employee stock bonus scheme is that companies in Taiwan pay bonuses through stock dividends instead of cash. In essence, companies issue new shares and allocate them to employees as bonuses.

This dividend payout scheme has evoked much controversy recently in Taiwan. As employee stock bonuses dilute the stock price, every existing shareholder bears the cost. Companies adopted this profit sharing scheme argue that stock bonus plan is necessary since government regulations do not allow firms to issue stock options in Taiwan. Without stock bonus scheme to replace stock options, firms would fail to provide sufficient incentive to attract and retain employees. A resulting brain drain problem could reduce the productivity and competitiveness of Taiwan's electronic firms. Many advocates of stock bonus plan believe that it is the main driving force for the success of Taiwan's electronic industry. Individual investors in Taiwan may not complain about this practice because share prices usually revert to their pre-dividend level in a bull market. However, foreign investors have raised the issue that this scheme shaves the value of existing shares and companies adopted this practice are diluting the value of existing shareholders.

Taiwan's tax code on stock bonus also caught the attention of the U.S. government. In 1998, the U.S. Commerce Department imposed tariffs on Taiwanese SRAMs for dumping activity. According to Taiwanese tax law, stock bonuses are not counted as labor costs. Micro Technology Inc. complained that the price of Taiwanese SRAMs exported to U.S. is lower than the total cost when stock bonuses are treated as the cost of good sold. In response to the complaint, U.S. Commerce Department charged Taiwanese firms as guilty of dumping activity. In this study, we do not address the issue of whether company should expense stock bonus or not. Instead, we address a more fundamental question, i.e. do stock bonuses enhance firm's technical efficiency? An answer to this question could shed light on the effectiveness of stock bonus as an incentive-enhancing tool. We examine the impact of employee stock bonuses on firm productivity by using the DEA method.

3. Data Envelopment Analysis

DEA is a non-parametric linear programming technique that can measure relative efficiency of individual firms. This method was first introduced in the literature by Farrel (1957) and Fare, Grosskopf, and Lovell (1985) further promote the application of DEA. Compared to other efficiency measure methods, DEA has the following advantages: 1) it can apply to multiple-input/output operations; 2) it does not require explicit form of production function to relate inputs to outputs; and 3) it can identify sources of inefficiency and provide information for efficiency improvement.

While many early applications of DEA were limited to nonprofit organizations (such as hospitals, schools etc.), a growing literature deals with for-profit firms (Charnes, Cooper, Sun, & Huang, 1990; Smith, 1990; Yue, 1991; Thore et al., 1996; Anderson, Fok, Springer, & Webb, 2002). Charnes et al. (1990) study the solvency of commercial banks, while Smith (1990) rate 47 pharmaceutical firms using data brought from their financial statement. Yue (1991) and Thore et al. (1996) examine the efficiency of US electronics and computer companies respectively. Anderson et al. (2002) measure technical efficiency and economy of scale for real estate investment trusts and find that REITs are operating at increasing returns to scale. They conclude that REIT's performance could be improved through expansion and increasing REIT diversification across property types can enhance scale efficiency.

The DEA method can be illustrated in Figure 1 using a simple example involving a firm using two inputs (x_1 and x_2) to produce a single output (y). In an input-oriented framework, the isoquant SS' in Figure 1 represents the various combinations of the two inputs required to produce a fixed amount of the output. All the combinations lie either on

SS' or to the northeast region of SS'. A firm is considered to be technically efficient if it is located on the isoquant, i.e., it uses the best available technology. Hence, a firm with input-output bundle P is technically inefficient. The technical efficiency of this firm is defined as the ratio of OQ/OP, which equals to one minus the percentage by which the firm could reduce its input by adopting the best technology, PQ/OP.

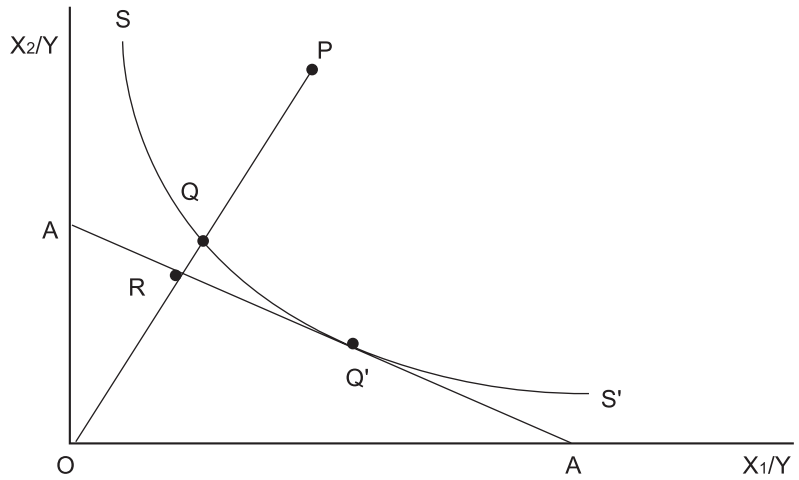

Figure 1 Technical efficiency

A measure of technical efficiency is developed using a linear programming (LP) program. The LP problem is stated as

Min TE (θ)

$$\begin{aligned} & y_i < \lambda Y \\ \text{subject to} \quad & \theta x_i > \lambda Y \\ & \lambda \in R_+ \end{aligned} \tag{1}$$

In this problem, y_i is the m dimensional vector of output produced by a particular firm; x_i is the n dimensional vector of inputs used by a particular firm; Y is the (k$\times$m) matrix of outputs where k represents the number of firms; X is the (k$\times$n) matrix of inputs; and λ is a (k$\times$1) vector of intensity parameters or weights attached to each observations. TE is a scalar with all of the symbols as defined previously. θ, the technical efficiency, corresponds to OQ/OP of point P in Figure 1.

The technical efficiency acquired from (1) is the efficiency score with respect to the technology displaying constant returns to scale (CRS), and it can be further decomposed into pure technical efficiency (PTE) and scale efficiency (SE). Pure technical efficiency is measured relative to a variable returns to scale (VRS) frontier, on which the best practice firms may operate with increasing returns to scale (IRS), constant returns to scale (CRS), and decreasing returns to scale (DRS). With technical and pure technical efficiency scores, we are able to back out estimates of scale efficiency using the relationship: TE = PTE * SE. If a firm is operating in an IRS or DRS region of the frontier, it could further improve its scale efficiency by attaining CRS. It is better off for a firm to operate at constant returns to scale than at variable returns to scale because it implies that the firm is efficient both technically and at optimal scale. The *pure technical efficiency* of a firm is thus the "true" technical efficiency measure of a firm after the scale economy factor is ruled out. Using data envelopment analysis, we can acquire the pure technical efficiency and scale efficiency scores by solving additional linear programming problems. Both efficiency measures vary between zero and one with an efficiency score of 1 implying full efficiency. The methodology also reveals whether a non-CRS firm is operating with IRS or DRS.

4. Data and Methodology

We analyze the effects of employee stock bonus on efficiency for a sample of Taiwanese electronic firms. The use of Taiwanese firms has advantage in that the electronic industry in Taiwan is one of the most competitive industries in the world, especially the IC and computer manufacturing sectors. An analysis of the determinants of its efficiency can shed lights on how it is achieved.

We select four inputs and one output in our analysis. The one output variable in our paper is y_1 = gross sales. The four input variables are x_1 = holdings of machine and equipment, x_3 = holdings of factory and land, x_3 = number of employees, and x_4 = R&D expenses. All the inputs and outputs are measured as dollar values at the end of 2001 and are deflated by the Consumer Price Index (CPI).

Our initial sample consists of all firms in the electronic sector traded in the Taiwan Stock Exchange (TSE) and over the counter (OTC) exchange from 1998 to 2005. There are 5,192 firms in the eight-year time span. We exclude 33 firms because their output (Gross Sales) value equals to zero. We also exclude 309 firms due to missing value of the R&D expenses. The final sample includes 4,850 firms, which comprises of 399, 502, 579, 657, 728, 734, 637 and 614 firms from year 1998 to 2005, respectively. Our final sample is

representative to firms in the electronic industry because it consists of 93.4% of the firms that were traded in the TSE and OTC exchange in our sample period. In addition, employee stock bonuses are measured based on the market value of the shares that was distributed to employees. Balance sheet and income statement data are obtained from the Taiwan Economic Journal (TEJ) database.

In the following sections, we provide summary statistics of the data used in this paper and compare the efficiency scores of firms with and without employee stock bonus scheme using data enveloped analysis. Because the efficiency score is censored at the maximum value of one, we use Tobit model to cope with this truncated dependent variable problem in the regression analysis.

5. Results and Discussions

Table 1 reports the summary statistics of the inputs and outputs of the DEA estimation and other independent variables used in this paper for 1998 to 2005. The reason for us to choose sample period from 1998 is to avoid possible structure breaks caused by Asian financial crisis in 1997. Panel A of Table 1 shows the inputs and outputs in our DEA analysis. The output variable is gross sales revenue. It can be seen that the average gross sales in our sample increased from NTD 2.9 billions in 1998 to over 10.9 billions in 2005. The input variables consist of value of machine, value of factory, number of employee and R&D expenses. They have a similar pattern with the gross sales from 1998 to 2005.

Panel B of Table 1 shows the descriptive statistics of independent variables used in our regression analysis, including the market value of stock bonus and other control variables. According to the previous literature, corporate governance structure in a firm also affects its performance. For example, Morck, Shleifer, and Vishny (1988) and Kesner (1987) find a strong relationship between proportion of board of directors and firm performance. Gorton and Schmid (2000) show that higher percentage of block shareholding improves the performance of German companies. In addition, McConnell and Servaes (1990) and DeAngelo and DeAngelo (1985) suggest that management and family shareholdings are positively related to company performance. We thus use proportion of board members, proportion of major shareholders, family shareholdings, managerial shareholdings and proportion of shareholdings by institutional investors as control variables as our proxies of corporate governance mechanism.

Our results show that proportion of shareholdings by board members, family and managerial shareholdings drop significantly over the years, while percentage of

shareholdings by institutional investors increased over the year. We added firm age as another control variable because previous studies (Lundvall & Battese, 2000) has shown that firm age has strong impact on firm efficiency. The variable leverage accounts for possible impact of leverage on firm's efficiency. It is defined as a ratio of earnings before interest and tax (EBIT) divided by EBIT minus interest expense. Our results show that the average leverage changes from a high of 4.0 in 1999 to a low of 2.0 in 2005.

Table 1 Summary statistics for inputs and outputs of DEA analysis

	1998	1999	2000	2001	2002	2003	2004	2005
Panel A: Inputs / Outputs Variables								
Gross sales	2,945,719	3,586,048	4,637,896	4,024,141	4,249,766	6,477,968	9,106,937	10,936,317
	(6,606,988)	(8,770,753)	(13,059,885)	(12,025,956)	(12,192,508)	(20,999,009)	(30,328,617)	(40,423,159)
Machine	965,181	1,201,875	1,791,852	1,861,156	1,475,230	2,549,975	3,331,917	3,954,287
	(4,961,252)	(5,984,655)	(12,258,132)	(13,370,071)	(10,259,516)	(19,146,158)	(21,604,964)	(26,322,296)
Factory	253,038	292,717	394,281	363,113	402,721	572,847	675,682	881,362
	(1,209,339)	(1,200,205)	(2,305,361)	(2,223,756)	(2,256,870)	(3,623,490)	(3,852,566)	(4,876,182)
Employee	508	524	583	485	504	672	796	892
	(1,304)	(1,230)	(1,434)	(1,057)	(1,478)	(1,826)	(1,839)	(2,399)
R&D	83,479	95,079	127,427	137,488	131,570	189,426	227,680	289,592
	(260,583)	(286,680)	(524,505)	(623,126)	(453,386)	(700,516)	(758,571)	(1,049,393)
Panel B: Independent Variables								
Bonus	141	479	193	111	139	143	239	249
	(815)	(1,370)	(1,376)	(591)	(656)	(747)	(1,270)	(1,436)
Board	40	18	17	32	32	28	23	22
member (%)	(12)	(12)	(12)	(11)	(15)	(14)	(12)	(12)
Major	16	6	6	17	14	16	15	16
shareholder (%)	(6)	(7)	(7)	(8)	(9)	(10)	(9)	(11)
Family (%)	30	6	7	18	11	11	11	11
	(14)	(10)	(10)	(9)	(11)	(12)	(10)	(10)
Managers (%)	10	1	1	4	2	2	2	2
	(6)	(2)	(3)	(3)	(4)	(4)	(3)	(3)
Institutional	19	32	29	26	37	35	33	32
investors (%)	(16)	(14)	(13)	(17)	(20)	(20)	(20)	(21)
Leverage	3	4	3	4	2	2	2	2
	(17)	(17)	(15)	(19)	(11)	(7)	(12)	(13)
Age	13	13	13	13	14	15	16	16
	(8)	(8)	(8)	(8)	(8)	(8)	(9)	(8)

Note: Numbers are means and standard deviations are in parentheses. Except number of employees, the units of inputs/outputs in Panel A are in thousands of New Taiwan dollars. The bonus variable in Panel B refers to the market value of stock bonuses and its unit is in thousands of New Taiwan dollars. Corporate governance variables, including board member, major shareholder, family, managers and institutional investors are shown in percentage. The leverage variable is defined as a ratio of earnings before interest and tax (EBIT) divided by EBIT minus interest expense and age is defined as the difference between established year and observation year of the firm.

We summarize the results of the DEA estimation in Table 2. A larger efficiency score implies that firms are operating more closely to the efficiency cost frontier and an efficiency score of one corresponds to a firm on the efficient frontier. We show the results of three measures: technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) in Table 2. It is seen that the technical efficiency scores of the electronic industry in Taiwan are between 0.17 in 1998 to 0.07 in 2005. In other words, the results suggest that on average the Taiwan's electronic firms in 2005 could have produced their outputs using 7 percent of the inputs that were actually consumed. We also calculate the scores of pure technical efficiency and scale efficiency in Table 2. Our results show that the scores of scale efficiency range from 0.523 in 2000 to 0.799 in 1999, and the average scores in eight years equal to 0.623. It is seen that these scale efficiency scores are larger than pure technical efficiency scores. The average scores for PTE in the sample are only 0.212. We can see that the low scores of technical efficiency are the results of low pure technical efficiency.

Using 3-outputs and 6-inputs in their framework, Thore et al. (1996) evaluates the efficiency of companies in the U.S. computer industry during the decade 1981-1990. They find a handful of companies stay efficient throughout the time period studied. For those firms that stay efficient, their scale efficiency scores are higher than the pure technical efficiency. Our results are consistent with Thore et al. (1996) in that most of the Taiwan electronic firms have better performance in their scale efficiency than in pure technical efficiency. The efficiency scores, specifically technical efficiency and pure technical efficiency scores in our analysis are lower than those in Thore et al. (1996). According to the previous literature (Berger & Humphrey, 1997), an increase in number of inputs/outputs constitutes higher DEA efficiency scores. We believe different inputs/outputs variables used in our study are the main reason why we get lower scores. We employ 1-output and 4-inputs in our DEA framework[2].

[2] We also try to replicate the inputs/outputs framework in Thore et al. (1996) and use 3-outputs, 6-inputs to calculate our DEA efficiency scores. Our results of efficiency scores are very close to one, implying that most of the electronic firms in Taiwan stay at the efficiency frontier. However, we believe our current 1-output, 4-inputs framework is more precise because inputs/outputs applied in current framework are not directly related with each other. We appreciate the suggestions from one anonymous referee.

Table 2 DEA efficiency estimates for electronics firms in Taiwan

	Year	1998	1999	2000	2001	2002	2003	2004	2005	AVG
TE	Mean	0.172	0.177	0.132	0.102	0.124	0.124	0.119	0.076	0.125
	S.D.	0.175	0.200	0.176	0.150	0.168	0.164	0.164	0.139	0.169
	Min	0.001	0.001	0.001	0.001	0.005	0.003	0.008	0.002	0.001
	Max	1	1	1	1	1	1	1	1	1
PTE	Mean	0.296	0.228	0.261	0.167	0.240	0.219	0.192	0.124	0.212
	S.D.	0.238	0.243	0.245	0.201	0.234	0.232	0.239	0.190	0.232
	Min	0.053	0.004	0.023	0.013	0.026	0.023	0.016	0.009	0.004
	Max	1	1	1	1	1	1	1	1	1
SE	Mean	0.604	0.799	0.523	0.618	0.524	0.591	0.710	0.654	0.623
	S.D.	0.270	0.218	0.274	0.244	0.273	0.263	0.273	0.286	0.277
	Min	0.001	0.014	0.006	0.001	0.021	0.009	0.012	0.008	0.001
	Max	1	1	1	1	1	1	1	1	1

We compare the average efficiency scores between firms which distribute stock bonus and firms that do not distribute bonus (Non-bonus). The results are summarized in Table 3. We first show that the numbers of firms in the electronic sectors that have employee stock bonus scheme are 3 to 4 times higher than firms without this scheme. Our results show that the technical efficiency scores for bonus firms are all higher than those for non-bonus firms from 1998 to 2005 except for 2004, though the result in 2004 is not significant. The differences of technical efficiency between these two groups of firms are significant at 5% level in four out of eight sample years, but the differences are less significant in recent years. Our results for pure technical efficiency and scale efficiency are similar. It is seen that scale efficiency scores for bonus firms are all higher than those for non-bonus firms throughout our sample years. In summary, the results indicate that the efficiency scores are higher for firms that distribute bonus to their employees in our sample.

Table 3 Average efficiency scores of bonus vs. non-bonus firms

Year		1998	1999	2000	2001	2002	2003	2004	2005	All
No. of Firms	Bonus	301	387	480	503	547	561	494	447	3720
	Non-Bonus	98	115	99	154	181	173	143	167	1130
TE	Bonus	0.18**	0.20***	0.14**	0.11	0.13**	0.13	0.11	0.08	0.13***
	Non-Bonus	0.14	0.11	0.10	0.09	0.10	0.11	0.14	0.07	0.10
PTE	Bonus	0.29	0.24***	0.27	0.17	0.24	0.22	0.19	0.13	0.22**
	Non-Bonus	0.30	0.18	0.24	0.16	0.23	0.21	0.21	0.11	0.20
SE	Bonus	0.64***	0.84***	0.53**	0.63***	0.54***	0.60	0.71	0.66	0.64***
	Non-Bonus	0.50	0.66	0.47	0.56	0.47	0.56	0.71	0.65	0.58

Note: TE stands for Technical Efficiency, PTE stands for Pure Technical Efficiency, SE represents Scale Efficiency. * and ** represent significance at the 5% and 1% levels.

Tables 4 to 6 report the Tobit regression results of employee stock bonuses on technical efficiency, pure technical efficiency and scale efficiency, respectively. The reason we use Tobit regression is due to the fact that the dependent variable, efficiency score, is truncated and contain values that range from zero to one. The numbers of observations are reduced each year because of missing values for corporate governance variables.

Panel A in Table 4 shows results using technical efficiency as dependent variable along with the contemporary employee stock bonus, corporate governance variables, leverage and age as independent variables. Our results in Panel A of Table 4 indicate that employee stock bonus has a positive and significant effect on efficiency estimates for 2001 to 2003. The governance variables seem to have different effects on the efficiency scores. It is seen that the percentage of shareholdings of major shareholders, managers and institutional investors have significant positive effects on efficiency scores over different years. However, the percentage of shareholdings by board members have significant negative impact on efficiency scores in 2002, which indicates that investors were more concerned about these board member shareholdings during the sample periods. The parameters of leverage variable is positive and significant at ten percent level in 1999. The coefficients for age in 1998 to 2005 are negative but they are insignificant at the five percent level.

To test possible lagged effects of the employee stock bonuses on efficiency estimates, we add a lagged one-period stock bonus variable ($Bonus_{t-1}$) in the regression analysis. The results of this regression analysis are reported in Panel B of Table 4. The parameter estimates of the lagged employee stock bonus variables are positive and significant at the ten

percent levels in four out of eight sample years. The results provide evidence that employee stock bonus variable has a lagged impact on firm efficiency.

Table 4 Tobit regression analysis of the effects of employee stock bonuses on technical efficiency

	1998	1999	2000	2001	2002	2003	2004	2005
Panel A: without lagged bonus variable								
Constant	0.2335**	0.1522**	0.1332**	0.0042	0.0862**	0.0849**	0.0745*	0.0505
	(4.21)	(4.91)	(4.78)	(0.12)	(2.59)	(2.90)	(2.32)	(1.69)
Bonus	2.34E-05	2.50E-06	-3.58E-06	4.80E-05**	7.07E-05**	2.29E-05*	9.17E-06	6.40E-06
	(1.92)	(0.34)	(-0.58)	(4.02)	(5.84)	(2.22)	(1.35)	(1.16)
Board	-0.0005	-0.0007	-0.0003	-1.70E-05	0.0001	-0.0015*	-0.0004	-0.0001
member (%)	(-0.36)	(-0.56)	(-0.21)	(-0.02)	(0.12)	(-2.01)	(-0.50)	(-0.12)
Major	-0.0010	-0.0014	0.0066**	0.0016	0.0005	-0.0010	0.0020	0.0012
shareholder (%)	(-0.54)	(-0.74)	(4.37)	(1.69)	(0.46)	(-1.05)	(1.80)	(1.47)
Family (%)	-0.0023	0.0013	-0.0023	0.0011	-0.0007	0.0009	-0.0014	-0.0005
	(-1.35)	(0.84)	(-1.46)	(0.92)	(-0.66)	(0.94)	(-1.21)	(-0.53)
Managers (%)	0.0040	0.0010	0.0024	0.0034	0.0024	0.0054**	0.0047	0.0016
	(1.32)	(0.21)	(0.70)	(1.22)	(1.04)	(2.77)	(1.83)	(0.60)
Institutional	2.80E-05	0.0009	-0.0005	0.0010	0.0008	0.0020**	0.0009	0.0011*
investors (%)	(0.02)	(0.89)	(-0.44)	(1.34)	(1.18)	(3.07)	(1.50)	(2.15)
Leverage	0.0009	0.0011*	0.0002	-1.02E-05	-0.0002	-0.0006	-0.0006	-0.0002
	(1.64)	(2.01)	(0.41)	(-0.03)	(-0.37)	(-0.63)	(-0.83)	(-0.40)
Age	-0.0004	-0.0003	-0.0006	0.0005	-0.0001	0.0008	-0.0002	-0.0011
	(-0.32)	(-0.22)	(-0.61)	(0.60)	(-0.14)	(0.87)	(-0.19)	(-1.24)
# of observations	297	387	461	512	531	518	391	393
Function value	114.71	84.93	145.84	268.70	186.06	189.33	162.24	194.65
Panel B: with a lagged one-period bonus variable								
Constant	0.2284**	0.1471**	0.1321**	0.0039	0.0851*	0.0789*	0.0870*	0.0369
	(3.40)	(4.41)	(4.35)	(0.11)	(2.26)	(2.50)	(2.24)	(1.09)
$Bonus_t$	1.87E-05	2.20E-06	-4.17E-06	4.74E-05**	6.52E-05**	1.92E-05	9.97E-06	6.22E-06
	(1.46)	(0.30)	(-0.67)	(3.96)	(5.05)	(1.84)	(1.37)	(1.12)
$Bonus_{t-1}$	3.19E-05*	2.26E-05**	1.32E-05*	8.20E-06	1.89E-05	4.41E-05**	9.34E-06	1.00E-06
	(2.42)	(3.01)	(2.14)	(0.71)	(1.44)	(4.05)	(1.27)	(0.17)
Board	-0.0006	-0.0003	-0.0006	-0.0001	0.0001	-0.0014	-0.0003	-0.0001
member (%)	(-0.31)	(-0.21)	(-0.40)	(-0.07)	(0.15)	(-1.75)	(-0.28)	(-0.08)
Major	-0.0010	-0.001	0.0076**	0.0020	0.0006	-0.0010	0.0021	0.0010
shareholder (%)	(-0.40)	(-0.54)	(4.61)	(1.91)	(0.55)	(-0.92)	(1.55)	(1.13)

Family (%)	-0.0022	0.0018	-0.0028	0.0011	-0.0006	0.0009	-0.0017	-0.0008
	(-0.92)	(1.03)	(-1.67)	(0.85)	(-0.57)	(0.87)	(-1.28)	(-0.73)
Managers (%)	0.0045	-0.0004	0.0024	0.0028	0.0027	0.0059**	0.0038	0.0032
	(1.17)	(-0.08)	(0.64)	(0.97)	(1.06)	(2.84)	(1.08)	(1.01)
Institutional	0.0005	0.0004	-0.0006	0.0011	0.0010	0.0022**	0.0007	0.0011
investors (%)	(0.32)	(0.41)	(-0.46)	(1.37)	(1.31)	(3.02)	(0.93)	(1.91)
Leverage	0.0011	0.0015*	0.0002	-0.0001	-0.0002	-0.0005	-0.0005	-0.0002
	(1.81)	(2.51)	(0.42)	(-0.16)	(-0.35)	(-0.53)	(-0.52)	(-0.39)
Age	-0.0009	-0.0003	-0.0004	-2.56E-05	-0.0007	0.0002	-0.0003	-0.0002
	(-0.69)	(-0.26)	(-0.41)	(-0.03)	(-0.72)	(0.21)	(-0.22)	(-0.19)
# of observations	255	334	417	467	469	450	296	306
Function value	91.72	70.27	136.07	257.81	149.42	163.59	108.89	155.03

Notes: *t*-values are in parentheses, * and ** represents significant at the 5% and 1% level, respectively.

Panels A and B in Table 5 show results using pure technical efficiency as dependent variable along with employee stock bonus, corporate governance variables, leverage and age as independent variables. It is seen that employee stock bonus has a positive and significant effect on efficiency estimates for 1998 to 2005 except 2004. The results of Panel B of Table 5 show that the parameter estimates of the lagged employee stock bonus variables are positive and significant for three of the eight sample years. Except shareholdings of board members, the corporate governance and leverage variables seem to have similar effects on pure technical efficiency as those in Table 4. The coefficients of age variable are significantly negative in 1998 and 2000. The results confirm that employee stock bonus variable has a lagged impact on firm efficiency.

Table 5 Tobit regression analysis of the effects of employee stock bonuses on pure technical efficiency

	1998	1999	2000	2001	2002	2003	2004	2005
Panel A: without lagged bonus variable								
Constant	0.3821**	0.2191**	0.2898**	-0.0035	0.1240**	0.0833*	0.0863	0.0553
	(4.94)	(5.81)	(7.77)	(-0.08)	(2.87)	(2.08)	(1.91)	(1.43)
Bonus	4.72E-05**	1.82E-05*	2.94E-05**	0.0001**	0.0001**	3.15E-05*	1.80E-05	1.51E-05*
	(2.77)	(2.05)	(3.54)	(4.34)	(6.71)	(2.23)	(1.89)	(2.10)
Board	0.0002	-0.0009	-0.0018	0.0001	0.0033**	0.0005	0.0007	-0.0003
member (%)	(0.10)	(-0.55)	(-1.07)	(0.12)	(3.58)	(0.46)	(0.57)	(-0.36)
Major	-0.0015	-0.0014	0.0042*	0.0014	0.0051**	0.0020	0.0050**	0.0020
shareholder (%)	(-0.58)	(-0.63)	(2.11)	(1.16)	(3.79)	(1.51)	(3.20)	(1.87)

Family (%)	-0.0032	0.0008	-0.0019	0.0023	-0.0036**	0.0002	-0.0022	-0.0004
	(-1.33)	(0.44)	(-0.91)	(1.56)	(-2.79)	(0.13)	(-1.40)	(-0.35)
Managers (%)	0.0102*	0.0019	0.0007	0.0059	-0.0004	0.0094**	0.0094**	0.0049
	(2.39)	(0.31)	(0.16)	(1.68)	(-0.15)	(3.54)	(2.64)	(1.44)
Institutional	-0.0009	0.0011	0.0005	0.0025**	-0.0011	0.0017	0.0001	0.0015*
investors (%)	(-0.53)	(0.90)	(0.34)	(2.66)	(-1.23)	(1.93)	(0.14)	(2.25)
Leverage	0.0019*	0.0009	0.0020**	-0.0001	0.0001	-0.0002	-0.0006	-0.0004
	(2.42)	(1.34)	(2.97)	(-0.14)	(0.10)	(-0.13)	(-0.58)	(-0.50)
Age	-0.0049**	-0.0020	-0.0028*	-0.0001	-9.75E-06	0.0003	0.0001	-0.0004
	(-2.99)	(-1.36)	(-2.08)	(-0.10)	(-0.01)	(0.26)	(0.09)	(-0.34)
# of observations	297	387	461	512	531	518	391	393
Function value	15.89	8.54	11.92	149.88	46.08	26.64	28.30	92.10
Panel B: with a lagged one-period bonus variable								
Constant	0.3849**	0.2126**	0.3016**	-0.0106	0.1391**	0.0658	0.0896	0.0260
	(4.03)	(5.16)	(7.31)	(-0.22)	(2.93)	(1.52)	(1.66)	(0.57)
$Bonus_t$	4.34E-05*	1.73E-05	3.00E-05**	0.0001**	0.0001**	2.64E-05	1.69E-05	1.41E-05
	(2.39)	(1.90)	(3.56)	(4.04)	(5.88)	(1.86)	(1.66)	(1.89)
$Bonus_{t-1}$	2.18E-05	2.10E-05*	9.71E-06	1.40E-05	4.70E-05**	0.0001**	9.46E-06	-1.79E-06
	(1.16)	(2.27)	(1.16)	(0.94)	(2.84)	(4.58)	(0.93)	(-0.23)
Board	0.000	-0.0003	-0.0016	0.0001	0.0036**	0.0007	0.0003	-0.0003
member (%)	(0.06)	(-0.16)	(-0.85)	(0.06)	(3.62)	(0.61)	(0.18)	(-0.26)
Major	-0.0014	-0.0007	0.0050*	0.0017	0.0050**	0.0021	0.0034	0.0017
shareholder (%)	(-0.42)	(-0.24)	(2.25)	(1.28)	(3.45)	(1.48)	(1.82)	(1.40)
Family (%)	-0.002	0.0011	-0.0029	0.0026	-0.0039**	0.0002	-0.0019	-0.0008
	(-0.88)	(0.48)	(-1.29)	(1.52)	(-2.70)	(0.16)	(-1.04)	(-0.54)
Managers (%)	0.0102	0.0013	0.0003	0.0057	-0.0013	0.0102**	0.0107*	0.0066
	(1.85)	(0.20)	(0.05)	(1.55)	(-0.41)	(3.63)	(2.18)	(1.56)
Institutional	-0.0006	0.0006	-1.98E-05	0.0028**	-0.0010	0.0021*	0.0007	0.0016*
investors (%)	(-0.27)	(0.45)	(-0.01)	(2.73)	(-1.08)	(2.19)	(0.70)	(2.11)
Leverage	0.0020*	0.0013	0.0020**	-0.0001	0.0001	9.52E-06	-0.0009	-0.0004
	(2.36)	(1.75)	(2.95)	(-0.28)	(0.12)	(0.01)	(-0.68)	(-0.49)
Age	-0.0054**	-0.0020	-0.0027	-0.0008	-0.0016	-0.0007	0.0003	0.0013
	(-2.87)	(-1.26)	(-1.89)	(-0.73)	(-1.25)	(-0.55)	(0.16)	(0.91)
# of observations	255	334	417	467	469	450	296	306
Function value	2.12	-0.08	7.96	138.17	39.14	23.17	12.03	63.59

Notes: *t*-values are in parentheses, * and ** represents significant at the 5% and 1% level, respectively.

In the scale efficiency models of Table 6, our results of bonus variable are somewhat different from the results above. The estimated coefficients for bonuses were all negative in

our sample years and significant in four of the eight years. The results of bonus variable in Panel B of Table 6 are similar to those in Panel A of Table 6. The coefficients of lagged bonus variables are not significant in the sample years.

Table 6 Tobit regression analysis of the effects of employee stock bonuses on scale efficiency

	1998	1999	2000	2001	2002	2003	2004	2005
Panel A: without lagged bonus variable								
Constant	0.7739**	0.6819**	0.3592**	0.7247**	0.6582**	0.7248**	0.8498**	0.6949**
	(9.22)	(20.63)	(8.94)	(13.07)	(13.69)	(17.36)	(17.24)	(12.83)
Bonus	-1.63E-05	-2.51E-05**	-2.25E-05*	-1.85E-05	-2.98E-06	-5.13E-06	-2.62E-05*	-2.80E-05**
	(-0.88)	(-3.23)	(-2.51)	(-0.96)	(-0.17)	(-0.35)	(-2.52)	(-2.79)
Board	-0.0027	-0.0003	-0.0002	-0.0039**	-0.0100**	-0.0085**	-0.0073**	-0.0038**
member (%)	(-1.29)	(-0.20)	(-0.09)	(-2.92)	(-9.84)	(-7.97)	(-5.63)	(-2.79)
Major	-0.0010	-0.0001	0.0063**	-0.0027	-0.0104**	-0.0092**	-0.0071**	-0.0049**
shareholder (%)	(-0.37)	(-0.04)	(2.89)	(-1.73)	(-7.00)	(-6.61)	(-4.20)	(-3.26)
Family (%)	-0.0014	0.0041*	0.0038	0.0007	0.0063**	0.0042**	0.0026	0.0027
	(-0.54)	(2.51)	(1.67)	(0.38)	(4.32)	(3.13)	(1.49)	(1.56)
Managers (%)	-0.0105*	0.0005	0.0130**	-0.0040	0.0088**	0.0002	-0.0056	-0.0085
	(-2.27)	(0.10)	(2.67)	(-0.88)	(2.64)	(0.09)	(-1.43)	(-1.79)
Institutional	0.0008	0.0002	0.0018	0.0013	0.0070**	0.0052**	0.0035**	0.0033**
investors (%)	(0.43)	(0.23)	(1.16)	(1.09)	(7.20)	(5.67)	(3.79)	(3.45)
Leverage	-0.0003	-0.0005	-0.0014	3.45E-05	-0.0025**	0.0003	-0.0006	-0.0009
	(-0.31)	(-0.85)	(-1.92)	(0.06)	(-2.74)	(0.19)	(-0.49)	(-0.83)
Age	0.0062*	0.0070**	0.0033*	0.0038**	0.0017	0.0033*	0.0016	0.0019
	(3.44)	(5.57)	(2.29)	(2.92)	(1.32)	(2.52)	(1.07)	(1.17)
# of observations	297	387	461	512	531	518	391	393
Function value	-8.60	59.75	-22.70	20.13	-10.32	6.14	-5.07	-39.08
Panel B: with a lagged one-period bonus variable								
Constant	0.8381**	0.6824**	0.3469**	0.7436**	0.6346**	0.7410**	0.8680**	0.7377**
	(8.78)	(19.22)	(8.09)	(12.46)	(12.03)	(16.47)	(16.54)	(11.91)
$Bonus_t$	-2.47E-05	-2.46E-05**	-2.48E-05**	-2.16E-05	5.22E-07	-5.55E-06	-2.28E-05*	-2.68E-05**
	(-1.36)	(-3.12)	(-2.83)	(-1.11)	(0.03)	(-0.37)	(-2.31)	(-2.65)
$Bonus_{t-1}$	2.67E-05	5.94E-06	1.41E-05	6.77E-06	-2.24E-05	-1.10E-05	1.27E-05	1.32E-05
	(1.43)	(0.74)	(1.62)	(0.36)	(-1.22)	(-0.71)	(1.28)	(1.24)
Board	-0.0014	-0.0007	-0.0007	-0.0036*	-0.0102**	-0.0086**	-0.0068**	-0.0041**
member (%)	(-0.53)	(-0.45)	(-0.38)	(-2.57)	(-9.34)	(-7.41)	(-4.86)	(-2.66)
Major	-0.0022	-0.0005	0.0078**	-0.0028	-0.0096**	-0.0088**	-0.0034	-0.0038*

shareholder (%)	(-0.65)	(-0.21)	(3.36)	(-1.66)	(-5.99)	(-5.95)	(-1.87)	(-2.25)
Family (%)	-0.0043	0.0053**	0.0039	4.03E-05	0.0069**	0.0043**	0.0016	0.0022
	(-1.31)	(2.77)	(1.64)	(0.02)	(4.35)	(2.87)	(0.87)	(1.10)
Managers (%)	-0.0088	-0.0024	0.0141**	-0.0065	0.0093**	-0.0001	-0.0083	-0.0046
	(-1.59)	(-0.42)	(2.64)	(-1.40)	(2.60)	(-0.05)	(-1.74)	(-0.80)
Institutional	0.0005	0.0001	0.0023	0.0011	0.0073**	0.0048**	0.0017	0.0028**
investors (%)	(0.21)	(0.12)	(1.36)	(0.84)	(6.83)	(4.77)	(1.69)	(2.71)
Leverage	0.0001	-0.0004	-0.0013	0.0002	-0.0025**	0.0001	0.0014	-0.0008
	(0.12)	(-0.65)	(-1.95)	(0.35)	(-2.70)	(0.09)	(1.14)	(-0.81)
Age	0.0047*	0.0074**	0.0030*	0.0038**	0.0022	0.0035*	0.0018	0.0001
	(2.51)	(5.33)	(2.01)	(2.85)	(1.56)	(2.51)	(1.12)	(0.05)
# of observations	255	334	417	467	469	450	296	306
Function value	1.99	49.62	-8.00	30.97	-9.46	4.83	20.07	-28.31

Notes: *t*-values are in parentheses, * and ** represents significant at the 5% and 1% level, respectively.

The coefficients for age are positive and significant from 1998 to 2001 and 2003, which indicate that old firms have higher scale efficiency scores. The governance variables have different effects on the scale efficiency scores than those in Tables 4 and 5. It is seen that the percentage of shareholdings of board members and major shareholders have significant negative impact on efficiency scores. However, the percentages of shareholdings by family members, managers, and institutional investors have significant positive effects on efficiency scores, which indicate that these variables are related to more scale efficiency for firms during the sample period.

We further examine the effect of stock bonus on scale efficiency[3]. Our results in Tables 4 and 5 show that when more stock bonuses are distributed, the technical and pure technical efficiency for firms become better. However, when firms are large enough and is operating at decreasing return to scale (DRS), they might invest too much on machine, factory and specifically human capital (the employees). In such case, more stock bonus distribution may not benefit the scale efficiency of the firm. Cummins, Tennyson, and Weiss (1999) show that firms operating with decreasing returns to scale are viewed as unattractive acquisition targets because they are already too large. We adopt this rationale and examine the DRS effect on our sample by adding a DRS dummy variable and an interaction term of DRS and bonus distribution. The DRS dummy takes the value of one when the firm is at decreasing

[3] We also performance analysis on the technical and pure technical efficiency, but our results are similar to those shown above for the bonus and lagged bonus variables.

return to scale and 0 otherwise. If our conjecture is true, we should find that the DRS-Bonus interaction term to be negative.

Our results of scale efficiency are shown in Table 7. It is seen that employee stock bonus variables has a positive effect on efficiency estimates from 1998 to 2005 and are significant in 6 out of 8 sample years in Panel A of Table 7. The coefficients for DRS dummy are all significantly positive at least at 10 percent level, implying that firms operating at DRS have higher scale efficiency. Specifically, our results show that the interaction terms of DRS and bonus are significantly negative at least at five percent level in six of our sample years.

The results in Panel B of Table 7 are very similar to those in Panel A. The coefficient of lagged bonus variable in year 2002 is negatively related to scale efficiency at ten percent level. Following similar rationale, we consider the interaction of DRS and lagged bonus variable and examine whether the lagged bonus is related to scale efficiency. Although not shown here, our results suggest that the lagged bonus variable has a positive effect on scale efficiency after considering the DRS effect and the results are consistent with those in Panel A of Table 7.

Table 7 Tobit regression analysis of the effects of employee stock bonuses and decreasing returns to scale (DRS) on scale efficiency

	1998	1999	2000	2001	2002	2003	2004	2005
Panel A: without lagged bonus variable								
Constant	0.1615***	0.6235***	0.4373***	0.7030***	0.6403***	0.7061***	0.7259***	0.5231***
	(2.857)	(8.809)	(11.408)	(12.849)	(13.432)	(16.911)	(15.066)	(10.312)
Bonus	0.0009***	0.0000	0.0002**	0.0001***	0.0001**	0.0001**	0.0000	0.0001*
	(3.884)	(0.135)	(2.198)	(3.390)	(2.283)	(1.971)	(0.420)	(1.854)
DRS	0.0789***	0.1712***	0.2859***	0.0565*	0.1024***	0.0922***	0.2121***	0.2896***
	(3.798)	(3.350)	(8.836)	(1.764)	(2.833)	(2.880)	(8.052)	(10.494)
DRS*Bonus	-0.0008***	-0.0001	-0.0003**	-0.0002***	-0.0001***	-0.0001***	0.0000	-0.0001***
	(-3.794)	(-0.355)	(-2.529)	(-5.234)	(-3.725)	(-2.602)	(-1.313)	(-2.590)
Board	0.0002	-0.0014	0.0025	-0.0039***	-0.0093***	-0.0074***	-0.0035***	-0.0010
member (%)	(0.112)	(-0.995)	(1.448)	(-2.905)	(-9.124)	(-6.730)	(-2.715)	(-0.844)
Major	-0.0009	-0.0016	0.0084***	-0.0019	-0.0092***	-0.0080***	-0.0033**	-0.0012
shareholder (%)	(-0.523)	(-0.823)	(4.140)	(-1.252)	(-6.153)	(-5.611)	(-1.978)	(-0.917)
Family (%)	-0.0021	0.0036**	-0.0015	0.0015	0.0058***	0.0034**	-0.0001	0.0002
	(-1.297)	(2.343)	(-0.670)	(0.825)	(4.060)	(2.514)	(-0.031)	(0.111)
Managers (%)	0.0051*	0.0010	0.0047	-0.0079*	0.0071**	-0.0004	-0.0056	-0.0078*
	(1.713)	(0.210)	(1.013)	(-1.777)	(2.155)	(-0.135)	(-1.525)	(-1.827)

Institutional	-0.0005	0.0011	-0.0026*	0.0013	0.0064***	0.0042***	0.0013	0.0010
investors (%)	(-0.469)	(1.043)	(-1.698)	(1.117)	(6.566)	(4.445)	(1.407)	(1.112)
Leverage	0.0010*	0.0000	-0.0014**	0.0002	-0.0028***	0.0003	-0.0007	-0.0010
	(1.825)	(0.075)	(-2.097)	(0.327)	(-3.187)	(0.209)	(-0.672)	(-1.067)
Age	-0.0009	0.0046***	0.0016	0.0037***	0.0016	0.0031**	0.0005	-0.0004
	(-0.803)	(3.613)	(1.210)	(2.904)	(1.261)	(2.399)	(0.371)	(-0.275)
# of observations	29	387	461	512	531	518	391	393
Function value	68.1759	81.8999	13.5189	33.6182	-1.9696	12.2062	24.9462	9.6174

Panel B: with a lagged one-period bonus variable

Constant	0.4875***	0.5656***	0.4138***	0.7296***	0.6192***	0.7259***	0.7476***	0.5504***
	(5.907)	(6.188)	(9.943)	(12.377)	(11.862)	(16.142)	(14.272)	(9.376)
$Bonus_t$	0.0008***	0.0001	0.0002	0.0001***	0.0001***	0.0001*	0.0000	0.0001*
	(2.899)	(0.792)	(1.180)	(3.489)	(2.605)	(1.887)	(0.653)	(1.909)
$Bonus_{t-1}$	0.0000	0.00001	0.00001	-0.00002	-0.00003*	-0.00002	0.00001	0.00001
	(1.266)	(1.240)	(1.174)	(-0.883)	(-1.884)	(-1.091)	(0.931)	(0.908)
DR	0.3302***	0.2157***	0.2462***	0.0395	0.0944**	0.0835**	0.1871***	0.2921***
	(11.747)	(3.081)	(7.043)	(1.219)	(2.432)	(2.460)	(6.585)	(9.211)
DRS*Bonus	-0.0008***	-0.0002	-0.0002	-0.0002***	-0.0001***	-0.0001**	0.0000	-0.0001***
	(-3.030)	(-0.956)	(-1.400)	(-5.321)	(-3.852)	(-2.475)	(-1.447)	(-2.602)
Board	-0.0015	-0.0017	0.0016	-0.0040***	-0.0096***	-0.0076***	-0.0032**	-0.0004
member (%)	(-0.697)	(-1.086)	(0.854)	(-2.858)	(-8.736)	(-6.359)	(-2.268)	(-0.256)
Major	-0.0023	-0.0021	0.0093***	-0.0022**	-0.0084***	-0.0077***	0.0002	-0.0007
shareholder (%)	(-0.819)	(-0.887)	(4.232)	(-1.342)	(-5.239)	(-5.080)	(0.140)	(-0.469)
Family (%)	0.0001	0.0042**	-0.0006	0.0012	0.0065***	0.0034**	-0.0008	-0.0007
	(0.040)	(2.327)	(-0.255)	(0.574)	(4.131)	(2.276)	(-0.437)	(-0.424)
Managers (%)	-0.0042	0.0001	0.0061	-0.0105**	0.0073**	-0.0009	-0.0081*	-0.0060
	(-0.933)	(0.023)	(1.163)	(-2.304)	(2.053)	(-0.298)	(-1.765)	(-1.152)
Institutional	0.0011	0.0013	-0.0015	0.0014	0.0068***	0.0039***	-0.0004	0.0005
investors (%)	(0.589)	(1.174)	(-0.917)	(1.125)	(6.302)	(3.715)	(-0.396)	(0.511)
Leverage	0.0002	0.0001	-0.0014**	0.0003	-0.0029***	0.0002	0.0011	-0.0009
	(0.282)	(0.164)	(-2.096)	(0.484)	(-3.187)	(0.106)	(0.968)	(-0.985)
Age	0.0030**	0.0048***	0.0016	0.0037***	0.0022	0.0034**	0.0009	-0.0017
	(1.977)	(3.474)	(1.147)	(2.838)	(1.590)	(2.468)	(0.605)	(-1.008)
# of observation	255	334	417	467	469	450	296	306
Function value	57.2190	67.5733	15.6278	44.7138	-1.4296	9.6892	40.4375	9.3177

Notes: *t*-values are in parentheses, * and ** represents significant at the 5% and 1% level, respectively.

We summarize our results in Tables 6 and 7 as following. We find that stock bonus has a negative effect on scale efficiency as shown in Table 6. However, this is because some

large firms which are already operating at decreasing returns to scale distribute stock bonuses to employees. Since they are already very large in size, distributing stock bonuses could make them inefficient in terms of scale economies. Our results in Table 7 show that after considering the interaction effect between DRS and bonus distribution, more bonus distribution still increase firm's scale efficiency.

6. Conclusions

This paper investigates the effect of employee stock bonuses on the technical efficiency of Taiwan's electronic manufacturers. We calculate three DEA efficiency scores for individual firms: technical, pure technical and scale efficiency scores. We select four inputs and one output in our DEA analysis. The output variable is gross sales and the four input variables are value of machine, value of factory, number of employees and R&D expenses.

Our results show that under our one-output, four-input framework, the technical efficiency of the Taiwan's electronic industry is 0.125 on average. Between the two components of technical efficiency, pure technical and scale efficiency, it is pure technical efficiency that result in the low scores of technical efficiency. We find that most of the electronic manufacturers have better scale efficiency performances. In addition, our results show that three types of efficiency scores are all higher for firms that distribute bonuses to their employees.

We also employ Tobit regression analysis to determine what characteristics influence the efficiency measures obtained. Our results show that higher level of employee stock bonuses are positively related to technical and pure technical efficiency but negatively related to scale efficiency. In other words, it suggests that employee stock bonuses could improve technical and pure technical efficiency but weaken scale efficiency at the same time. By investigating the impact of firms operating at decreasing returns to scale (DRS), we find that distributing stock bonuses make firms that are already too large in size less efficient in terms of scale economies. After excluding the DRS factor, stock bonus variable is positively related to scale efficiency. In sum, the results from Tables 4 to 7 indicate a positive and significant relationship between stock bonus and firm efficiency. Moreover, the significant parameter estimates of the lagged stock bonus variables show that employee stock bonus variable has a lagged impact on firm efficiency.

Thore et al. (1996) evaluates the efficiency of companies in the U.S. computer industry from 1981 to 1990 and find that for firms who stay efficient, their scale efficiency scores are

higher than their pure technical efficiency scores. Our results are consistent with Thore et al. (1996) in that most of the Taiwan electronic firms have better performance in their scale efficiency than in pure technical efficiency. Jones and Kato (1995) report that the results for Japanese firms on the effects of employee stock ownership plans and bonuses by estimating production functions. Their results show that the introduction of stock bonus plans in Japan increases 4 to 5 percent productivity and it takes time to get this productivity payoff. Our results are thus consistent with the results provided by Jones and Kato (1995).

Moreover, we also examine the impact of some corporate governance variables on firm efficiency in the Taiwan's electronic industry. Our results show that these measures have important effects on firm efficiency. We also find that age seems to have a positive effect on scale efficiency, but a negative effect on pure technical efficiency. The results imply that old firms have better performance in their scale efficiency but worse performance in the pure technical efficiency. Age thus does not have significant effect on technical efficiency as TE is the product of the previous two efficiency measures.

We believe our results provide some new evidence on how the competitiveness of electronic industry in Taiwan is achieved. Indeed, we find that stock bonus scheme helps companies to reach higher efficiency, and the effect of stock bonus distribution lasts more than the contemporary year. With the accounting rules changing in recent years, regulators in Taiwan should pay more attention on possible impact to the electronic industry as companies may not be able to retain valuable employees if other incentive-enhancing mechanism is not available.

References

Anderson, R. I., Fok, R., Springer, T., & Webb, J. 2002. Technical efficiency and economics of scale: A non-parametric analysis of REIT operating efficiency. ***European Journal of Operational Research***, 139 (3): 598-612.

Berger, A. N., & Humphrey, D. B. 1997. Efficiency of financial institutions: International survey and directions for future research. ***European Journal of Operational Research***, 98 (2): 175-212.

Charnes, A., & Cooper, W. W. 1985. Preface to topics in data envelopment analysis. ***Annals of Operation Research***, 2 (1): 59-94.

Charnes, A., Cooper, W. W., Sun, D. B., & Huang, Z. M. 1990. Polyhedral cone-ratio DEA models with an illustrative application to large commercial banks. ***Journal of Econometrics***, 46 (1/2): 72-91.

Cummins, J. D., Tennyson, S., & Weiss, M. A. 1999. Consolidation and efficiency in the US life insurance industry. ***Journal of Banking and Finance***, 23 (2/4): 325-357.

D'Art, D., & Turner, T. 2004. Profit sharing, firm performance and union influence in selected European countries. ***Personnel Review***, 33 (3): 335-350.

DeAngelo, H., & DeAngelo, L. 1985. Managerial ownership of voting rights: A study of public corporations with dual classes of common stock. ***Journal of Financial Economics***, 14 (1): 33-69.

Fare, R., Grosskopf, S., & Lovell, C. A. K. 1985. ***The measurement of efficiency of production***. Boston, MA: Kluwer-Nijhoff.

Farrel, M. J. 1957. The measurement of productive efficiency. ***Journal of Royal Statistical Society***, 120 (3): 253-290.

Gorton, G., & Schmid, F. A. 2000. Universal banking and the performance of German firms. ***Journal of Financial Economics***, 58 (1): 29-80.

Jones, D. C., & Kato, T. 1995. The productivity effects of employee stock-ownership plans and bonuses: Evidence from Japanese panel data. ***American Economic Review***, 85 (3): 391-414.

Kesner, I. 1987. Directors' stock ownership and organizational performance: An investigation of fortune 500 companies. ***Journal of Management***, 13 (3): 499-507.

Kim, S. 1998. Does profit sharing increase firm's profits? ***Journal of Labor Research***, 19 (2): 351-370.

Kruse, D. L. 1993. ***Profit sharing: Does it make a difference***? Kalamazoo, MI: W. E.

Upjohn Institute for Employment Research.

Lundvall, K., & Battese, G. E. 2000. Firm size, age and efficiency: Evidence from Kenyan manufacturing firms. ***Journal of Development Studies***, 36 (3): 146-163.

McConnell, J. J., & Servaes, H. 1990. Additional evidence on equity ownership and corporate value. ***Journal of Financial Economics***, 27 (2): 595-612.

Morck, R., Shleifer, A., & Vishny, R. W. 1988. Management ownership and market valuation: An empirical analysis. ***Journal of Financial Economics***, 20 (2): 293-315.

Poole, M. 1989. ***The origins of economic democracy: Profit sharing and employee shareholding scheme***. London, UK: Routledge.

Seiford, L. M., & Thrall, R. M. 1990. Recent developments in DEA: The mathematical programming approach to frontier analysis. ***Journal of Econometrics***, 46 (1/2): 7-38.

Sesil, J. C., Kruse, D. L., & Blasi, J. R. 2001. ***Sharing ownership via employee stock ownership***. Working paper no. 2001/35, United Nations University.

Smith, P. 1990. Data envelopment analysis applied to financial statements. ***Omega International Journal of Management Science***, 18 (2): 131-138.

Thore, S., Phillips, F., Rueflis, T. W., & Yue, P. 1996. DEA and the management of the product cycle: The U.S. computer industry. ***Computers Operations Research***, 23 (4): 341-356.

Wang, C. H., Gopal, R. D., & Zionts, S. 1997. Use of data envelopment analysis in assessing information technology impact on firm performance. ***Annals of Operations Research***, 73: 191-213.

Yue, P. 1991. ***Competition between U.S. and Japanese electronics companies***. Working paper, The University of Texas at Austin.

Biographical Notes

鄭士卿

美國羅德島大學保險財務博士。現職為國立政治大學風險管理與保險學系專任副教授。研究領域主要為效率分析、金融機構風險管理及保險財務。

霍熾榮

美國阿拉巴馬大學財務金融學博士。現職為威斯康辛大學 Parkside 分校商學院副教授。研究興趣包括首次公開招股、金融機構效率研究、資本市場和國際金融市場。

張元晨

英國蘭卡斯特大學財務博士。現職為國立政治大學財務管理學系專任教授。研究領域主要為外匯市場、金融機構管理及公司財務。