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BOARD INDEPENDENCE, FAMILY CONTROL, AND PERFORMANCE IN TAIWANESE LISTED SEMICONDUCTOR COMPANIES

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Abstract

We examine the relationship between board independence, family control, and operating efficiency, and the moderating effect of family control on the relationship between board independence and operating efficiency. We apply the dynamic slacks-based measure (DSBM) model to estimate operating efficiency. Using a sample of 42 Taiwanese listed semiconductor companies for the period 2005-2012, we employ truncated regression with a bootstrapping procedure for multivariate analysis. The presence of board independence is significantly positively related to operating efficiency. Family control has a negative impact on operating efficiency. The positive effect of board independence on operating efficiency is significantly weakened in family companies.

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JEL Classification Codes: G3, G32, L22

I. *Introduction*

Board independence has come under scrutiny following several high-profile corporate scandals. A gradual and marked shift in the focus of board independence has taken place in developed countries. Kang et al. (2007) claim that the topic has been restricted to U.S. data, and the findings may not be generalized and extended across all countries due to various reasons such as different regulatory and economic environment. This implies that we should individually examine the importance of board independence in each country.

Since 2011, Taiwan's securities regulator has mandated listed companies and financial institutions to appoint independent directors. However, the system of independent directors is only a partial mandate and thus still controversial in Taiwan because only 354 of 795 companies listed on Taiwan Stock Exchange (TWSE) hire independent directors to serve on the board as of December 31, 2011. Left unattended to, this issue may cause a severe problem especially in a family-controlled high-tech (complex)[1] company because family control entrenchment effect may weaken board independence (Anderson and Reeb 2003; Bozec and Laurin 2008; Yang 2010).

Taiwan is a civil law country characterized by many listed family companies with poor investor protection (Tsai et al. 2006; Executive Yuan 2003). Specifically, family leaders dominate the corporate governance (CG) environment in Taiwan (Liu et al. 2011). Principal-principal conflicts may exist because board dominance and nepotism of hiring family members in family companies are common (La Porta et al. 1999; Claessens et al. 2000), indicating that poor governance ensues (Yeh and Woidtke 2005). Directors who are independent from the companies could thus act as the key monitor to ensure the sustainability of family companies and to protect the interests of minority shareholders from potential expropriation by families.

In addition, Taiwan is one of the world's leading manufacturers of semiconductors (Yang et al. 2007; Chang and Chen 2008), with leading foundries like Taiwan Semiconductor Manufacturing Company (TSMC) and United Microelectronics Corporation (UMC) being top-ranking global players. It is worth mentioning the case that the former chairman and vice chairman of UMC, the world's second biggest contract chipmaker, failed to gain approval from the board before making investments in Chinese start-up chipmaker HeJian Technology (Chang and Wang 2011). Moreover, the economic slowdown in 2011 and the rise of China and other lower-cost production centers have posed great challenges to Taiwan's semiconductor industry and have eroded away Taiwan's competitiveness.

An in-depth study focusing on the relationship between CG and performance in the Taiwanese semiconductor industry is appealing to interested parties globally as its stakeholders include the upstream resource providers and the downstream consumers. For example, TSMC's

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[1] The term complex refers not only to high technology, but also the family businesses that tend to be complex Brenes, E.R., Madrigal, K. and Requena, B. (2011), "Corporate governance and family business performance," *Journal of Business Research* 64, pp. 280-85.

primary customers are from the U.S., Asia, and Europe, stated in descending order. Note that the primary economic resource of Taiwan is its exports, in which semiconductors, electronic parts, and printed circuit boards (PCBs) make up most of the exported electronic products (Wang et al. 2008). With a diverse global customer base in the highly cyclical semiconductor industry, board independence and type of ownership, which are important mechanisms of CG, could enable Taiwanese semiconductor companies remain technological leaders in the semiconductor industry. Taken as a whole, Taiwan's semiconductor industry provides an ideal setting for this study.

Since the semiconductor industry is highly cyclical, the profits and margins of semiconductor companies may fluctuate significantly. If a semiconductor company is unable to respond to dynamic semiconductor market in a well-timed manner, it may lose its competitive advantages. Performance evaluation is thus the key to maintaining a competitive edge and survival (Lu and Hung 2010; Chen and Chien 2011). To measure corporate performance, we can use financial ratios. However, financial ratios are uni-dimensional and subject to problematic interpretation (Feroz et al. 2003). In contrast, data envelopment analysis (DEA) offers advantages in evaluating corporate performance because it accommodates simultaneously various attributes to evaluate multiple activities in an aggregated basis (Yeh 1996; Homburg 2001; Cooper et al. 2006). In this study, we apply the dynamic DEA model called dynamic slacks-based measure (DSBM) model (Tone and Tsutsui 2010) to gauge the operating efficiency of our sample firms. The DSBM model is able to deal with interconnecting activities over a long-term period and it provides greater accuracy in the measurement of time-specific operating efficiency.

To the best of our awareness, there is a noticeable absence of studies dealing with board independence, family control, and operating efficiency in the Taiwanese high-tech (complex) semiconductor industry. To fill this gap, this study aims to investigate the relationship between board independence, family control, and operating efficiency. We also examine the existence of family control in moderating the effect of board independence on operating efficiency among Taiwanese listed semiconductor companies using truncated regression with a bootstrapping procedure (Simar and Wilson 2007). In estimating operating efficiency, we use sales and market value separately as output measures. That is, we calculate two different efficiency measures. It is expected that efficient utilization of such inputs as staff expenses and cost of goods sold would result in greater sales or market value. However, the existence of family control might results in poor governance (Yeh and Woidtke 2005), and family owners might extract private benefits from the outcomes of better operating efficiency. In other words, board independence might be impaired in a family-controlled company.

This study makes three contributions. First, using the DSBM model, this study reveals the difference in the management of resources between family and non-family companies. Although DEA has been applied to measure performance, to the best of our knowledge, we are the first to employ the DSBM model to evaluate the operating efficiency in the semiconductor industry by using a dynamic process. Second, this study may help investors assess whether board independence actually improves company values in Taiwan. This study may provide the regulators with some insights for drafting CG best-practice principles, particularly with regards to board independence. Third, this study enriches extant CG literature focusing on board independence in family-controlled companies through Simar and Wilson's (2011) truncated regression with a bootstrapping approach.

The remaining sections of this study are organized as follows. The next section reviews prior literature and develops the main hypotheses. Section 3 describes research methodology. In section 4, we present and discuss the findings. Finally, conclusions are drawn together with limitations and suggestions for further research.

II. *Literature Review and Hypotheses Development*

In the principal-agent context (Fama 1980) where separation of ownership and control exists, board of directors who have delegated responsibility from the shareholders play vital monitoring roles in minimizing agency problems and thus costs (Fama and Jensen 1983). Brenes, Madrigal, and Requena (2011), in line with Fama and Jensen (1983), also emphasize that the board of directors serve as the major mechanism in CG as they are the ultimate controllers who influence top management functions. It is thus inevitable that the central concern with regards to the accountability of the board of directors is attached to the board independence, which can be observed from the number of independent directors and the separation of the Chairman and Chief Executive Officer (CEO) positions.

As an internal control mechanism, board independence is enhanced by the inclusion of independent directors (Fama 1980), who act as arbiters in disagreements among internal managers and handle serious agency problems (Fama and Jensen 1983). According to Harford et al. (2008), managerial entrenchment problems could be mitigated by having independent directors through their contribution in the forms of expertise and objectivity. That is, the empirical evidence suggests that the higher the percentage of independent directors, the better the corporate performance. For instance, Ezzamel and Watson (1993) illustrate that the proportion of non-executive directors has a positive impact on firm profitability. Similarly, Lefort and Urzúa (2008) indicate that the percentage of independent directors is positively and significantly correlated with Tobin's Q. The positive relationship between board independence and corporate performance, particularly in high-performing companies, is exemplified in the study of Ramdani and Witteloostuijn (2010).

This study echoes the agency perspective which underscores that independent directors could help minimize agency costs. Moreover, as the appointment of independent directors were made mandatory for Taiwanese listed companies since 2011, as the authority predicts the significance of having more independent directors to serve on the board. The first hypothesis of this study is thus stated in alternate form as follows:

Hypothesis 1: There is a positive relationship between the proportion of independent directors and corporate performance, *ceteris paribus.*

CEO duality is another noteworthy determinant of board independence. CEO duality refers to a leadership structure that a CEO concurrently serves as the Chairman of the board. Jensen (2010) discloses that CEO duality allows the CEO to have too much power and control in which this concentration of power compromises the board's governance and finally lead to agency problems. Rechner and Dalton (1991) argue that companies with separate CEO and Chairman outperform companies having CEO duality as leadership structure since dominant CEO may compromise board independence (Bliss 2011). In other words, agency theorists argue that the separation of Chairman and CEO positions would prevent a CEO from dominating the board. As agency theorists argue, if the Chairman and CEO positions are separated, the potential for CEO dominance and entrenchment is reduced and board independence is thus heightened (Rhoades et al. 2001) given that the CEO has less power to influence the board decision making. This study takes a similar view as that of agency theory and hypothesizes that:

Hypothesis 2: There is a positive relationship between the separation of Chairman and CEO positions and corporate performance, *ceteris paribus*.

As noted earlier, Taiwanese listed companies are predominantly family-controlled companies as shown in the high ownership concentration (Claessens et al. 2000), whereby Claessens, Simeon, Fan, and Lang (2002) conclude that the family is the largest blockholder in approximately 70 per cent of their 908 sample firms. La Porta, Lopez-De-Silanes, and Shleifer (1999) find that participation by family members in the management of a family-controlled company occurs at least 69 per cent of the time. More specifically, Claessens et al. (2000) also note that nearly 80 per cent of Taiwanese listed companies hire family members to serve in the management.

Family management is active rather than passive, since family owners generally have a longer investment horizon to uphold their reputation and to cede the companies to their next generations (Schulze et al. 2003). They are thus motivated to increase the long-term firm value (Anderson and Reeb 2003). However, over-active or mere participation in management from family members may restrict the talented labor pool, which will eventually cause competitive disadvantages (Anderson and Reeb 2003). This signifies that the excessive nepotism of electing family members to the boards is common for the reason that families control a substantial amount of voting rights, and this makes the transfer of wealth easier (Tsai et al. 2006). As such, family companies may be less efficient than non-family companies. Both Barth et al. (2005) and Chiang and Lin (2007) establish similar findings that family companies are less productive than non-family companies.

Consistent with the preceding negative aspect of family control view, Yeh and Woidtke (2005) discover that board dominance by family members results in poor governance. The preference of family companies to hire family members instead of outside professional managers may result in the loss of expertise. Moreover, family managers and directors who face no or less pressure of replacement (Schulze et al. 2001; Villalonga and Amit 2006) might not always be profit-oriented in view of the fact that they are at an advantage in benefiting themselves at the expense of minority or other shareholders (Chu 2009). Since family relations may cause more serious agency conflicts (Schulze et al. 2001), this study therefore further outlines the following hypothesis:

Hypothesis 3: There is a negative relationship between family control and corporate performance, *ceteris paribus*.

Therefore, board independence might be impaired if a majority of the board members is comprised of family-elected directors seeing the possibility of favorable bias of family CEOs towards electing family-member directors, in line with the principal-principal agency problems (Anderson and Reeb 2004). The statement is consistent with the principal-principal agency problems, which establishes that conflict of interest exists between controlling shareholders and minority shareholders wherein family owners have incentives to limit monitoring by independent directors they hire[2] (Anderson and Reeb 2004). Besides, this type of agency problem states that boards are typically ineffective, and monitoring is achieved mainly through family consensus as outlined in Young, Peng, Ahlstrom, Bruton, and Jiang (2008). This suboptimal choice could reduce the effectiveness of monitoring by independent directors (Schulze et al. 2003). Similarly, by holding both the CEO and Chairman positions, family members have dominant control over the board (La Porta et al. 1999). With that, the following two hypotheses are developed for testing the expectation:

Hypothesis 4: The positive effect of the proportion of independent directors on corporate performance is weaker for family-controlled semiconductor companies, *ceteris paribus.*

Hypothesis 5: The positive effect of the separation of Chairman and CEO positions on corporate performance is weaker for family-controlled semiconductor companies, *ceteris paribus.*

III. *Research Design*

1. Dynamic Production Process for a Semiconductor Company

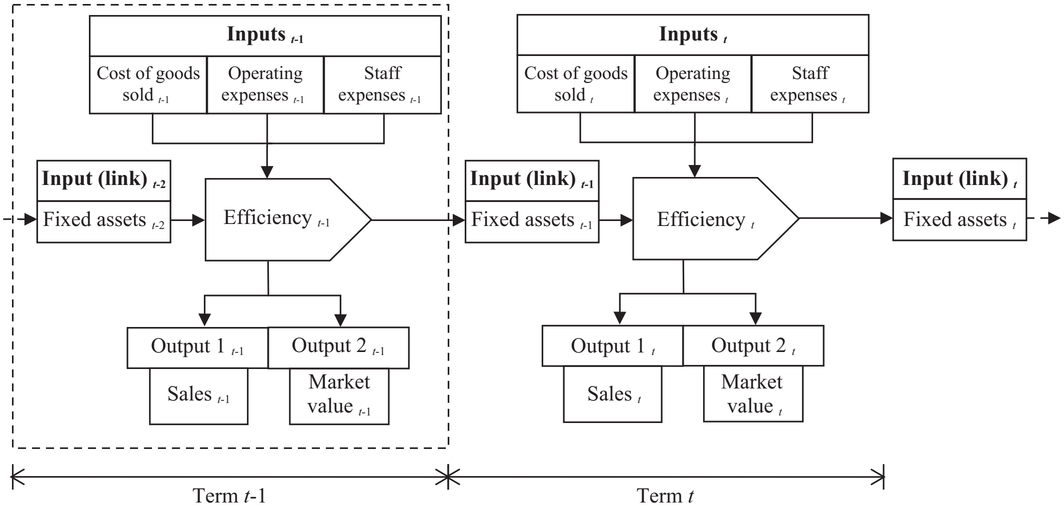
The business environment is dynamic and it is getting more challenging. Therefore, the changes of the corporate performance over a long-term period must be emphasized. According to the going-concern concept in accounting, a business will operate continuously over long-term periods. A company operating on a continuum basis would have periodic inputs and outputs and interconnecting carry-over items. In accounting terms, we call this type of item permanent account (Reeve et al. 2011). For example, liabilities at term t are interconnected with liabilities at term $t+1$. See Figure 1 for the dynamic production process of a semiconductor company. In this study, fixed assets represent the carry-over (link) items and are carried forward from one period to another (from $t-1$ to t and from t to $t+1$).

2. Data

The sample consists of 42 semiconductor companies that are listed on Taiwan Stock Exchange for the period from 2005 to 2012. Focusing merely on semiconductor companies meets the requirement of the DEA that necessitates homogenous sample companies as well as controls for the different nature of corporate governance across the industry sectors. We obtain necessary financial data and data on corporate governance from the Taiwan Economic Journal (TEJ) databank. TEJ is a leading database recognized as providing the most authoritative and

[2] As discussed, families generally control substantial amount of equity that gives them control or voting rights Claessens, S., Djankov, S. and Lang, L.H.P. (2000), "The separation of ownership and control in East Asian corporations," *Journal of Financial Economics* 58, pp. 81-112.
, Yeh, Y. and Woidtke, T. (2005), "Commitment or entrenchment?: Controlling shareholders and board composition," *Journal of Banking & Finance* 29, pp. 1857-85.. They thus have the ability to appoint outside directors that they favor, suggesting that board independence with independent directors will be lower in family companies than that of non-family companies Chen, E.T. and Nowland, J. (2010), "Optimal board monitoring in family-owned companies: Evidence from Asia," *Corporate Governance: An International Review* 18, pp. 3-17..

FIGURE 1. THE DYNAMIC PRODUCTION PROCESS



reliable source of data in Taiwan; it is subscribed by many international research agents like Datastream and Reuters (Chu 2009). The input, output, and carry-over variables used in this study are summarized in Table 1.

TABLE 1. DEFINITIONS OF VARIABLES USED IN DYNAMIC DEA

Variables		Definitions
Input Variables:		
Cost of goods sold (I_1)	=	The direct costs attributable to the production of the goods sold by a company.
Operating expenses (I_2)	=	The sum of administrative expenses, advertising expenses, and research and development expenses.
Staff expenses (I_3)	=	The sum of staff salaries and other employee benefits such as bonuses.
Output Variables:		
Sales (O_1)	=	The amount of sales generated after the deduction of returns and any discounts allowed.
Market value (O_2)	=	The year-end closing quoted share price multiplies by the total number of shares outstanding.
Carry-Over Variable:		
Fixed assets (L_1)	=	Non-current tangible assets that are carried over from year to year.

Table 2 summarizes the Pearson and Spearman rank correlation coefficients of the input and output variables used. Both types of correlations findings show that there are significantly positive relations between the input and output variables. This means that when the inputs are increased, the outputs are also increased. The data thus fulfill the assumption for DEA on the characteristic of 'isotonicity' relations and are thus suitable for further analysis (Golany and Roll 1989).

Overall, we employ two different output measures, dealing with accounting and market measures in two DEA models, respectively. Sales (accounting measure) is used as the output

TABLE 2. CORRELATION COEFFICIENTS OF VARIABLES USED IN EFFICIENCY ANALYSIS

Variable	Cost of goods sold	Operating expenses	Staff expenses	Fixed assets	Sales	Market value
Cost of goods sold		0.921*	0.926*	0.961*	0.980*	0.908*
Operating expenses	0.753*		0.944*	0.893*	0.938*	0.909*
Staff expenses	0.848*	0.841*		0.897*	0.934*	0.869*
Fixed assets	0.745*	0.533*	0.817*		0.949*	0.897*
Sales	0.987*	0.806*	0.871*	0.720*		−
Market value	0.786*	0.840*	0.813*	0.593*	−	

Note: The Pearson (Spearman) correlations are shown above (below) the diagonal. * denotes significance at < .01 levels.

for the first efficiency measure (OE1), while market value (market measure) is included as the output for the second efficiency measure (OE2). The untabulated Wilcoxon signed rank test to investigate whether the observed differences between the two different efficiency measures is significant. This outcome indicates that the mechanism that lies behind the relationship between CG mechanisms and corporate productivity may differ from the mechanism that controls the relationship between CG mechanisms and corporate market value. For example, the simple fact that a company appointed an independent director may send a positive signal to investors, which causes increases in stock price and market value of the firm without any productivity growth.[3]

3. Performance Measure – The Dynamic Slack-based Measure Model

Even though such available methods as window analysis (Klopp 1985) and Malmquist productivity indices (Färe et al. 1994) have the undeniable merit of offering valuable insights to measure performance changes over time, Tone and Tsutsui (2010) indicate that the two models have some limitations: (i) carry-over activities between two consecutive periods are neglected; and (ii) independent separate time periods are emphasized with which only local optimization in a single period is achieved.

Therefore, this study applies the DSBM model proposed by Tone and Tsutsui (2010). The predominant reason is that the DSBM model incorporates carry-over activities and enables more accurate measurement of time-specific dynamic efficiency over a long-term period (Tone and Tsutsui 2010). Another marked feature of the DSBM model is that it permits inputs, outputs, and links (the carry-overs) to be individually dealt with.

We devote some space to the input-oriented DSBM formulation. Suppose k decision-making units (DMUs) (j = DMU$_1$, DMU$_2$, ..., and DMU$_k$) over T terms (t = 1, 2, ..., T) are observed in the dynamic production process, each of which utilizes common d inputs (i = 1, 2, ..., d) and e carry-over items (c = 1, 2, ..., e) to produce f outputs (g = 1, 2, ..., f) at each term. Let x_{ijt} denotes the amount of inputs used by DMU j at term t; let z^{σ}_{cjt} be the amount of carry-over[4] items of DMU j at term t; and let y_{gjt} denotes the amount of outputs produced by

[3] We thank an anonymous reviewer for suggesting us to use sales and market value separately as output measures, as it fits well with our framework.

[4] This study treatsa carry-over item as an input and its value is restricted to be not greater than the observed one. The symbol σ is used to denote the carry-over.

DMU j at term t. To evaluate the levels of the observed DMUs' operating efficiency, the input-oriented DSBM model under variable returns to scale in the following fractional program has to be solved:

$$IOE_o^* = \min \frac{1}{T}\sum_{t=1}^{T} [1 - \frac{1}{d+e}(\sum_{i=1}^{d} \frac{s_{it}^-}{x_{iot}} + \sum_{c=1}^{e} \frac{s_{ct}^\sigma}{z_{cot}^\sigma})] \quad (1)$$

Subject to:

$$x_{iot} = \sum_{j=1}^{k} x_{ijt}\,\lambda_{jt} + s_{it}^-, \ (i=1,2,...,d\ ;\ t=1,\ 2,\ ...,\ T)$$
$$z_{cot}^\sigma = \sum_{j=1}^{k} z_{cjt}^\sigma\,\lambda_{jt} + s_{ct}^\sigma, \ (c=1,2,...,e\ ;\ t=1,\ 2,\ ...,\ T)$$
$$y_{got} = \sum_{j=1}^{k} y_{gjt}\,\lambda_{jt} - s_{gt}^+, \ (g=1,2,...,f\ ;\ t=1,\ 2,\ ...,\ T)$$
$$\sum_{j=1}^{k} z_{cjt}^\sigma\,\lambda_j^t = \sum_{j=1}^{k} z_{cjt}^\sigma\,\lambda_j^{t+1}, \ (\forall c\ ;\ t=1,\ 2,\ ...,\ T-1)$$
$$\sum_{j=1}^{k} \lambda_j^t = 1, \ (t=1,\ 2,\ ...,\ T)$$
$$\lambda_{jt} \geq 0,\ s_{it}^- \geq 0,\ s_{gt}^+ \geq 0,\ s_{ct}^\sigma \geq 0$$

where, s_{it}^-, s_{gt}^+, and s_{ct}^σ are slack variables denoting input excess, output shortfall, and carry-over excess, respectively. This objective function is based on the input-oriented SBM model. The main targets of evaluation of the objective function are excesses in both input resources and carry-over values. Since carry-over items have similar feature as inputs (to be exact, a smaller amount is preferred to more), both are accounted in the objective function in the similar way. Carry-over items are those that have the role of connection of two consecutive terms. From model (1), it can be inferred that the efficiency of the term t is measured by the relative slacks of inputs and carry-over items. Model (1) is thus the weighted average of term efficiencies over the whole terms. Note that this study defines the input-oriented overall efficiency (IOE_o^*) as a ratio ranging between 0 and 1 and it is equal to 1 when all slacks are zero. Moreover, it is units-invariant.

Since the IOE_o^* of model (1) is a weighted average of term efficiencies over the whole terms, model (2), the model for measuring term efficiency is strikingly notable for comprehension. If the optimal solution for model (2) satisfies $IOE_{ot}^* = 1$, DMU$_o$ is considered input-oriented term efficient because the optimal slacks for the term t in model (2), are all zero [more specifically, $s_{iot}^{-*} = 0(\forall i,\ t)$ and $s_{cot}^{\sigma *} = 0(\forall i,\ t)$].

$$IOE_{ot}^* = [1 - \frac{1}{d+e}(\sum_{i=1}^{d} \frac{s_{iot}^{-*}}{x_{iot}} + \sum_{c=1}^{e} \frac{s_{cot}^{\sigma *}}{z_{cot}^\sigma})],\ (t=1,\ 2,\ ...,\ T) \quad (2)$$

As for overall efficiency during the period (IOE_o^*), it can be described by replacing model (2) into model (1), which gives the following:

$$IOE_o^* = \min \frac{1}{T}\sum_{t=1}^{T} IOE_{ot}^* \quad (3)$$

If $IOE^*_o = 1$, DMU_o is considered input-oriented overall efficient. Also interesting is that DMU_o is called input-oriented overall efficient, if and only if its $IOE^*_{ot} = 1$ for all terms.

4. Truncated Regression Model

Efficiency scores range from zero to one. Simar and Wilson (2007) point out that direct regression analysis is invalid due to the unknown serial correlation among the efficiency scores, which means applying OLS in the second-stage estimation is consistent only under very peculiar and unusual assumptions about the data-generating process that limit its applicability. Simar and Wilson (2007) and Simar and Wilson (2011) argue that truncated regression, combined with bootstrapping as a re-sampling technique, best overcomes the unknown serial correlation complicating the two-stage analysis. As the truncated regression technique is able to offset the bias involved in estimating such parameters, this study adopts truncated regression with a bootstrapping approach proposed by Simar and Wilson (2007) to examine the impact of exogenous factors on operating efficiency. This study assumes and tests the following specification:

$$OE_m = \alpha + X_m\beta + \varepsilon_m,\ \mathrm{m} = 1, \ldots, n \tag{4}$$

where α is the intercept, ε_m is the error term, and X_m represents a vector of observation-specific variables for firm m that is expected to have an impact on the firm's efficiency score, OE_m. Instead of using a common practice, Tobit estimation, Simar and Wilson (2007) propose an approach based on a truncated regression with a bootstrapping procedure for estimating Equation (4). The performance of their Monte Carlo experiments is satisfactory.

More specifically, the distribution of ε_m is restricted by the condition $\varepsilon_m \geq 1 - \alpha - X_m\beta$ in Eq. (4). By following Simar and Wilson (2007), this study modifies Equation (4). The true but unobserved efficiency score, OE_m, in Equation (4) is replaced by its estimate $\widehat{OE}_m$ and the distribution is assumed to be truncated normal with zero mean (before truncation), unknown variance, and truncation point that are determined by different conditions. Accordingly, this study estimates the following:

$$\widehat{OE}_m \approx \alpha + X_m\beta + \varepsilon_m,\ \mathrm{m} = 1, \ldots, n \tag{5}$$

where $\varepsilon_m \sim N\,(0, \sigma^2_\varepsilon)$ such that $\varepsilon_m \geq 1 - \alpha - X_m\beta$, $m = 1, \ldots, n$. To gain more precise confidence intervals, this study uses the parametric bootstrap for the regression process to derive the confidence intervals for the estimates of parameters $(\beta, \sigma^2_\varepsilon)$.

In the multivariate analysis, the following truncated regression model containing the two board independence variables, family control dummy, and control variables is estimated:

$$\mathrm{OE}_{mt+1} = \beta_0 + \beta_1 \mathrm{INDTOT}_{mt} + \beta_2 \mathrm{SCC}_{mt} + \beta_3 \mathrm{FAM}_{mt} + \beta_4 \mathrm{CV}_{mt} + \varepsilon_{mt} \tag{6}$$

As it takes time until the opinion of an independent director or Chairman bears fruits as increased efficiency, we use a time lag between the dependent (corporate performance) and independent variables to cope with the potential causality problem. Meanwhile, interaction terms between the two board independence variables and family control dummy are added into Equation (6) next in order to assess the moderating effect of family control on the relationship between board independence and operating efficiency.

$$\mathrm{OE}_{mt+1} = \beta_0 + \beta_1 \mathrm{INDTOT}_{mt} + \beta_2 \mathrm{SCC}_{mt} + \beta_3 \mathrm{FAM}_{mt} + \beta_4 (\mathrm{INDTOT}_{mt} \times \mathrm{FAM}_{mt}) + \beta_5 (\mathrm{SCC}_{mt} \times \mathrm{FAM}_{mt}) + \beta_6 \mathrm{CV}_{mt} + \varepsilon_{mt} \quad (7)$$

where the variables are explained in the following subsections. Table 3 provides an overview of the definitions of the variables.

TABLE 3. VARIABLES AND THE DEFINITIONS

Variables		Definitions
Dependent Variable:		
Operating Efficiency (OE)	=	The efficiency scores derived using the input-oriented DSBM model under variable returns to scale. i) OE1 = efficiency scores derived using sales as the output. ii) OE2 = efficiency scores derived using market value as the output.
Board Independence Variables:		
Independent Director (INDTOT)	=	The ratio of independent directors to total directors.
CEO Non-Duality (SCC)	=	A dummy variable coded 1 if the Chairman and CEO positions are separated and those two positions must not be occupied by two persons of the same controlling family, and equal to 0 otherwise.
Moderating Variable:		
Family Control (FAM)	=	A dummy variable coded 1 if a company is a family-controlled business and equal to 0 otherwise.
CG Control Variables (CV):		
Board Size (BSIZE)	=	The natural logarithm of the number of directors on the board.
Board Shareholding (BSH)	=	The percentage of shares held by board of directors.
Entrenchment Effect (VC)	=	The difference between voting rights and cash flow rights.
Major Shareholder's Shareholding (MSSH)	=	The percentage of shares held by other major shareholders.
Non-CG Control Variables (CV):		
Firm Size (FSIZE)	=	The natural logarithm of total assets.
Firm Age (FAGE)	=	The natural logarithm of the number of years a company has since gone listed.
Firm Leverage (LEV)	=	The ratio of total liabilities to total assets.
Market to Book (MTB)	=	The ratio of market capitalization to book value of total assets.
Reform (RFM)	=	A dummy variable coded 1 if the sample period is 2011-2012 and equal to 0 otherwise.

(1) Measure of Board Independence

The first variable, INDTOT, is measured as the proportion of independent directors on the board. Consistent with Jaggi et al. (2009) and Ferreira et al. (2011), the definition of an independent director is that: (i) the director does not hold any executive position at the company, (ii) the director does not have any second-degree consanguine relationship with the directors and supervisors[5] of the company, and (iii) the director's shareholding cannot exceed 1%. Grey directors are thus not included in the INDTOT.

SCC that signifies the independence of Chairman of the board if the Chairman and CEO positions are separated is another proxy for the board independence. Since the board

[5] Supervisors are not counted as directors in Taiwan Chen, E.T. and Nowland, J. (2010), "Optimal board monitoring in family-owned companies: Evidence from Asia," *Corporate Governance: An International Review* 18, pp. 3-17..

independence could still be impaired if the positions of Chairman and CEO are held by different persons of the same controlling family (Lam and Lee 2008), this study measures SCC to a stricter extend as a dummy variable equal to one if the Chairman and CEO positions are separated and those two positions must not be occupied by two persons of the same controlling family.

(2) Identification of Family Companies

The measure of family companies in this study is completed by following the classification of the TEJ databank, whereby family companies are identified following La Porta et al. (1999). TEJ defines family companies as those with controlling shareholding by family members and with the involvement of family members in the board and top management. Regarding the former, if the sum of direct and indirect ownership by the largest family shareholder of a company exceeds the company's critical control level, the company is classified as a family company. Meanwhile, the latter concerns the percentage of board controlling seats. Of the 44 semiconductor companies, 19 are classified as family companies while the rest are classed as non-family companies.

(3) Control Variables

Four control variables that relate to other CG factors are included in the model as statistical controls because prior research has suggested that these variables affect operating efficiency. Besides, since operating efficiency is firm-specific, the remaining five non-CG control variables used to control firm-specific effects include FSIZE, FAGE, LEV, MTB, and RFM. It is worth noting that we include an indicator variable of the reform in 2011 (RFM) to control for the time period specific factors because the sample comprises semiconductor companies for the period 2005-2012 and Taiwan's securities regulator has mandated the appointment of independent directors in listed companies and financial institutions since 2011.

We perform the diagnostics of variance inflation factors (VIF)[6] for multicollinearity analysis by including interaction terms. All of the VIF values obtained are less than 4.5.[7] An untabulated Pearson correlation coefficients strongly confirms that no multicollinearity exists between the independent variables.

IV. *Empirical Results*

1. Efficiency Analysis

Table 4 reports the mean operating efficiencies scores for family companies and non-family companies. The results show that non-family companies are more efficient than family companies across the sample period from 2005 to 2012. Using a Mann-Whitney U test, we reject the null hypothesis that there is no significance difference in the overall corporate

[6] Note that truncated regression approach does not allow for calculations of the VIF. The VIF is obtained through an ordinary least squares regression that is more conservative.

[7] The rule of thumb for harmful multicollinearity: VIF greater than 10 Kennedy, P. (1998), *A guide to econometrics*, Cambridge, MIT Press..

performance between family companies and non-family companies at the 1% significance level. The results continue to hold when analyses are performed using data for separate years. However, we only observe significance differences in years 2005, 2006, and 2007 for OE2 and none for OE. Consistently, the corporate performance of both types of companies have increased by approximately 8 per cent from 2005 to 2012 in terms of OE1. Overall, the results show that the corporate performance of the sample companies fluctuate over the sample period. We also provide results of the efficiency scores of the 42 semiconductor companies (See Appendices 1 and 2 for OE1 and OE2, respectively).

Table 4. Average Efficiency Scores between Family Companies and Non-family Companies

	N	Efficiency scores (Output = Sales)		Efficiency scores (Output = Market Value)	
		Mean	Test of Difference (p-value)	Mean	Test of Difference (p-value)
2005-2012					
Family companies	144	0.766	0.009	0.518	0.000
Non-family companies	192	0.827		0.646	
2005					
Family companies	18	0.701	0.126	0.442	0.028
Non-family companies	24	0.784		0.634	
2006					
Family companies	18	0.720	0.232	0.398	0.004
Non-family companies	24	0.771		0.655	
2007					
Family companies	18	0.729	0.212	0.468	0.075
Non-family companies	24	0.790		0.622	
2008					
Family companies	18	0.800	0.234	0.521	0.231
Non-family companies	24	0.856		0.589	
2009					
Family companies	18	0.774	0.177	0.595	0.190
Non-family companies	24	0.841		0.681	
2010					
Family companies	18	0.836	0.256	0.634	0.274
Non-family companies	24	0.872		0.696	
2011					
Family companies	18	0.798	0.251	0.574	0.253
Non-family companies	24	0.843		0.666	
2012					
Family companies	18	0.784	0.178	0.537	0.240
Non-family companies	24	0.853		0.620	

2. Univariate Analysis

The descriptive statistics for the full sample and those for both family companies and non-family companies are reported in Table 5. The findings for difference-in-means tests are summarized as follows. An analysis of median yield similar findings; however, only results based on mean are presented for brevity purpose. Again, means of the OE1 (OE2) scores of family companies are 0.766 (0.518), which are significantly lower than those of non-family companies (OE1=0.827; OE2=0.646), in support of hypothesis 3 of this study that family companies are less efficient than non-family companies. Besides, family companies have significantly lower levels of independent directors and percentage of the separation of Chairman and CEO positions than non-family companies.

Table 5. Descriptive Statistics and Difference-in-means Tests

	All companies (N = 336)		Family companies (N = 144)		Non-family companies (N = 192)		Difference in means
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	*t*-stat
OE1	0.801	0.214	0.766	0.226	0.827	0.201	2.633***
OE2	0.591	0.315	0.518	0.311	0.646	0.308	3.745***
INDTOT	0.158	0.158	0.089	0.128	0.211	0.158	7.591***
SCC	0.684	0.338	0.614	0.417	0.669	0.374	2.282**
BSIZE	1.929	0.258	1.887	0.244	1.961	0.264	2.614***
BSH	0.141	0.092	0.149	0.085	0.135	0.096	-1.389
VC	0.079	0.110	0.081	0.132	0.079	0.091	-0.150
MSSH	0.171	0.107	0.194	0.130	0.153	0.082	-3.494***
FSIZE	16.372	1.438	16.173	1.421	16.522	1.436	2.213**
FAGE	2.194	0.605	2.317	0.501	2.102	0.659	-3.260***
LEV	0.283	0.158	0.343	0.184	0.238	0.117	-6.407***
MTB	1.462	1.117	1.147	0.756	1.698	1.277	4.614***
RFM	0.250	0.434	0.236	0.426	0.260	0.440	-

Note: ***, **, * denotes significance at <.01, <.05 and <.10 levels, respectively for two-tailed *t*-tests (non-family-family).

In summary, family companies have poorer corporate performance and lower level of board independence. However, running multivariate regression analysis would provide a more robust test to evaluate whether family control diminish the positive relationship between board independence and operating efficiency due to the weakness of the univariate test that do not control for the variables used simultaneously in an empirical model.

3. Regression Results

To further analyze i) the effects of board independence and family control on operating efficiency, ii) the moderating effect of family control on the relationship between board independence and operating efficiency, and to control for other factors that might affect operating efficiency, a multivariate analysis is performed.

The empirical evidence of regression model (6) from Table 6 depicts a significantly positive relationship between the proportion of independent directors and OE1, whereby the coefficient for INDTOT is 1.152. The result shows a positive and statistically significant coefficient on SCC, indicating a positive relationship between separation of Chairman and CEO positions and operating efficiency. In contrast, family control (FAM) has a significantly negative relationship with operating efficiency. Taken together, the findings suggest that both higher percentage of independent directors and separation of Chairman and CEO positions are associated with greater operating efficiency, but family control would result in lower corporate performance. The findings support hypothesis 1, hypothesis 2, and hypothesis 3 of this study, respectively.

Also of interest to this study are the two interaction terms. Based on the results of regression model (7), the effects of family companies on board independence is statistically proven to be significant and negative in the interaction terms on INDTOT*FAM and SCC*FAM. This noticeably illustrates the disadvantages of family members' involvement in the board and management. It can be inferred that the potential costs of family ownership outweigh its potential benefits. In short, we find significant outcome supporting hypotheses 4 and 5, consistent with Jaggi et al. (2009).

Table 6. Truncated Regression Analysis (Dependent variable = OE1)

Variable	Pred. sign	Equation (6)			Equation (7)		
		Coefficient	z-stat	p-value	Coefficient	z-stat	p-value
INTERCEPT	?	7.832***	10.674	0.000	7.364***	10.485	0.000
INDTOT	+	1.152***	2.845	0.002	1.848***	4.130	0.000
SCC	+	0.192*	1.787	0.074	0.371*	1.805	0.071
FAM	−	−0.491***	−3.443	0.000	−0.935***	−5.524	0.000
INDTOT*FAM	−				−4.315***	−5.422	0.000
SCC*FAM	−				−1.591**	−2.196	0.014
BSIZE	?	0.396*	1.611	0.054	0.351*	1.502	0.067
BSH	?	1.937***	2.561	0.005	2.879***	4.012	0.000
VC	?	0.018***	2.788	0.003	0.018***	2.956	0.002
MSSH	−	3.892***	7.082	0.000	4.683***	8.960	0.000
FSIZE	−	−0.282***	−6.359	0.000	−0.271***	−6.160	0.000
FAGE	?	0.158***	1.448	0.074	0.297***	2.849	0.002
LEV	+	−3.242***	−7.916	0.000	−3.638***	−9.336	0.000
MTB	+	0.493***	8.682	0.000	0.487***	9.020	0.000
RFM	+	0.318**	2.273	0.012	0.418***	3.119	0.001
Adjusted R^2		0.261			0.284		
Variance		0.034			0.033		
Total observations		336			336		

Note: ***, **, * denotes significance at <.01, <.05 and <.10 levels, respectively.

Finally, the results are qualitatively unchanged if we employ OE2 as the dependent variable. In Table 7, all of our main results persist, with the exception of the interaction term on SCC*FAM that is insignificant and positive. This insignificant result related to hypothesis 5 is in line with Lam and Lee (2008).

(1) Potential Causality Issue

The above regression results are obtained by assuming that our testing variable, board independence, is exogenous. Specifically, while board independence positively affects operating

TABLE 7. TRUNCATED REGRESSION ANALYSIS (Dependent variable = OE2)

Variable	Pred. sign	Equation (6)			Equation (7)		
		Coefficient	z-stat	p-value	Coefficient	z-stat	p-value
INTERCEPT	?	2.540***	4.426	0.000	3.947***	5.264	0.000
INDTOT	+	0.493**	2.211	0.027	1.696***	3.569	0.000
SCC	+	0.476*	1.711	0.087	0.670*	1.691	0.091
FAM	−	−0.405***	−3.636	0.000	−0.751***	−4.027	0.000
INDTOT*FAM	−				−0.893*	−1.799	0.072
SCC*FAM	−				0.123	1.071	0.284
BSIZE	?	0.927***	4.847	0.000	0.715***	2.849	0.002
BSH	?	7.690***	13.432	0.000	9.195***	12.423	0.000
VC	?	−0.039***	−7.916	0.000	−0.036***	−5.507	0.000
MSSH	−	4.245***	10.035	0.000	5.532***	10.017	0.000
FSIZE	−	−0.312***	−9.188	0.000	−0.409***	−8.971	0.000
FAGE	?	0.267***	3.197	0.001	0.510***	4.699	0.000
LEV	+	−1.351***	−4.130	0.000	−2.195***	−5.048	0.000
MTB	+	0.790***	18.420	0.000	0.790***	14.401	0.000
RFM	+	0.416***	3.882	0.000	0.188*	1.339	0.090
Adjusted R^2		0.447			0.449		
Variance		0.055			0.055		
Total observations		336			336		

Note: ***, **, * denotes significance at <.01, <.05 and <.10 levels, respectively.

efficiency, we may also argue that top managers of high-performing firms can afford to appoint independent directors. Therefore, the regression models might be misspecified if the testing variable is endogenous. To test for endogeneity problems in the models, following Filatotchev et al. (2005), we regress a potentially endogenous variable against two instrumental variables (including one- and two- period lagged values of the potentially endogenous variables) and the truly exogenous variables in the model, whereby we have artificial equations in reduced form. The two-stage least squares method (2SLS) is used. For example, the equation for examining the endogeneity of INDTOT is specified as follows:

$$\begin{aligned}\mathrm{INDTOT}_{mt+1} = {} & \beta_0+\beta_1\mathrm{OE1}_{mt}+\beta_2\mathrm{SCC}_{mt}+\beta_3\mathrm{FAM}_{mt}+\beta_4\mathrm{CV}_{mt}+\beta_5\mathrm{INDTOT}_{mt}+\\ & \beta_6\mathrm{INDTOT}_{mt-1}+\varepsilon 1_{mt}\end{aligned} \tag{8.1}$$

The residuals obtained from the first stage (Equation 8.1) are then added as an additional independent variable in the following equation:

$$\begin{aligned}\mathrm{OE1}_{mt+1} = {} & \beta_0+\beta_1\mathrm{INDTOT}_{mt}+\beta_2\mathrm{SCC}_{mt}+\beta_3\mathrm{FAM}_{mt}+\beta_4\mathrm{CV}_{mt}+\beta_5\mathrm{CV}_{mt}+\varepsilon 2_{mt}\\ & \beta_5\ \mathrm{INDTOT\_res}_{mt} + \varepsilon 2_{mt}\end{aligned} \tag{8.2}$$

Untabulated results indicate that the coefficient β_5 is statistically insignificant, suggesting that 2SLS is not justified to be applied to Equation (6). Likewise, the Durbin–Wu–Hausman (DWH) tests performed in this study show that coefficients of residuals of our testing variables are not statistically significant, suggesting that all testing variables are exogenous. In other words, the regression results obtained from Equations (6) and (7) are consistent and unbiased.

4. Managerial Implication

The present empirical findings illustrate that the proportion of independent directors and operating efficiency are significantly positively related (β=1.152, p-value=0.002 for the OE1 results; β=0.493, p-value=0.027 for the OE2 results). This finding demonstrates that the measure taken by Taiwan's Financial Supervisory Commission (FSC) may be seen as guiding the Taiwanese CG system towards the right direction. Another proxy used for measuring board independence shows the similar result. The separation of Chairman and CEO positions (SCC) also significantly affects operating efficiency (β=0.192, p-value=0.074 for the OE1 results; β=0.476, p-value=0.087 for the OE2 results). Taken as a whole, it would be advisable that the number of independent directors be increased and the board leadership of Chairman and CEO positions be separated.

Although prior research provides ambiguous results regarding the effect of family control on corporate performance (O'Boyle et al. 2011), the significantly negative result of family control (FAM) (β=−0.491, p-value=0.000 for the OE1 results; β=−0.405, p-value=0.000 for the OE2 results) of this study supports the notion that family companies may result in lower corporate performance. The difference-in-means test show that family companies indeed operate at significantly lower efficiency (p-value=0.000) than non-family companies do for both efficiency measures, testifying the potential existence of nepotism in family companies. An important implication here for the managers of a family company is that they should pursue diversification when making recruitment decisions rather than restricting the pool of talents.

The outcome of the interaction term between the proportion of independent directors and family control dummy is significantly negative (p-value=0.000 for the OE1 results; p-value=0.072 for the OE2 results). This finding sheds a new light for Taiwan's authority as the incremental benefits of the proportion of independent directors are likely to be diluted in family companies. Noticeably, it illustrates the disadvantages of family members' involvement in the board and management.

Regardless of the more stringent criterion set for determining the separation of the CEO and Chairman positions, the OE2 results report an insignificant interaction term between the separation of Chairman and CEO positions (SCC), and family control (FAM) (β=0.123, p-value=0.284). The result critically indicates that Article 24[8] of the CG best-practice principles for TWSE listed companies – the separation of Chairman and CEO positions is necessary for Taiwanese listed companies since it brings about benefits to the corporate performance irrespective of ownership.

In summary, board independence results in higher operating efficiency but family ownership might cause negative impact on corporate performance. The moderating effect of family control on the positive relationship between board independence and operating efficiency is only consistently observed in one of the measures, i.e. the proportion of independent directors.

[8] Article 24 states that "clear distinctions shall be drawn between the responsibilities and duties of the chairman of the board of a TSE/GTSM listed company and those of its general manager."

V. *Conclusions*

We scrutinize how board independence affects operating efficiency. We also evaluate the moderating effect of family control on the relationship between board independence and corporate performance. The findings can be summarized as follows. (i) The higher the proportion of independent directors, the better operating efficiency; (ii) The separation of Chairman and CEO positions has a positive impact on operating efficiency; (iii) Family companies have lower operating efficiency as it negatively affects operating efficiency; and (iv) The positive effect of proportion of independent directors on operating efficiency is lower in family companies as compared to non-family companies. While the conventional wisdom on proportion of independent directors is held valid, that of board leadership structure seems not convincing to support the agency theory in the Asian context, specifically Taiwan.

The modest contribution of this study is that it is the first to apply the DSBM model to evaluate the performance of Taiwanese semiconductor companies. Further studies in other industries and countries are open for debate. Future study can also take into account the bona fide essence of familiness (O'Boyle et al. 2011). Besides, dynamic network DEA may be applied to explore operating efficiency in greater details.

Appendices

Appendix 1 Efficiency scores of the 42 semiconductor companies (output = sales)

DMU	2005	2006	2007	2008	2009	2010	2011	2012	Overall Score
GTM Corp.	0.727	0.843	0.874	1.000	1.000	1.000	1.000	1.000	0.931
Rectron	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
United Microelec.	0.541	0.496	0.489	0.610	0.624	0.743	0.723	0.764	0.624
ASE	0.641	0.710	0.688	0.728	0.707	0.736	0.830	0.828	0.733
Siliconware Prec.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Orient Semi	0.370	0.356	0.371	0.524	0.371	0.450	0.438	0.474	0.419
TSMC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Macronix	0.386	0.509	0.697	0.755	0.861	1.000	0.649	0.461	0.665
Taiwan Mask	0.851	0.734	0.728	0.717	0.626	0.820	0.751	0.697	0.740
Mosel Vitelic	0.662	0.556	0.600	0.527	0.417	0.581	0.402	0.345	0.511
Winbond	0.368	0.404	0.303	0.312	0.301	0.709	0.418	0.397	0.402
SDI Corp.	0.513	0.517	0.534	0.574	0.483	0.646	0.555	0.554	0.547
Silicon Integrated	0.502	0.468	0.512	0.923	1.000	0.704	0.580	1.000	0.711
Lingsen Precision	0.506	0.552	0.584	0.742	0.834	1.000	0.769	0.695	0.710
Realtek	0.557	0.563	0.624	0.865	0.888	0.853	0.992	1.000	0.793
VIA Technologies	0.458	0.435	0.434	0.521	0.519	0.561	0.531	0.478	0.492
Sunplus	0.560	0.543	0.654	0.743	0.691	0.649	0.541	0.557	0.617
Nanya Technology	0.708	0.831	0.645	1.000	1.000	1.000	1.000	1.000	0.898
Mospec	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000
Weltrend	0.750	0.709	0.861	1.000	0.911	1.000	1.000	1.000	0.904
Greatek	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
King Yuan Elec	0.431	0.552	0.499	0.527	0.374	0.544	0.444	0.540	0.489
Transcend	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MediaTek	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Elan	0.533	0.510	0.589	0.700	0.730	0.740	0.824	0.854	0.685
Pan Jit	0.552	0.498	0.506	0.588	0.509	0.671	0.623	0.540	0.561
Elite Sem Memory	0.807	0.806	1.000	1.000	0.922	1.000	0.792	0.773	0.888
ITE Tech.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Precision	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Novatek	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Faraday	0.702	0.564	0.601	0.765	0.703	0.791	0.868	0.796	0.724
Ali Corp.	0.549	0.652	0.801	0.954	1.000	1.000	1.000	1.000	0.869
Carry	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kinsus	0.791	0.759	0.736	0.804	0.686	0.766	0.883	0.855	0.785
Lite-On Semi.	0.593	0.466	0.479	0.552	0.455	0.482	0.507	0.537	0.509
Sonix	0.817	0.797	0.806	0.919	0.950	0.928	0.930	0.924	0.884
Power Quotient	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Holtek	0.931	1.000	0.913	1.000	1.000	1.000	1.000	1.000	0.981
Powertech	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sigurd	0.608	0.581	0.539	0.608	0.624	0.750	0.755	0.780	0.656
Richtek	0.842	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.980
Sitronix	1.000	1.000	1.000	1.000	0.946	0.879	0.827	0.811	0.933

Appendix 2 Efficiency scores of the 42 semiconductor companies (output = market value)

DMU	2005	2006	2007	2008	2009	2010	2011	2012	Overall Score
GTM Corp.	0.538	0.664	0.741	1.000	1.000	1.000	1.000	1.000	0.868
Rectron	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
United Microelec.	0.312	0.297	0.223	0.218	0.322	0.327	0.273	0.218	0.274
ASE	0.316	0.383	0.452	0.415	0.527	0.634	0.550	0.501	0.472
Siliconware Prec.	0.454	0.436	0.532	0.454	0.477	0.459	0.396	0.404	0.452
Orient Semi	0.084	0.108	0.133	0.098	0.176	0.117	0.122	0.109	0.119
TSMC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Macronix	0.084	0.123	0.165	0.255	0.287	0.375	0.230	0.122	0.205
Taiwan Mask	0.442	0.356	0.452	0.487	0.465	0.572	0.624	0.547	0.493
Mosel Vitelic	0.454	1.000	1.000	0.697	0.598	0.547	0.297	0.280	0.609
Winbond	0.121	0.118	0.092	0.097	0.230	0.254	0.120	0.128	0.145
SDI Corp.	0.219	0.220	0.203	0.222	0.402	0.322	0.230	0.221	0.255
Silicon Integrated	0.244	0.291	0.294	0.545	0.860	0.785	1.000	1.000	0.628
Lingsen Precision	0.208	0.141	0.185	0.193	0.283	0.422	0.323	0.294	0.256
Realtek	0.266	0.370	0.354	0.243	0.295	0.285	0.225	0.209	0.281
VIA Technologies	0.168	0.262	0.212	0.367	0.414	0.877	0.686	0.498	0.436
Sunplus	0.242	0.274	0.405	0.385	0.453	0.417	0.436	0.415	0.379
Nanya Technology	0.166	0.184	0.167	0.129	0.392	0.246	0.111	0.219	0.202
Mospec	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Weltrend	0.613	0.513	0.751	1.000	0.920	1.000	1.000	1.000	0.850
Greatek	0.768	0.924	0.948	0.652	0.640	0.571	0.582	0.546	0.704
King Yuan Elec	0.379	0.273	0.183	0.166	0.213	0.211	0.177	0.274	0.235
Transcend	1.000	0.728	0.757	1.000	1.000	1.000	1.000	1.000	0.936
MediaTek	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Elan	0.195	0.197	0.523	0.600	0.725	0.633	0.599	0.559	0.504
Pan Jit	0.245	0.196	0.394	0.385	0.470	0.720	0.401	0.298	0.389
Elite Sem Memory	0.559	0.405	0.617	0.662	0.772	0.742	0.634	0.371	0.595
ITE Tech.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Precision	1.000	0.817	1.000	1.000	1.000	1.000	1.000	1.000	0.977
Novatek	1.000	1.000	0.510	0.317	0.458	0.497	0.542	0.507	0.604
Faraday	0.410	0.455	0.518	0.431	0.612	0.596	0.587	0.397	0.501
Ali Corp.	0.326	0.527	0.680	0.593	0.920	0.863	0.923	0.637	0.684
Carry	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kinsus	1.000	0.509	0.521	0.335	0.552	0.689	0.563	0.537	0.588
Lite-On Semi.	0.314	0.190	0.180	0.220	0.325	0.355	0.371	0.297	0.282
Sonix	0.593	0.657	0.547	0.542	0.714	0.705	0.792	0.776	0.666
Power Quotient	0.317	0.284	0.271	0.480	0.726	1.000	1.000	1.000	0.635
Holtek	0.638	0.779	0.570	0.653	1.000	1.000	1.000	1.000	0.830
Powertech	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sigurd	0.376	0.215	0.202	0.219	0.324	0.443	0.444	0.438	0.333
Richtek	0.740	1.000	1.000	1.000	1.000	1.000	0.582	0.475	0.850
Sitronix	1.000	0.745	0.566	0.451	0.505	0.522	0.598	0.358	0.593

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