The effects of bonus systems on firm performance in Taiwan's high-tech sector

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This research investigates the effects of cash and stock bonus systems in Taiwan's high-tech sector on firm performance, as measured by sales and value-added. To test the robustness of the estimated results, two proxies for bonuses are adopted, namely the total value of bonuses per employee and bonus payments as a percentage of total payroll. This study adopts three production functions, including the Cobb–Douglas, Translog and CES functions, to estimate the performance effects of bonuses. Our results show that, to a great extent, the bonus systems have positive impacts on firm performance. *Journal of Comparative Economics* **35** (1) (2007) 235–249. Department of Business Administration, National Chengchi University, No. 64, Sec. 2, Zhi-nan Rd., Wenshan, Taipei 11605, Taiwan; Department of Money and Banking, National Chengchi University, No. 64, Sec. 2, Zhi-nan Rd., Wenshan, Taipei 11605, Taiwan.

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1. Introduction

During much of the past two decades, Taiwan's high-tech sector, in particular the information industry, has experienced phenomenal growth in terms of both scale and revenues. In 1983, while only 37 high-tech firms were located in the Hsinchu Science Park, the first and largest high-tech industrial park in Taiwan, and they generated approximately US $85 million in total revenues, in 2003, the number of firms had soared to 369, and together they yielded total revenues amounting to US $24,500 million. This represented an astounding increase rate of 28,250% since 1983 (Hsinchu Science Park, 2005). It is claimed that in addition to government subsidies and complementary infrastructure for the development of high-tech industries in Taiwan, the largescale adoption of the bonus systems by these high-tech firms has played a crucial role and can be credited for this rapid growth. In recent years, annual bonus payments in some firms have exceeded US $100,000 per employee. On account of the powerful incentives they provide, the bonus systems undoubtedly have the capability of attracting talented employees to join such organizations and motivating them to exert greater efforts toward boosting the productivity of the firms, particularly those in the fields of integrated circuits, computers and peripherals, as well as telecommunications industries. According to the Park's official statistics, average labor productivity in terms of sales revenues per worker increased from approximately US $73,600 in 1986 to around US $248,000 in 2003. By virtue of the strengths of benefits associated with their bonus systems, Taiwan's high-tech industries do, indeed, provide an extremely interesting arena for examining the effects of employee financial participation on firm performance.

Despite the numerous reports regarding the phenomena surrounding the bonus systems in Taiwan's high-tech industries, very few systematic studies on the performance effects of such systems have, until now, been conducted. Theoretical works have presented two conflicting perspectives on the performance effects of employee financial participation (Alchian and Demsetz, 1972; Putterman, 1982). To resolve the controversial nature of the issue, it is necessary to take into account the extent of employee financial participation in greater detail as well as the implications for employee motivation and performance. Although empirical studies on productivity effects have also generated inconclusive results (Blasi et al., 1996; Kruse, 1993), this may have been associated with problems pertaining to measurements in many empirical studies that have used dummy variables to measure employee financial participation as opposed to the extent of the financial participation. Important to note is that some studies have, nevertheless, shown that diverse forms of employee participation may result in different outcomes (Ben-Ner et al., 1996; Cotton et al., 1988). Using this dichotomous variable may, in reality, overlook the diversity and extent of different employee financial participation schemes and their true effects on firm performance. In addition, studies using cross-sectional data may give rise to biases in the estimations of the performance effects of employee financial participation due to the problem of endogeneity and the fixed effects of the firm.

In an effort to more thoroughly examine the effects of bonuses on firm performance, this study uses the monetary amount and the extent of bonuses as the measures of employee financial participation. To do so, it is based on a longitudinal data of publicly-held firms in Taiwan's high-tech sector.

This study makes contributions to the extant field of research in two ways. The first is that it examines the performance effects of bonuses in Taiwan's high-tech sector, an area which has, until now, only received scant attention. Taiwan's high-tech firms provide an interesting arena for examining the performance effects of employee financial participation owing to the unique features of the bonus systems practiced by these high-tech firms. Secondly, it departs from traditional tests because rather than use a dichotomous variable, we employ more refined measures of bonuses in the context of a longitudinal design, all in an attempt to attenuate the methodological problems referred to above.

This paper is organized as follows. The next section highlights the uniqueness of the bonus systems in Taiwan's high-tech sector by comparing and contrasting them with employee financial participation schemes in US-type employee stock ownership plans (ESOPs). Then, we discuss the theoretical predictions of the bonus systems in Taiwan's high-tech firms in light of their unique features. The final section of this paper presents the empirical results of our study and the conclusions we draw.

2. Features of bonuses in Taiwan's high-tech sector

Since the early 1980s, the practice of giving bonuses has been widely adopted by high-tech firms in Taiwan. In the broadest sense, they take on three major forms, namely cash bonuses, stock bonuses and combination plans. Table 1 shows the incidence of adopting bonus systems in Taiwan's economy during the 1989–2000 period. The statistics make it clear that the number of stock bonuses and, to a lesser degree, the number of combination plans increased dramatically during that period. It should be noted, however, that these statistics were collected by the government agency in charge of labor affairs, and in Taiwan, it is not uncommon for governmental statistics to present somewhat of a conservative picture of such phenomena due to the incomplete sampling of establishments under the jurisdiction of the Fair Labor Standard Law. Thus, we firmly take the view that these statistics actually underestimate the number of firms which have adopted bonus systems.

In recent years, the value of bonuses oftentimes represents a large share of the total after-tax revenues of all publicly-held firms listed on Taiwan's Stock Market Exchange. Take 2001 as our example, when the total value of bonuses in publicly-traded firms approximated US $2 billion which represented 74.6% of the total revenues of all firms after taxes. In practice, companies adopting cash bonus plans typically share a small portion, say 1–15 percent, of their profits with their employees on an annual basis. The amount of the cash bonuses that an employee receives is commonly based on his or her pay grade, seniority, position, and individual performance rating. In that there is no tax advantage for companies to adopt a cash bonus scheme in Taiwan, only a minority of them offer cash bonuses. On the other side of the coin, however, an increasing number of high-tech firms in Taiwan have been adopting stock bonus plans as incentives which are based on a firm's profitability during the previous year. Some high-tech companies and their employees, in other words, have been sharing a significant portion of the companies' profits in the form of stocks in recent years, and given the dramatic growth in this industrial sector, as a whole, the total value of stock bonuses in Taiwan's high-tech firms increased substantially from 1998 to 2002. In 2002, for instance, a firm primarily engaged in integrated circuit design shared a large portion of its stocks with its 248 employees, with each employee receiving stock worth NT $25,150,000, approximately US $739,706, in market value. It is unambiguous that these high-tech firms with substantive stock-sharing have undeniably certain distinct advantages when it comes to attracting and motivating talented job candidates from the market and retaining better personnel in the firm, all of which enhances the general efficiency of their business operations (Chen and Wang, 2001). In addition, the fact that many firms allow their employees to sell their stock bonuses immediately upon receiving them is, to many employees, most appealing (Cin et al., 2003).

Table 1
Number of cash bonus and stock bonus plans in Taiwan (unit: establishments)

Year	Cash bonuses	Stock bonuses	Combination plans
End of 1989	546	186	NA
End of 1990	539	268	122
End of 1991	589	293	132
End of 1992	647	343	141
End of 1993	663	355	144
End of 1994	678	363	146
End of 1995	501	362	142
End of 1996	511	371	146
End of 1997	528	384	155
End of 1998	524	421	174
End of 1999	545	430	175
2nd quarter of 2000	545	430	175

Sources: Monthly Bulletin of Labor Statistics (1997, p. 50; 2000, pp. 58–59).

In essence and in practice, the bonus systems in Taiwan's high-tech sector share some similarities with American cash profit-sharing and ESOPs. This is especially the case in terms of the purpose of such schemes. Both incentive schemes purport to attract the talented people from outside, retain them in the firm, and eventually closely link their efforts and intelligence to the firm's overall performance. Additionally, both plans reward employees with cash bonuses and/or company stock provided that firm performance has been enhanced. Another similarity is that cash bonuses in Taiwan's high-tech sector are similar to cash profit-sharing in US firms.

The similarities aside, there do, of course, exist some important differences between US ESOPs and stock bonuses in Taiwan. First, US ESOPs are typically long-term incentives in that employees share in the long-term performance of a firm, this being in the form of stock ownership, such as broad-based stock option plans (Milkovich and Newman, 2002). Taiwan's stock bonuses, by contrast, are relatively short-term in nature because employees in many of Taiwan's high-tech firms are, in general, allowed to sell their shares immediately after receiving them and to reap the financial benefits whenever they wish. Second, US ESOPs tend to encourage employees to direct their efforts towards future performance, while Taiwan's stock bonuses reward employees retrospectively, based on the profitability of the preceding year. Third, under the US stock purchase plans, employees have to pay to purchase the company's stocks, whereas employees in Taiwan's high-tech firms usually obtain such stock bonuses without making any payment. Fourth, unlike in the US where stock ownership may be only a small part in the total compensation of an employee, in many cases in Taiwan, stock bonuses represent a very substantial portion of an employee's total annual compensation. The explanation for this is that the salary level in Taiwan's high-tech sector is relatively lower than that in subsidiaries of large US multinational corporations, like IBM and HP. Hence, many high-tech firms in Taiwan adopt this sharing scheme to make their total compensation package more competitive in the market, thereby putting them on equal footing in order to attract and retain better personnel. In particular, this sharing scheme works extremely well in firms with high profitability and stock prices. Thus, stock bonuses may, in a sense, serve as a high-power incentive in the eyes of employees, to use Oliver Williamson's term (Williamson, 1985). Given such unique features, it is interesting to investigate the effects of Taiwan’s stock bonuses on firm performance.

3. Theory and evidence

As mentioned above, in some aspects, the cash and stock bonus systems of Taiwan’s high-tech firms resemble cash profit-sharing and ESOPs of the United States. Given such similarities, it is our belief that economic theories that predict the performance effects of profit sharing and ESOPs can be applied to explain the performance effects of cash and stock bonuses on Taiwan’s high-tech firms. Economic theories have put forth two competing perspectives on the performance effects of profit sharing and ESOPs. On the one hand, some theories argue that profit sharing and employee stock ownership can enhance firm performance; while on the other hand, others contend that such incentives may actually be detrimental to firm performance (Alchian and Demsetz, 1972; Blasi et al., 1996; Bradley et al., 1991; FitzRoy and Kraft, 1986; Jensen and Meckling, 1979).

The theoretical rationale in favor of positive performance effects of bonuses can be explained in the following ways. First, it is argued that bonuses likely tend to induce employees to exert a greater effort or develop innovative ways to improve operational efficiency,[1] thereby enhancing not just individual but also organizational performance (Ben-Ner and Jones, 1995; Blasi et al., 1996; Fakhfakh and Perotin, 2000). The rationale behind this argument is that the prospect of high future cash and/or stock bonuses which are dependent on a firm’s profitability and stock prices motivates its employees to work harder and smarter (Bhargava, 1994; Kruse, 1993; Kumbhakar and Dunbar, 1993; Weitzman and Kruse, 1990). In particular, the motivational and performance effects can be large when these incentives are broad-based and when a firm shares a substantial amount of the profits in cash and/or in stocks with employees (Jones and Kato, 1995). Second, on account of their linkage to a firm’s profitability, cash and stock bonuses can attenuate agency problems inherent in a fixed-wage employment contract and reduce the impact of any conflict of interests between the owner and employees (Blasi et al., 1996; Kruse, 1993).[2] With this realignment of interests, it can be expected that employees become more committed to the firm’s objectives and strive to accomplish its ultimate goals, perhaps the most notable of which is higher profitability since, in turn, this leads to higher cash and stock bonuses (Chen and Wang, 2001).

Third, when the payment of cash and stock bonuses is an ‘add-on’ portion of the total remuneration of an employee, this portion may have an ‘efficiency-wage’ effect that can reduce employees’ shirking, decrease turnover problems, attract better qualified job applicants and foster increased reciprocity in social exchanges between the firm and its employees (Akerlof and Yellen, 1986; Yellen, 1984). Collectively, these benefits facilitate the accumulation of firm-specific human capital and organizational competencies, thus improving overall firm performance (Ben-Ner et al., 2000).

Fourth, providing cash and stock bonuses can create peer group pressure and motivate employees to monitor their co-workers in order to ensure that high performance standards across the firm are the rule (FitzRoy and Kraft, 1986; Kruse, 1993; Levine and Tyson, 1990). More importantly, the interdependent nature of these group incentives at the same time encourages cooperation among employees (Weitzman and Kruse, 1990). Cooperation may foster the evolution of a group norm and, therefore, enhance firm performance (Kandel and Lazear, 1992; Lazear, 1992). It is likely that cooperation may facilitate information flow within the firm and, in all likelihood, increase flexibility in management, thus again contributing to improved firm performance (Kruse, 1993; Putterman, 1982; Strauss, 1990).

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1 Based on his personal experiences, Morris Chang, CEO of Taiwan Semiconductor Manufacturing Co. (TSMC), has been quoted as saying that high rewards lead to innovation. TSMC is one of Taiwan’s high-tech firms that previously implemented cash and stock bonuses on a broad basis. Such sharing may very well explain the firm’s outstanding economic success during the past fifteen years.

2 Hsin-chen Tsao, CEO of the second largest semiconductor manufacturer in Taiwan (i.e., UMC), reportedly agrees that cash and stock bonuses in his company improved labor relations and enhanced employees’ loyalty and organizational commitment. Bonuses are rewards for ‘entrepreneurship’, whereas fixed pay is the payment for being ‘hired employees’ (Tsao, 1999).

Theoretical arguments that are not in favor of the performance effects of cash and stock bonuses are based on economic theories concerning problems associated with group incentives. For one, it is claimed that such group incentives as cash and stock bonuses may induce 'free-rider' problems among employees according to which an individual employee may have a tendency to shirk his/her responsibilities, particularly in the event that group incentives are shared equally and the connection between individual efforts and personal reward is a weak one (Blasi et al., 1996). If the free-rider problem prevails, then the overall performance of the firm with group incentives could even deteriorate, as participants in the so-called 'Prisoner's Dilemma' game will lead to a sub-optimal equilibrium (Kruse, 1993). The second argument against the positive performance effects of these group incentives draws on the theory of team production (Alchian and Demsetz, 1972). This theory posits that optimal monitoring requires that the management of the firm be the 'residual claimant' of the equity of the firm. If profits are shared with employees under group incentives, then management's motivation to supervise employees may be diluted. And thus, firm performance may be reduced accordingly (Jensen and Meckling, 1979).

Though these two competing perspectives might hold under certain conditions, the true performance effects are contingent on the nature of the incentives under investigation. When discussing the performance effects of cash and stock bonuses, researchers need to carefully look at the reality of the incentive scheme in practice. In Taiwan's high-tech sector, solid evidence has indeed shown that the arguments in support of the positive performance effects of cash and stock bonuses are more applicable and do explain the effects of such sharing schemes. Many academics and practitioners in Taiwan's high-tech firms think that cash and stock bonuses do lead to favorable human resource outcomes, such as attraction, retention, motivation and accumulation of firm-specific human capital, as well as positive organizational behaviors, like loyalty and organizational commitment (Biagioli and Curatolo, 1999; Chen and Wang, 2001; Chiu and Tsai, in press; Tsao, 1999). It is unambiguous that such positive outcomes play a leading role in boosting the all round performance of firms, which has manifested itself in the strikingly rapid growth of Taiwan's high-tech industries throughout the past two decades.

Equally noteworthy is that a large sharing of stock over many years in some firms could very well have been contributing to an increased sense of psychological ownership which has induced positive behavioral consequences, that is, those which are usually pro-social and highly productive. In a recent study of cash and stock bonuses and their effects on organizational citizenship behaviors in Taiwan's high-tech firms, Chiu and Tsai (in press) found that stock bonuses and combination plans positively influenced employees' organizational citizenship behaviors. This aside, organizational commitment evidently mediates the relationship between stock bonuses or combination plans and organizational citizenship behaviors. This phenomenon is especially evidenced in some Taiwanese high-tech firms that share a large portion of their profits with their employees. Returning to our earlier example, Lien-Fa Technology Co., a successful IC designer in Taiwan, distributed stocks worth approximately US $514,285 on average to each employee in 2001 and a considerably higher US $739,706 one year later. In reality, the shares of stock bonuses in most firms are not equally distributed, but rather are based on performance, seniority, position and other factors. In other words, top performers and management receive much larger stock bonuses than do lower performers and lower levels of employees. Such a design has great potential to eliminate the 'free-rider' problem frequently occurring in the context of group incentives and to increase management's incentive to supervise. By now, this record has reached a historical peak in the sharing of stock bonuses with employees in Taiwan. Taiwan-style cash and stock bonuses indeed seem to have continuously led to motivational effects in terms of attraction, retention and performance of valuable staff members.

Cash and stock bonuses in Taiwan's high-tech sector have, to a great extent, generated several advantages from the perspective of employers and employees alike. As stated earlier, it has been reported that these firms have been quite effective at attracting and retaining employees (Common Wealth Magazine, 1997; Today Weekly, 1998), but what is noteworthy here is that many well-known foreign multinational corporations in Taiwan, like IBM, once widely viewed by job seekers as 'the special group of preferred employers', are currently being confronted with 'fierce warfare' against local high-tech firms since both are in quest for new and qualified talent. Many foreign companies have even lost some of their most valued employees to some local high-tech firms which have successfully been able to lure them with their highly valuable stock bonus schemes. In some companies, cash and stock bonuses represent a very large share of their total payroll costs (Fong, 1998), and this parallels the experience in numerous US high-tech firms

(Smith, 1988).

4. Econometric model

To examine the effects of bonuses on firm performance, we adopt three specifications, including the Cobb–Douglas without parameters restrictions (CD),3 the Translog Function and the Constant Elasticity of Substitution (CES), which are:

Cobb–Douglas without parameters restrictions:

$$\text{Log } y_{it} = \beta_0 + \beta_1 \text{Log } K_{it} + \beta_2 \text{Log } L_{it} + \alpha_1 Salary_{it} + \alpha_2 R\&D_{it} + \alpha_3 Bonus_{it} + year\ and\ industrial\ dummies + \mu_{it}. \quad (1)$$

Translog:

$$\text{Log } y_{it} = \beta_0 + \beta_1 \text{Log } K_{it} + \beta_2 \text{Log } L_{it} + \beta_3 (\text{Log } K_{it})^2 + \beta_4 (\text{Log } L_{it})^2 + \beta_5 \text{Log } K_{it} \text{Log } L_{it} + \alpha_1 Salary_{it} + \alpha_2 R\&D_{it} + \alpha_3 Bonus_{it} + year\ and\ industrial\ dummies + \mu_{it}. \quad (2)$$

CES:

$$\text{Log } y_{it} = \text{Log } \gamma - (\upsilon/\rho) \text{Log}\left\{\delta K_{it}^{-\rho} + (1-\rho)\beta_2 \text{Log } L_{it}^{-\rho}\right\} + \alpha_1 Salary_{i,t} + \alpha_2 R\&D_{it} + \alpha_3 Bonus_{it} + year\ and\ industrial\ dummies + \mu_{it}. \quad (3)$$

Here Log y, which is the performance of a firm in logarithmic form, is proxied by Log *Sales* and Log *Value-added*. *Sales* are the operating revenues, while *Value-added* is the gross operation profit. K and L are the capital and labor, respectively. *Salary* is the total salary divided by the number of employees. $R\&D$ is the research and development spending divided by total assets. And subscripts i and t denote the firm i at time t .We attempt two different definitions of bonuses: *Bonus*1 represents the sum of cash and stock bonuses divided by the number of employees and *Bonus*2 is the sum of cash and stock bonuses divided by the total payroll. Note that stock bonus is the stock dividends multiplying by closing prices of stock. For simplicity, *Bonus* is used through the paper. Table 2 gives the definitions of the variables used in this study and the corresponding mean values and standard deviations associated with these variables.

Table 2
Variable definitions and descriptive statistics

	Description	Mean	S.D.
Dependent variable			
Log $Sales_{it}$	Natural logarithm of sales (= operation revenues) in firm i at year t	14.223	1.638
Log $Value\text{-}added_{it}$	Natural logarithm of gross operation profit (= operating revenues − operating expenses) in firm i at year t	12.350	1.648
Independent variable			
Log K_{it}	Natural logarithm of fixed capital in firm i at year t	12.634	1.942
Log L_{it}	Natural logarithm of the number of employees in firm i at year t	5.859	1.269
Log $Salary_{it}$	Natural logarithm of total salary divided by the number of employees in firm i at year t	5.046	0.851
$R\&D_{it}$	Research and development divided by total assets in firm i at year t	0.024	0.048
$Bonus1_{it}$	(Stock bonus + cash bonus)/employees/1000 in firm i at year t	1.964	6.679
$Bonus2_{it}$	(Stock bonus + cash bonus)/total salary in firm i at year t	11.918	37.156

Notes. (1) Mean and SD denote the mean and standard deviation of the variables, respectively.
(2) Stock bonus = stock dividend × closing price.

The data set used in this study comprises 672 publicly-held firms in the high-tech sector listed on Taiwan's Stock Exchange.[4] The average sample length, however, is from 1993 to 2004. We collected all data from the Taiwan Economic Journal, a private agency which compiles financial data of all publicly-held firms in Taiwan. By focusing on the high-tech sector, we are able to reduce problems with regard to heterogeneity that may have affected previous studies.

Tables 3 to 4 respectively report the estimated results using *Sales* and *Value-added* as dependent variables. With each dependent variable, two different bonus measures, each with three different specifications, are attempted, for a total of six specifications. All equations adopt year and industry dummies, but these dummy variables are not reported here due to space constraints. To tackle the endogeneity problem associated with *Bonus*, we used the two-stage least square (2SLS) method, where the first stage created the forecast of each bonus variable (which is referred to as *Bonus_hat*) with all above exogenous variables,[5] as well as the lagged variable of after-tax profit, firm and year dummies on the right-hand side of the equations. Inclusion of these variables as predictors for bonuses is because Taiwan's high-tech firms usually share profits with their employees according to the profitability of the preceding year (Cin et al., 2003). In addition, beside firm type and year, the size of the firm, R&D intensity and compensation level may also affect the bonus payments (Chen and Wang, 2001; Fong, 1998). The estimated results including the instruments used are reported in the appendix, Table A.1. The majority of the coefficients in Table A.1 are significant. To make sure the lagged variable of profit is a valid instrument for *Bonus*, we performed Hansen's test to examine the validity of the instruments (Hansen, 1982). The test is typically denoted as J -statistics which is equal to $J = (\_Z\mu/N)\_W(\_Z\mu/N)$, where $W = (\_Z\mu/\sqrt{N})^{-1}, \mu$ is the error term from these equations and Z is the instruments vector. When *Value-added* is employed as dependent variable, the J statistics are 1.504 (0.214) and 0.6107 (0.4345) for *Bonus*1 and *Bonus*2, respectively, where p-values are reported in parenthesis. When *Sales* is employed as the dependent variable, the J statistics are 1.7085 (0.191) and 7.5437 (0.006) for two bonus variables. Accordingly, the instruments used pass the J test except for the *Bonus*2 when *Sales* is used as the dependent variable.

The second stage employed the expected value of *Bonus* as the independent variable in the equations in Tables 3 and 4. The *t*-value is based on White's heteroskedasticity consistent estimated standard errors. Table 3 reports the estimated results when *Sales* is used as the dependent variable. In the first two columns, when the Cobb–Douglas function without parameters restriction is used, the coefficients of *Bonus* are found to be overwhelmingly significantly positive regardless of the proxies adopted. Hence, it is clear that issuing bonuses has beneficial effects on gross sales. Other variables reveal several points of interest. The first two rows consider Log$K$ and Log$L$ as explanatory variables where their coefficients are circa 0.100 and circa 0.850, respectively, regardless of the specifications. It is known that when the sum of their coefficients is unity, the equation is reduced to the Cobb–Douglas function. F-tests indicate that the null of the Cobb–Douglas function is decisively rejected since the p-values of the tests are overwhelmingly smaller than 0.000. Furthermore, the coefficients of *Salary* are overwhelmingly positive, suggesting that the more the salary expenses, the higher the sales. By contrast, the coefficients of $R\&D$ are all negative, suggesting that the higher the R&D intensity, the less the sales.

The next two columns of Table 3 employ the Translog function. Similar significant positive coefficients are found on all bonus variables. The effects of control variables of *Salary* and $R\&D$ also remain the same as those used in the Cobb–Douglas function without parameters restrictions. The elasticities of *Sales* to Log$K$ and Log$L$ in the Translog function are circa 0.07 and circa 0.75, respectively.[6]

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3 The reason we refer Eq. (1) to the Cobb–Douglas function without parameter restrictions is that we do not impose the sum of coefficients of β_1 and β_2 to be unity. It is the (exact) Cobb–Douglas function only when their sum is equal to unity.

4 We use seventeen industrial dummy variables for high-tech firms, which are in the fields of logistics (69), the IC industry (51), CD-ROM (40), power supply (38), computer (46), monitor display (33), main board (32), telecommunications and telecommunication equipment (44), cellular mobile manufacturing (34), PCB/substrate (53), system integration (55), connector (40), equipment and instrument (36), software (34), DRAM (24), LCD (35) and electronic parts (28), where the numbers in parentheses represent the number of firms in the industry.

5 Estimated results using the OLS method are reported in the appendix, Tables A.2 and A.3. Results are slightly different from those of using the 2SLS method.

Table 3
Effects of bonuses on Log *Sales*: 2SLS estimations

Variables	Cobb–Douglas		Translog		CES	
Constant	9.953***	9.994***	9.815***	9.846***		
	(15.940)	(16.058)	(11.179)	(11.586)		
Log K	0.035*	0.041**	0.629***	0.167*		
	(1.925)	(2.504)	(4.581)	(1.710)		
Log L	0.786***	0.767***	−0.443**	0.708***		
	(31.668)	(31.079)	(2.559)	(5.356)		
$(\text{Log}\,K)^2$			−0.047***	−0.029***		
			(4.793)	(4.104)		
$(\text{Log}\,L)^2$			−0.008	−0.118***		
			(0.418)	(8.038)		
Log K Log L			0.103***	0.114***		
			(4.243)	(6.118)		
Log *gamma*					−4.748***	−4.724***
					(5.127)	(6.799)
Nu					0.611***	0.618***
					(37.260)	(35.013)
Delta					0.321	0.245
					(0.527)	(0.611)
Rho					0.270	0.162
					(0.623)	(0.507)
Salary	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(25.303)	(25.870)	(24.814)	(32.184)	(23.362)	(24.565)
R&D	−2.458***	−2.653***	−2.802***	3.930***	−2.665***	−2.2921***
	(5.343)	(6.326)	(5.859)	(11.427)	(6.091)	(5.340)
*Bonus*1	0.002**		0.003**		0.002***	
	(2.151)		(2.263)		(2.960)	
*Bonus*2		0.625***		1.170***		0.073
		(4.757)		(10.256)		(0.700)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
K-elasticity	0.035	0.041	0.051	0.091	0.016	0.027
L-elasticity	0.786	0.767	0.723	0.799	0.584	0.591
N	4843	4843	4843	4843	4843	4843
R^2	0.568	0.570	0.573	0.649	0.285	0.284

Notes. t values are presented in brackets. The bonus variables are the predicted values of bonuses using regressions of bonuses on all exogenous variables.

* Statistical significance at the 10% level.
** Idem, 5%.
*** Idem, 1%.

The last two columns of Table 3 report the estimated results using the CES function. Because this function is nonlinear intrinsically, it requires the attempt of different initial values. The set of initial values that maximizes the log likelihood function will be chosen. The results, in fact, change little from those reported using the Cobb–Douglas and Translog functions except that the coefficient of *Bonus*2 becomes insignificantly different from zero.

Table 4 provides the estimated results of using *Value-added* as the dependent variable. When the Cobb–Douglas specification without parameters restriction is employed, the coefficients of *Bonus* are also overwhelmingly positive and significant regardless of the proxies adopted. Thus, the increases of bonuses do increase the value of production. The coefficients of *Salary* are also significantly positive, supporting the concept that salary can stimulate the production. The coefficients of *R&D* are 4.020 and 4.017, all statistically significant. The coefficients of K and L *are* around 0.1 and 0.8 and do not change too much when different bonuses are employed. Aside from this, the null of the Cobb–Douglas function is also rejected right out since the F-tests are around 800. The next two columns of Table 4 report the estimated results using the Translog function.

These results are qualitatively the same as those using the Cobb–Douglas function without parameters restrictions. The estimated results of using the CES function, which are reported in the last two columns of Table 4, display similar results as the previous two specifications.

Table 4
Effects of bonuses on Log *Value-added*: 2SLS estimations

Variables	Cobb–Douglas		Translog		CES	
Constant	5.100***	5.127***	4.514***	4.788***		
	(10.427)	(10.565)	(6.667)	(7.337)		
Log K	0.051***	0.071***	0.348***	0.167*		
	(3.592)	(5.586)	(3.261)	(1.710)		
Log L	0.858***	0.822***	0.391***	0.708***		
	(43.957)	(42.451)	(2.912)	(5.356)		
$(\text{Log } K)^2$			−0.049***	−0.029***		
			(6.288)	(4.104)		
$(\text{Log } L)^2$			−0.144***	−0.118***		
			(9.444)	(8.038)		
Log K Log L			0.165***	0.114***		
			(8.468)	(6.118)		
Log *gamma*					2.944***	3.922***
					(4.977)	(6.227)
Nu					0.969***	0.901***
					(75.157)	(68.183)
Delta					0.937***	0.814***
					(11.734)	(4.943)
Rho					0.842***	0.581***
					(3.440)	(3.195)
Salary	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(29.992)	(31.105)	(31.108)	(32.184)	(30.903)	(32.564)
R&D	4.020***	4.017***	3.422***	3.930***	3.668***	3.561***
	(10.593)	(11.632)	(8.717)	(11.427)	(10.662)	(10.568)
*Bonus*1	0.006***		0.009**		0.009***	
	(6.552)		(7.844)		(18.403)	
*Bonus*2		1.098***		1.170***		1.652***
		(10.470)		(10.256)		(21.407)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
K-elasticity	0.051	0.071	0.066	0.091	0.586	0.205
L-elasticity	0.858	0.822	0.825	0.799	0.383	0.696
N	4843	4843	4843	4843	4843	4843
R^2	0.639	0.644	0.646	0.649	0.627	0.635

Notes. t values are presented in brackets. The bonus variables are the predicted values of bonuses using regressions of bonuses on all exogenous variables.
* Statistical significance at the 10% level.
** Idem, 5%.
*** Idem, 1%.

5. Conclusion

It is, indeed, true that Taiwan's high-tech industries have grown at an almost stunning rate since the early

1980s, but this is ever so much more pronounced in the information technology sector. Frequently cited among the major reasons for such outstanding success are the unique employee financial participation schemes adopted by many Taiwanese high-tech firms during that period. With a view to investigating the effects of bonus schemes in Taiwan's high-tech sector on firm performance, this research adopts two proxies for the performance of firms, that is, *Sales* and *Value-added*. To investigate the robustness of the estimated results, two proxies for bonuses are adopted. These are *Bonus*1, measured by the sum of stock and cash bonuses divided by the number of employees and *Bonus*2, measured by the sum of stock and cash bonuses divided by the value of total payroll. We find that two different measures of bonuses have overwhelmingly positive effects on sales and valued-added. Thus, the practice of having bonus schemes in force has a strong positive impact on firm performance.

Drawing on the data from high-tech firms on Taiwan's Stock Exchange, our empirical results tend to substantiate the theoretical perspective that proposes positive effects of these group incentives on firm performance. The primary reason for these results is that the incentive effects of the bonus systems in Taiwan's high-tech sector are very strong, so that they generate many benefits for both the firms and their employees. Beyond this, it is apparent that these benefits have usually outweighed the costs of the implementation of such bonus systems during our study period. Worth bearing in mind is that our measures of bonuses are derived from financial reports on publicly-held, high-tech firms in Taiwan. Though the data provide the researchers with the monetary amounts of cash and stock bonus payments, they do not provide more detailed information as to the type of bonuses and the policies concerning their distribution among employees. Thus, with this in mind, it is recommended that future studies collect further information on the nature of the bonus systems by using survey questionnaire or field study method. Additionally, future research should ideally investigate the precise, detailed processes by which bonuses affect firm performance.

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6 In the Translog function, the elasticity of sales to capital is equal to $\beta_1 + 2\beta_3 \text{Log}K_{it} + \beta_5 \text{Log}L_{it}$ and the Translog of sales to L is $\beta_2 + 2\beta_4 \text{Log}L_{it} + \beta_5 \text{Log}K_{it}$, where Log$K$ and Log$L$ are substituted by their respective means.

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Appendix A.

Table A.1
The first-stage regression of 2SLS method

Variables	*Bonus*1	*Bonus*2
Constant	−38.794	−0.564***
	(1.274)	(3.210)
Log K_t	−1.333	−0.007
	(1.846)	(0.626)
Log L_t	12.174***	0.125***
	(3.431)	(6.070)
$Profit_{t-1}$	0.047***	0.0003***
	(6.501)	(7.735)
$Salary_t$	0.088***	−0.0001
	(7.616)	(1.264)
$R\&D_t$	−349.565***	−1.780***
	(5.743)	(5.058)
Firm dummy	Yes	Yes
Year dummy	Yes	Yes
F-test	11.920***	8.542***
N	4960	4960
R^2	0.665	0.587

Notes. *t* values are presented in brackets. The bonus variables are the predicted values of bonuses using regressions of bonuses on all exogenous variables.
*** Statistical significance at the 1% level.

Table A.2
Effects of bonuses on Log *Sales*: OLS estimations

Variables	Cobb–Douglas		Translog		CES	
Constant	9.071***	9.035***	9.606***	9.408***		
	(26.637)	(26.589)	(14.630)	(14.321)		
Log *K*	0.053***	0.054***	0.493***	0.512***		
	(3.295)	(3.367)	(3.926)	(4.081)		
Log *L*	0.784***	0.784***	−0.347**	−0.332*		
	(31.384)	(31.589)	(2.028)	(1.939)		
$(\text{Log } K)^2$			−0.037***	−0.039***		
			(4.116)	(4.407)		
$(\text{Log } L)^2$			0.004	−0.007		
			(0.228)	(0.398)		
Log *K* Log *L*			0.084***	0.093***		
			(33.606)	(3.972)		
Log *gamma*					−4.705***	−4.818***
					(7.180)	(6.793)
Nu					0.622***	0.624***
					(38.911)	(38.800)
Delta					0.218	0.265
					(0.603)	(0.655)
Rho					0.135	0.173
					(0.436)	(0.563)
Salary	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(26.085)	(27.289)	(24.923)	(26.106)	(24.557)	(25.678)
R&D	−2.092***	−2.067***	−2.333***	−2.287***	−2.314***	−2.313***
	(5.264)	(5.223)	(5.861)	(5.776)	(5.610)	(5.635)
*Bonus*1	0.0004***		0.0004***		0.0003*	
	(2.745)		(2.886)		(1.872)	
*Bonus*2		0.069***		0.063**		0.057**
		(2.684)		(2.447)		(2.129)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
K-elasticity	0.053	0.054	0.064	0.070	0.040	0.025
L-elasticity	0.780	0.784	0.717	0.719	0.582	0.599
N	4843	4843	4843	4843	4843	4843
R^2	0.568	0.644	0.573	0.575	0.284	0.287

Notes. *t* values are presented in brackets. The bonus variables are the predicted values of bonuses using regressions of bonuses on all exogenous variables.

* Statistical significance at the 10% level.
** Idem, 5%.
*** Idem, 1%.

Table A.3
Effects of bonuses on Log *Value-added*: OLS estimations

Variables	Cobb–Douglas		Translog		CES
Constant	5.374***	5.399***	6.049***	5.626***	
	(21.136)	(21.376)	(12.909)	(12.061)	
Log *K*	0.059***	0.070***	0.133	0.142	
	(4.950)	(5.968)	(1.469)	(1.582)	
Log *L*	0.889***	0.854***	0.470***	0.587***	
	(48.772)	(47.355)	(3.801)	(4.786)	

Variables	Cobb–Douglas		Translog		CES	
$(\text{Log } K)^2$			−0.034***	−0.032***		
			(5.246)	(4.961)		
$(\text{Log } L)^2$			−0.125***	−0.128***		
			(9.064)	(9.354)		
Log *K* Log *L*			0.143***	0.134***		
			(8.193)	(7.747)		
Log *gamma*					−3.187***	−3.209***
					(9.900)	(10.176)
Nu					0.587***	0.567***
					(42.097)	(40.448)
Delta					−0.081	−0.072
					(0.652)	(0.579)
Rho					−0.051	−0.057
					(0.255)	(0.253)
Salary	0.002***	0.002***	0.002***	0.002***	0.001***	0.002***
	(30.598)	(37.891)	(31.286)	(38.607)	(16.495)	(20.935)
R&D	4.292***	4.575***	4.162***	4.502***	2.720***	2.945***
	(14.018)	(15.098)	(13.647)	(14.922)	(7.193)	(7.813)
*Bonus*1	0.003***		0.003**		0.002***	
	(27.686)		(28.028)		(17.908)	
*Bonus*2		0.531***		0.535***		0.410***
		(28.977)		(29.320)		(17.904)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
K-elasticity	0.059	0.070	0.081	0.094	−0.065	−0.057
L-elasticity	0.889	0.854	0.841	0.817	0.652	0.624
N	4843	4843	4843	4843	4843	4843
R^2	0.687	0.692	0.693	0.698	0.309	0.309

Notes. *t* values are presented in brackets. The bonus variables are the predicted values of bonuses using regressions of bonuses on all exogenous variables.

** Statistical significance at the 5% level.

*** Idem, 1% level.

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