The effects of managerial ability on firm performance and the mediating role of capital structure: evidence from Taiwan

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Abstract

This study utilizes mediation analysis and bootstrapping to analyze the mediating effect of capital structure on the association between managerial ability and firm performance. The dataset consists of 6384 firm-year observations from the Taiwanese electronics industry during 2005–2018. Our results indicate that (1) low (high) levels of debt are likely observed in firms with CEOs with high (low) ability, (2) managerial ability positively affects firm performance, and (3) capital structure mediates the positive relationship between managerial ability and firm performance. Overall, the findings may have limited generalizability due to the specific sample characteristics and provide convincing support for the importance of capital structure as a mediator in the managerial ability-firm performance nexus. Specifically, this study highlights the need for examining the effect of managerial ability on firm performance through a mediator.

Keywords: Managerial ability, Capital structure, Firm performance, Mediation analysis, StoNED, Taiwan

Introduction

In today's fast-changing business climate, only focusing on the direct effect of managerial ability on firm performance may not fully reflect a manager's ability to sustain competitive advantage. The current gap in the literature that links managerial ability to capital structure or firm performance, does so inadequately. Notably, although the literature shows that managerial ability has only unobservable effects on capital structure (Matemilola et al. 2013), there is less empirical evidence to show how it affects firm performance except for Ford and Shonkwiler (1994) and Wang et al. (2021). As a result, the association between managerial ability and firm performance may be considered spurious in the absence of a mediator. Thus, a study on the effect of managerial ability on firm performance via the role of a mediator is needed.

Additionally, literature has extensively examined the factors of corporate decision-making, including capital structure (Chen 2004; Chen et al. 2019; Huang et al. 2018; Klasa et al. 2018; Matemilola et al. 2019; Vo 2017) and firm performance (Hansen and Wernerfelt 1989; Hui et al. 2019; Huselid et al. 1997; Kafouros and Aliyev 2016; Liljeblom

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et al. 2019). A firm's capital structure evidences managers' abilities and affects profitability. According to the pecking order theory (Myers and Majluf 1984), if a company is profitable, it has retained earnings or cash for financing. Similarly, capital structure is a key factor in firm performance (Saeedi and Mahmoodi 2011). This is confirmed by agency theory (Jensen and Meckling 1976). Moreover, while managerial ability may explain a company's debt level, Hackbarth (2008) suggests an association between managerial traits and capital structure decisions. Managers might have the ability, but their impact on firm performance may be indirect and operating through other variables such as capital structure. This mediating effect has not been investigated in the literature; hence, our study fills a much-needed gap.

Specifically, this study aims to assess how capital structure mediates the effects of managerial ability on firm performance by applying the mediation technique of Preacher and Hayes (2004, 2008) and Sobel (1982) and Sobel (1987) with a bootstrapping approach for robustness checks. We hypothesize and test a partial mediation among managerial ability, capital structure, and firm performance using 456 unique electronics firms listed in the Taiwanese stock exchange (or 6384 firm-year observations) from 2005 to 2018. We selected Taiwan's electronics industry, one of the largest industries in the region, for the following reasons. Among the major global players, the Taiwan Semiconductor Manufacturing Company, whose customers include Apple, Advanced Micro Devices, and the Foxconn Technology Group, whose customers include Apple, Amazon.com, Cisco, and Sony, encompass all areas of computers and component technologies, and significantly contribute to the advancement of today's development. Moreover, electronics companies are normally R&D intensive and thus face higher debt costs than firms with low R&D investments (Chiao 2002; De Rassenfosse and Fischer 2016). The high-tech nature of businesses with short product life cycles also suggests the need for a strong knowledge base and capabilities (Deeds et al. 2000) and managerial ability (Mishra 2019). Due to the potential costs of debt in the industry, the positive effect of managerial ability on firm performance may be lower when considering capital structure as a mediator. Therefore, while managerial ability might explain firm performance, its indirect effect on firm performance may be clear.

Our study makes the following contributions: First, managerial ability explains a low level of leverage, resulting in less remarkable firm performance. These relationships suggest that firm performance may be enhanced by managerial ability but attenuated by high leverage. Based on the literature review, our study is the first to test the mediating effect of capital structure on the managerial ability-firm performance nexus. Our results demonstrate that capital structure indeed mediates. Second, this study improves the measurement of managerial ability using the residual-based concept of quantifying managerial ability. Therefore, the residuals explain managerial ability after simultaneously accounting for firms and board characteristics with a multiple input–output efficiency evaluation model. Our direct distance function (DDF) based stochastic nonparametric envelopment of data (StoNED) framework enables multiple outputs to estimate the effect of managerial ability on financial performance while including exogenous factors. Third, using a secondary panel data set and a longer sample period, we provide investors and policymakers with a better understanding of the mediating role of capital structure in the managerial ability-firm performance nexus. We depart from the commonly

assumed direct effect of managerial ability on the capital structure on firm performance. In contrast, we argue that capital structure needs to be accounted for as a mediator in examining the effect of managerial ability on firm performance.

The remainder of this paper is organized as follows. "Literature review and hypotheses development" section reviews the relevant literature. "Methodology and data" section presents the research methodology and data. "Empirical results" section discusses the findings, and "Conclusion" section concludes the paper.

Literature review and hypotheses development

Theoretical discussion

Upper echelons theory: Based on Hambrick and Mason (1984), organizational strategic outcomes and processes are a function of the managerial characteristics of top managers. Specifically, strategic choices are more due to behavioral factors than mechanical optimization (Chuang et al. 2009). The theory emphasizes that top managers' different characteristics such as ability, age, financial position, and career experiences affect their strategy and structure decisions and directly affect organizational performance (Đerđa 2017; Dubey et al. 2018; Lee et al. 2018; Rule and Tskhay 2014; Ting et al. 2015).

Pecking order theory: Firms may have different debt levels; thus, there is no well-defined optimal debt ratio. Firms follow a hierarchy of financial decisions when establishing a capital structure (Myers 1984; Myers and Majluf 1984). Accordingly, high-profit firms tend to have low debt levels. Specifically, they prioritize financing via internal resources, hence using less debt (Frank and Goyal 2003) and maximizing shareholder value. A firm will incur debt only if its internal resources are insufficient and external debt financing is required. Moreover, information asymmetries decrease, and financial access improves along the procyclical business cycle, increasing the flexibility and lower transaction costs in obtaining internal resources (Martinez et al. 2019).

Agency theory: Developed by Jensen and Meckling (1976) and Myers (1977), it elucidates the nature of conflicts between firm shareholders and debtholders. An agency contract is optimized to delineate the interests of both parties. The conflicts between parties result in higher debt levels (lower levels of equity capital), generating higher agency costs and lower firm performance. Thus, this theory supports the negative effects of debt on firm performance.

This study takes insights from all three theories to examine the mediating effect of capital structure on the managerial ability-firm performance nexus.

The literature and hypotheses development

The effect of managerial ability on firm performance

Managerial ability is significant in establishing, progressing, and achieving firm success, measured by productivity, investment decisions, compensation, and overall firm performance. Literature shows that specific manager traits, such as ability, skills, and talent, affect a firm's performance, such as finance, accounting, and managerial research and practice (Demerjian et al. 2012). Bhutta et al. (2021) found that managers with better ability take initiatives and innovative actions to utilize firm resources for long-run financial sustainability. Additionally, they found that a manager's personality traits and competencies drive optimal resource utilization. High-ability managers are receptive

to risk-taking, associated with an increased firm value (Yung and Chen 2018). Phan et al. (2020) found that more able managers better understand their firm's operating environment, allowing them to make better investment decisions and improve firm performance.

Managerial abilities focus on changing and creating operational capabilities. Such abilities depend on a firm's evolutionary paths and processes and are learning-based (Corrêa et al. 2019). Additionally, high-ability managers can accumulate reputational capital (Palvia et al. 2015), inspire stakeholder trust (Fernando et al. 2020) and provide positive signals on firm quality to investors (Andreou et al. 2017). This positively affects firm performance and reduces information asymmetry (Ambrosini and Altintas 2019; Curi and Lozano-Vivas 2020). High-ability managers focus on innovating and increasing productivity, whereas low-ability managers make ineffective decisions. High managerial ability prompts scanning a firm's environment to identify threats, opportunities, and competitive advantages (Bellner 2014). According to Andreou et al. (2013), CEOs with high ability facilitate increased investment, making their firms less vulnerable to financial constraints during a crisis. Ng et al. (2015) associate managerial ability with effective monitoring structures that improve the quality of earnings and firm value. Mishra (2019) confirmed that the greater the strategic ability of management, the more opportunity-focused they are, improving firm innovativeness (Chen et al. 2015).

High managerial abilities facilitate raising funds to increase firm value (Andreou et al. 2013). Nevertheless, a firm with good management abilities raises funds, as they consistently generate cash flow from their operations. Thus, good management abilities reflect high firm value and consistency in operations. Setiawan (2015) found that firms with managerial abilities make sound decisions that result in efficient company performance, reflected in financial reports. Therefore, managerial abilities contribute to effective and efficient firm performance. Thus, we propose the following hypothesis:

H_1: Managerial ability is associated significantly and positively with better firm performance.

The effect of managerial ability on capital structure

Managerial ability may impact capital structure, affecting a firm's market value. Petkevich and Prevost (2018) found that high-ability managers have a significant presence in corporate financing policies. Bhagat et al. (2011) constructed a principal-agent model that incorporated taxes, bankruptcy costs, and managerial transparency in financing and performance to facilitate deriving a manager's contract and a firm's capital structure. They found that managerial decisions resulting in reducing long-term debt lead to a decline in managerial ability and a manager's internal equity ownership, increasing long-term risks to a firm's value. Matemilola et al. (2018) found that experienced and capable managers use more debt to shield the firm's profits from taxes, thus increasing debt capital.

Bhagat et al. (2011) also found that managerial transparency and manager shareholder agency conflicts affect a firm's financial policies, affecting the capital structure and market value. Thus, they are significant determinants of a firm's financial structure and can explain its leverage. Yung and Chen (2018) found that high-ability managers are more

receptive to risk-taking. Thus, they spend more on R&D and less on capital expenditures via internal equity, attenuating risk (Gan 2019).

Naseem et al. (2020) found that higher education affects CEOs' ability to make sound financing and investment decisions. Hackbarth (2008) found that optimistic and confident managers are likely to choose high debt levels based on their industry hierarchy, positively affecting firm value. For instance, a high debt level may prevent a manager from diverting funds, thus increasing firm value and reducing conflicts between managers and shareholders. Thus, we propose the following hypothesis:

H_2: Managerial ability is significantly associated with capital structure.

The effect of capital structure on firm performance

A firm's capital structure is a combination of its debt and equity utilized in financing business operations. It includes equity, infinite maturity, non-callable long-term debt, and non-discretionary short-term debt (Oluwagbemiga 2013). Each is associated with working capital requirements, such as inventories, accounts receivable, and employee compensation. Fumani and Moghadam (2015) note that decision-making regarding a firm's capital structure affects earnings per share and shareholder wealth. Therefore, capital structure decisions should be made cautiously, as their positive and negative outcomes determine the future of the business.

Empirical evidence (Dalci 2018; Forte and Tavares 2019; Le and Phan 2017; Yazdanfar and Öhman 2015) indicates the negative impact of debt on firm performance substantiating agency theory. Forte and Tavares (2019) found that long-term debt negatively affects firm performance due to its high default and credit risk. Ullah et al. (2020) found that a firm's aggregate capital structure infers the level of obligation and value capital structure; thus, negatively impacting financial performance. Underestimating bankruptcy costs may lead to more than optimal debt accumulation. Therefore, a high debt ratio should decrease firm performance (Le and Phan 2017).

Chowdhury and Chowdhury (2010) investigate the impact of capital structure on firm value. They found that the debt-to-equity ratio facilitates managerial decisions, given that high leverage signifies a high risk of bankruptcy for firms with low market value (Ugwuanyi and Ibe 2012). Unlike outsiders, managers have quick access to financial information; thus, the debt structure evidences market value.

Antwi et al. (2012) found that long-term debt reduces the value of high-growth firms while enhancing the value of low-growth firms. Such over-investment can be reduced if managers service debts, thus enhancing firm value. A firm with long-term debt could reject projects with no positive net present value if the benefits accrued from accepting the project do not increase shareholders' wealth. Based on this discussion, we propose the following hypothesis.

H_3: Capital structure is significantly and negatively associated with firm performance.

Although the importance of managerial ability in pursuing firm performance is known, the specific means by which it influences firm performance are under-researched. Managerial ability is the direct driver of firm performance, and the interaction of managerial ability with capital structure may be related to firm performance. Capital structure bridges the relationship between managerial ability and firm performance.

Based on the literature (Curi and Lozano-Vivas 2020; Fernando et al. 2020; Naseem et al. 2020), we propose an alternative mechanism for the managerial ability-firm performance nexus whereby the capital structure mediates the effect of managerial ability on firm performance. Curi and Lozano-Vivas (2020) investigated how managerial ability affects bank performance and how managerial ability and predicted firm performance affect bank risk-taking in the second stage. However, they only focused on the direct role of managerial ability on firm performance without a mediator. Fernando et al. (2020) explored the mediating role of managerial ability in the relationship between gender diversity and firm performance. They found a direct link between human capability via the upper echelon theory to examine the relationship between gender diversity and firm performance. Naseem et al. (2020) used CEO characteristics as the main explanatory variable to explain its impact on firm performance and if capital structure mediates this relationship. Although the sample period was only seven years, they focused on CEO duality, tenure, age, gender, and education level.

Methodology and data

Data

This study examines the relationship between capital structure, managerial ability, and firm performance outside the western region in Taiwan. The study focuses on Taiwan's electronics industry, one of Taiwan's largest industries. Its principal firms, the Taiwan Semiconductor Manufacturing Company and Foxconn Technology Group, produce all types of computers and component technologies. Additionally, Taiwanese electronics companies are R&D intensive and thus face higher debt costs than firms with low R&D investments (Chiao 2002; De Rassenfosse and Fischer 2016). We obtained secondary data from the Taiwan Economic Journal (TEJ) database, which provides complete data beginning from 2005. After excluding observations with missing data, our final sample size is a balanced panel dataset of 6384 firm-year observations with 456 electronics firms listed in Taiwan during 2005–2018.

Managerial ability

To measure managerial ability, we follow Demerjian et al. (2012) while applying the residual-based model: First, we estimate firm efficiency in deploying corporate resources to generate sales using data envelopment analysis (DEA); second, we regress the estimated efficiency scores on firm characteristics using a Tobit regression. After accounting for firm characteristics and efficiency, the unexplained residuals represent managerial ability (Demerjian et al. 2012).

We applied a DDF-based StoNED framework (Kuosmanen et al. 2015), enabling us to simultaneously include firm and board characteristics with a multiple-input–output efficiency evaluation model to overcome the potential noise problem forewarned by Demerjian et al. (2012). This approach improves the DEA and stochastic frontier analysis (SFA) while removing statistical noise and contextual effects. Specifically, based on Kuosmanen (2008) we show an equivalent finite-dimensional representation in terms of quadratic programming. A firm's ability to operate efficiently depends on operational conditions and practices, such as the production environment and firm-specific characteristics, such as managerial practices.

Currently, two-stage DEA is widely applied to investigate the importance of contextual variables (Simar and Wilson 2007), that is, operational conditions and practices (Banker and Natarajan 2008). However, its statistical foundation has been debated (Simar and Wilson 2007, 2011; Banker and Natarajan 2008). We introduce the contextual variables in r-dimensional $\mathbf{z}_i$ vectors that represent the measured values of operational conditions and practices to obtain the following semi-nonparametric linear equation (Johnson and Kuosmanen 2011, 2012), a quadratic programming problem:

$$
\begin{aligned}
&\underset{\alpha,\beta,\gamma,\varepsilon}{Min} \sum_{i=1}^{n} \left(\varepsilon_i^{StoNED} \right)^2 \\
&s.t. \\
&\quad \boldsymbol{\gamma}_i' \mathbf{y}_i = \alpha_i + \boldsymbol{\beta}_i' \mathbf{x}_i + \delta \mathbf{z}_i - \varepsilon_i^{StoNED} \,\forall i = 1, \ldots, n, \\
&\quad \alpha_i + \boldsymbol{\beta}_i' \mathbf{x}_i - \boldsymbol{\gamma}_i' \mathbf{y}_i \leq \alpha_h + \boldsymbol{\beta}_h' \mathbf{x}_i - \boldsymbol{\gamma}_h' \mathbf{y}_i, \\
&\quad \boldsymbol{\gamma}_i' \boldsymbol{\eta}^y + \boldsymbol{\beta}_i' \boldsymbol{\eta}^x = 1 \,\forall i = 1, \ldots, n, \\
&\quad \boldsymbol{\beta}_i' \geq 0 \,\forall i = 1, \ldots, n, \\
&\quad \boldsymbol{\gamma}_i' \geq 0 \,\forall i = 1, \ldots, n.
\end{aligned}
\tag{1}
$$

The residual ε_i^{StoNED} represents the estimated value of d_i (i.e., $\overrightarrow{D}(\mathbf{x}_i, \mathbf{y}_i, \eta^x, \eta^y) + u_i$). The new firm-specific coefficients $\boldsymbol{\gamma}_i'$ represent the marginal effects of the outputs on the DDF. The first constraint defines the distance to the frontier as a linear function of the inputs and outputs. The linear approximation of the frontier is based on tangent hyperplanes, analogous to the original StoNED formulation. The second set of constraints is the Afriat inequality system, which imposes global concavity. The third constraint is a normalization that ensures the translation property. The last two constraints impose monotonicity on all the inputs and outputs. The StoNED estimator of function d satisfies the axioms of free disposability, convexity, and translation property.

Given the StoNED residuals ε_i^{StoNED}, the expected value of the inefficiency term $\mu = E(u_i)$ can be estimated. Note that if the variance of inefficiency is constant across firms (homoscedasticity), then the expectation is unconditional and constant across firms. Alternatively, the expected value of the inefficiency term is estimated using the method of moments (Aigner et al. 1977), quasi-likelihood estimation (Fan et al. 1996), and the nonparametric kernel deconvolution (Hall and Simar 2002). We used the method of moments, requiring additional parametric distributional assumptions. The moment conditions are known for the commonly used half-normal and exponential inefficiency distributions but not for all distributions considered in the SFA literature (e.g., the gamma distribution).

We now discuss the commonly assumed cases of half-normal inefficiency and normal noise. Stated formally, we assume that

$$
u_i \sim N^+ \left(0, \sigma_u^2 \right) \text{ and } v_i \sim N \left(0, \sigma_v^2 \right)
\tag{2}
$$

The StoNED residuals sum to zero is $\sum_{i=1}^{n} \hat{\varepsilon}_i = 0$ (Seijo and Sen 2011). Hence, we can calculate the second and third central moments of the residual distribution as

$$\hat{M}_2 = \sum_{i=1}^{n} \left(\varepsilon_i^{StoNED} \right)^2 \Big/ (n-1) \tag{3}$$

$$\hat{M}_3 = \sum_{i=1}^{n} \left(\varepsilon_i^{StoNED} \right)^3 \Big/ (n-1) \tag{4}$$

The second central moment $\hat{M}_2$ is the sample variance of the residuals, and the third central moment $\hat{M}_3$ is a component of the skewness measure. The hatted statistics are estimators of the true but unknown values of the central moments. If the parametric assumptions of half-normal inefficiency and normal noise hold, then the second and third central moments are equal to

$$M_2 = \left[\frac{\pi - 2}{\pi} \right] \sigma_u^2 + \sigma_v^2 \tag{5}$$

$$M_3 = \left(\sqrt{\frac{2}{\pi}} \right) \left[1 - \frac{4}{\pi} \right] \sigma_u^2 \tag{6}$$

Note that the third moment depends only on the standard deviation of the inefficiency distribution (σ_u). Thus, given the estimated $\hat{M}_3$ (which should be negative), we can estimate σ_u as

$$\hat{\sigma}_u = \sqrt{ \frac{\hat{M}_3}{ \left(\sqrt{\frac{2}{\pi}} \right) \left[1 - \frac{4}{\pi} \right] } } \tag{7}$$

From Eq. 10, the standard deviation of the error term σ_v is estimated as follows:

$$\hat{\sigma}_v = \sqrt{ \hat{M}_2 - \left[\frac{\pi - 2}{\pi} \right] \hat{\sigma}_u^2 } \tag{8}$$

The literature disagrees on how to proceed if $\hat{M}_3$ is positive. For example, Almanidis and Sickles (2011) adopted the alternative inefficiency distributions that allowed for positive skewness, whereas Simar and Wilson (2009) maintained the standard distributional assumptions, suggesting bootstrapping.

Measuring the distance from observation to the frontier is not sufficient for estimating efficiency in the stochastic setting because all observations are subject to noise. Hence, the measured distance consists of both inefficiency and noise (plus any error in our frontier estimate). In the normal-half-normal case, Lovell et al. (1994) developed a formula for the conditional distribution of inefficiency u_i, given ε_i. The commonly used estimator of inefficiency is the conditional mean $E(u_i | \varepsilon_i)$. Given the parameter estimates $\hat{\sigma}_u$ and $\hat{\sigma}_v$, the conditional expected value of inefficiency is calculated as follows:

$$E\left(u_i\middle|\hat{\varepsilon}_i\right) = \frac{\hat{\sigma}_u\hat{\sigma}_v}{\sqrt{\hat{\sigma}_u^2 + \hat{\sigma}_v^2}}\left[\frac{\phi\left(\frac{\hat{\varepsilon}_i\hat{\sigma}_u}{\hat{\sigma}_v\sqrt{\hat{\sigma}_u^2+\hat{\sigma}_v^2}}\right)}{1 - \Phi\left(\frac{\hat{\varepsilon}_i\hat{\sigma}_u}{\hat{\sigma}_v\sqrt{\hat{\sigma}_u^2+\hat{\sigma}_v^2}}\right)} - \frac{\hat{\varepsilon}_i\hat{\sigma}_u}{\hat{\sigma}_v\sqrt{\hat{\sigma}_u^2+\hat{\sigma}_v^2}}\right],\tag{9}$$

where ϕ is the density function of the standard normal distribution $N(0,1)$, Φ is the corresponding cumulative distribution function, and

$$\hat{\varepsilon}_i = \hat{\varepsilon}_i^{StoNED} - \hat{\sigma}_u\sqrt{2/\pi}\tag{10}$$

is the estimator of the composite error term. Notably, there is nothing stochastic in Eq. (10); the formula is a simple deterministic transformation of the StoNED residuals to a new metric that represents the conditional expected value of the inefficiency term.

The inefficiency measures can be converted to output technical efficiency (TE) (Farrell 1957) using:

$$TE_i = \frac{1}{e^{-E(u_i|\hat{\varepsilon}_i)}}\tag{11}$$

For the efficiency variables, we include the number of employees (*EMP*), the cost of goods sold (*COGS*), operating expenses (*OPEX*), property, plant, and equipment (*PPE*), and goodwill and intangibles (*GW&Intan*) as inputs, and market value (*MV*) and revenues (*sales*) as outputs. This first step assesses the efficiency of our sample firms in utilizing resources to generate revenue and market value. Table 1 provides summary statistics and correlation analysis of the variables.

It is important to note two points: First, Golany and Roll (1989) recommend two times the sum of the inputs and outputs as the minimum number of decision-making units (DMUs). Therefore, the total number of DMUs was $456 > 2 \times (5+2) = 14$. Second, Golany and Roll (1989) proposed a DEA isotonicity hypothesis: the output should not decrease when input increases, and a correlation analysis is required to verify whether the input and output indicators have an isotonic relationship. The correlation outcomes in Table 1 indicate a significant positive relationship between the input and output indicators. Thus, further supporting variable selection.

Table 1 Summary statistics and correlation analysis of DEA indicators

	Summary statistics		Correlation analysis					
	Mean	SD	Input 1	Input 2	Input 3	Input 4	Input 5	Output 1
Input 1: *EMP*	848	2184						
Input 2: *COGS*	18,436,891	90,066,701	0.3635					
Input 3: *OPEX*	1,712,886	5,715,219	0.5811	0.8651				
Input 4: *PPE*	5,860,873	28,909,042	0.8666	0.4758	0.6477			
Input 5: *GW&Intan*	393,415	2,241,545	0.4481	0.4953	0.6787	0.5428		
Output 1: *MV*	19,808,763	100,166,683	0.7011	0.5625	0.7294	0.7351	0.4669	
Output 2: *Sales*	21,458,473	99,696,727	0.4126	0.9968	0.8927	0.5203	0.5232	0.6202

The correlation coefficients are all significant at the 1% significance level

Table 2 Summary statistics and correlation analysis of Eq. (12)

	Summary statistics		Correlation analysis					
	Mean	SD	TE	InTA	MKTSHR	FCFD	InAGE	BUSSEG
TE	0.6874	0.2503						
InTA	15.2325	1.4119	− 0.148***					
MKTSHR	0.2193	0.9843	− 0.070***	0.512***				
FCFD	0.6066	0.4886	0.006	− 0.002	0.007			
InAGE	1.7935	0.5431	− 0.161***	0.338***	0.193***	0.004		
BUSSEG	0.7282	0.2194	0.049**	0.102***	0.110***	− 0.006	− 0.010	
BSIZE	4.0798	1.6282	− 0.097***	0.249***	0.074***	− 0.084***	0.238***	0.016

**, ***Significance levels of 5% and 1%, respectively

Table 3 Regression analysis of Eq. (12)

	Coefficient	*t*-statistics	VIF
Intercept	0.9522***	13.2867	
InTA	− 0.0201***	− 4.1468	1.5382
MKTSHR	0.0017	0.1105	1.3686
FCFD	0.0023	0.1332	1.0089
InAGE	− 0.0584***	− 5.2006	1.1676
BUSSEG	0.0746***	2.8724	1.0185
BSIZE	− 0.0072**	− 2.0181	1.1114
Year fixed effects	Yes		
R-squared	0.203		
F-statistic	16.297***		

**, ***Significance levels of 5% and 1%, respectively

The regressors include: firm size (*lnTA*) as the natural logarithm of total assets; market share (*MKTSHR*) as the annual ratio of firm sales to industry sales; free cash flow (*FCFD*), a dummy variable equal to one if a firm has a positive free cash flow, and zero otherwise; firm age (*lnAGE*), the natural logarithm of the number of years of listing; business segment (*BUSSEG*), the ratio of a firm's business segment's sales to its total sales across all business segments. While these variables comport with Demerjian et al. (2012), we also include board size (*BSIZE*), measured as the number of directors on the board, and year fixed effects. According to our preceding discussion, ε_i^{StoNED} is the proxy for managerial ability. Thus, the regression model is as follows:

$$TE_{it} = \beta_0 + \beta_1 \ln TA_i + \beta_2 MKTSHR + \beta_3 FCFD + \beta_4 \ln AGE + \beta_5 BUSSEG + \beta_6 BSIZE + \text{Year fixed effects} + \varepsilon_i^{StoNED}$$

(12)

Table 2 reports the summary statistics and correlation analysis of the dependent and explanatory variables used in Eq. (12); Table 3 presents the results from Eq. (12). In Table 3, the *TE* value of 0.6874 indicates that the sample companies have a 32.26% scope for improving efficiency. More importantly, the correlation analysis suggests that multicollinearity is not an issue, and likewise, via the variance inflation factor (VIF) values (see Table 3). The significant F-statistic of 16.297 (see Table 3) suggests that the model fits well.

The mediation steps

The association between managerial ability and firm performance may be spurious in the absence of a mediator. Therefore, the main feature of our model is the inclusion of capital structure as a mediator in the managerial ability-firm performance nexus, seen in Fig. 1.

We test our mediation model using the Preacher and Hayes (2004, 2008) mediation technique, involving the following three steps:

Step 1: We test the association between managerial ability (explanatory variable) and firm performance (dependent variable). Path c, the sum of paths c and ab, represents the respective associations without including any mediating variables. A significant association suggests an effect of managerial ability and capital structure (or firm performance), which may potentially be mediated.

Step 2: We test the association between managerial ability and capital structure (mediator). This step is represented by path a, which treats the mediator as a dependent variable corresponding to managerial ability. We then test the association between the mediator (capital structure) and the dependent variable (firm performance) by estimating path b. An indirect effect of managerial ability on firm performance can be estimated with paths a and b. However, individually examining each step is insufficient because firm performance and capital structure, both affected by managerial ability, may be correlated. Thus, we performed Step 3.

Step 3: We estimate paths b and c in the same equation to examine whether the capital structure as the mediator completely or partially mediates the association between managerial ability and firm performance. The effect of managerial ability on firm performance controlling for capital structure as the mediator (path c′) should be zero for a complete mediation scenario or significantly non-zero for a partial mediation scenario. We tested the indirect effect using the bootstrapping method with a bias-corrected bootstrap method (Hayes and Scharkow 2013). With 5000 bootstrapped resamples, we obtained a 95% confidence interval (Preacher and Hayes 2008).

We measured firm performance using Tobin's q (*TBQ*), the ratio of market value to total assets. Capital structure is measured by the market-valued leverage ratio (*MLR*), the ratio of the sum of short-term and long-term debt to the sum of total debt and
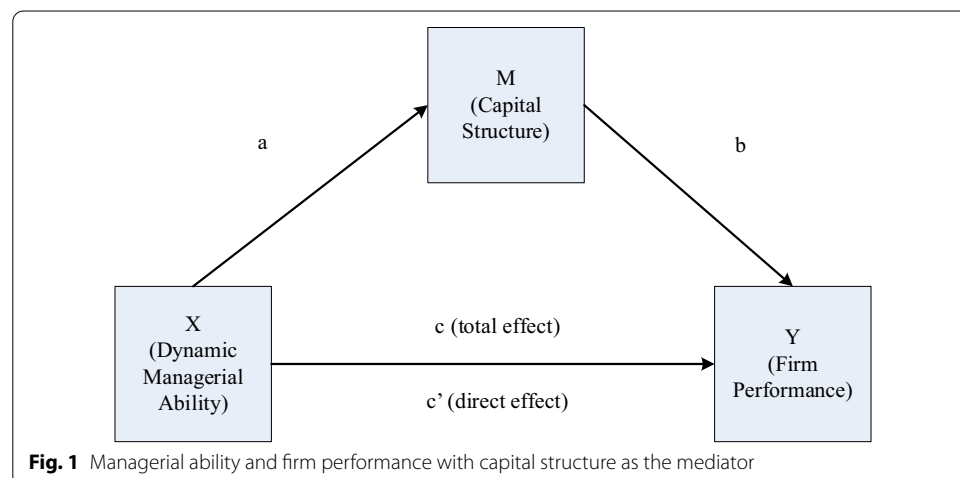

Fig. 1 Managerial ability and firm performance with capital structure as the mediator

market capitalization (Matemilola et al. 2019; Öztekin 2015). As indicated in the previous subsection, we measured managerial ability (*MA1*) as a residual-based measure of managers' efficiency in utilizing resources to generate financial outcomes (i.e., sales and market value) following Demerjian et al. (2012). However, we used a DDF-based StoNED framework (Kuosmanen et al. 2015); in other words, we included exogenous factors that explain firm efficiency. After considering firm and board characteristics, the residuals or unexplained factors derived from the StoNED analysis were attributable to managerial ability.

Based on the literature (Huang et al. 2018; Matemilola et al. 2019; Öztekin 2015), we included the following control variables: *Firm characteristics*: (1) tangibility (*TANG*), defined as fixed assets divided by total assets; (2) firm age (*FAGE*), the natural logarithm of the number of years a firm has been listed; (3) volatility (*Vol*), the standard deviation of profitability by year, and (4) median market-valued leverage ratio (*MedMLR*), a dummy variable equal to one if a firm's *MLR* is greater than the median value of industry *MLR* by year, and zero otherwise. The same computation applies to *MedBLR,* measuring the median book-valued leverage ratio. *Governance characteristics*: (1) board independence (*BIND*) is the proportion of independent board directors to total directors, (2) board shareholdings (*BShares*) is the percentage of common stock held by the board of directors, and (3) institutional ownership (*INSTOWN*), the percentage of common stock held by institutional organizations. Table 4 summarizes the variables' measurements of stages 1 and 2.

Empirical results

Descriptive statistics and the mean differences test

Table 5 presents the descriptive statistics. The average *TBQ* of 1.2357 indicates that the sample companies' market value is 123.57% of their total assets. Additionally, 5.32% of total assets have been generated as earnings (*ROA*). The mean difference test shows that firms with low *MLR* have significantly better performance (*TBQ* and *ROA*) than those with high *MLR*, implying that sample firms with lower liabilities outperform those with higher liabilities. The mean of *MA1* is 14.9817; thus, managers' efficiency score in utilizing resources to generate financial outcomes is 14.98, and 50% of the CEO's annual salary is greater than the annual median value of all industry CEOs' salaries (*MA2*). The mean differences test indicates that high *MLR* firms have significantly lower managerial ability vis-à-vis low *MLR* firms (14.6526 vs. 15.2848 for *MA1*; 0.4401 vs. 0.5552 for *MA2*). The average annual CEO salary of the sample companies is NTD 30,895.79 million (USD 1 = NTD 28.01, as of 20 May 2021).

The means of *MLR* and *BLR* are 0.2143 and 0.1888, respectively, indicating that, on average, 21.43% and 18.88% of the sample firms' total assets are financed by debts. Firms with high *MLR* have significantly greater *MLR* than those with a low *MLR* (0.3831 vs. 0.0428). Moreover, high *MLR* firms have significantly lower *MA* than low *MLR* firms, and firms with low *MLR* have significantly larger *TBQ* than those with high *MLR*.

The average *TANG* of 0.2607 implies that 26.07% of total assets are fixed, and high *MLR* firms use significantly more fixed assets than low *MLR* firms (0.3143 vs. 0.2114). The firm age (*FAGE*) of 1.7935 indicates that the sample firms have been listed for six years on average. Firm age is significantly higher in the high *MLR* than in the low *MLR*

Table 4 Measurements of the variables

Variable	Abbreviation	Measurements
Input and output for efficiency		
Number of employees	*EMP*	Number of employees
Cost of goods sold	*COGS*	Cost of goods sold
Operating expenses	*OPEX*	Operating expenses, comprising selling, general, and administrative expenses Property, plant, and equipment, i.e., fixed assets
Property, plant and equipment	*PPE*	Total revenue received from selling goods in the normal operations of a firm
Goodwill and intangibles	*GW&Intan*	Goodwill and intangibles
Market-based value	*MV*	Market value
Sales	*Sales*	Revenues generated from sales of goods and services
First stage: Firm-specific factors on firm efficiency		
Dependent variable		
Technical efficiency	*TE*	Firm efficiency from DEA StoNED
Independent variables		
Firm size	*lnTA*	The natural logarithm of total assets
Market share	*MKTSHR*	The ratio of a firm's sales to the overall sales of the industry by year
Free cash flow dummy	*FCFD*	Dummy variable equal to one if a firm has a positive free cash flow, and zero otherwise
Firm age	*lnAGE*	The natural logarithm of the number of years of listing
Business segment	*BUSSEG*	The ratio of a firm's business segment's sales to its total sales across all business segments
Board size	*BSIZE*	The number of directors on board
Second stage: Managerial ability, capital structure and firm performance		
Firm performance		
Tobin Q	*TBQ*	Market value divided by total assets
Return on assets	*ROA*	Earnings divided by total assets
Managerial ability 1	*MA1*	Managerial ability derived from DDF based StoNED
Managerial ability 2	*MA2*	Dummy variable equal to one if a CEO's salary is greater than the median value of all CEOs' salaries by year, and zero otherwise
Capital structure		
Market-valued leverage ratio	*MLR*	(Short-term debt + long-term debt)/(total debt + market capitalisation)
Market-valued leverage ratio	*BLR*	(Short-term debt + long-term debt)/total assets
Control variables		
Tangibility	*TANG*	Fixed assets divided by total assets
Firm age	*FAGE*	The natural logarithm of the number of years a firm has been listed
Volatility	*Vol*	The standard deviation of profitability by year
Median market-valued leverage ratio	*MedMLR*	Dummy variable equal to one if a firm's MLR is greater than the median value of all firms' MLR by year, and zero otherwise
Median book-valued leverage ratio	*MedBLR*	Dummy variable equal to one if a firm's BLR is greater than the median value of all firms' BLR by year, and zero otherwise
Board independence	*BIND*	The proportion of independent directors to total directors
Board shareholdings	*BShares*	The percentage of common stock held by board of directors

Table 4 (continued)

Variable	Abbreviation	Measurements
Institutional ownership	*INSTOWN*	The percentage of common stock held by institutional organisations

Table 5 Descriptive statistics and mean differences test

Variable	Summary statistics		Mean differences test		
	Mean	SD	High *MLR*	Low *MLR*	Differences
TBQ	1.2357	0.9579	0.8467	1.5938	− 20.1985***
ROA	0.0532	0.1269	0.0064	0.0962	− 18.0552***
MA1	14.9817	1.5785	14.6526	15.2848	− 9.7486***
MA2	0.5000	0.5001	0.4401	0.5552	− 5.5259***
CEOSalary	30,895.7683	84,466.3089			
MLR	0.2143	0.2151			
BLR	0.1888	0.1728			
TANG	0.2607	0.1692	0.3143	0.2114	15.2162***
FAGE	1.7935	0.5431	1.8481	1.7433	4.6228***
Vol	0.1247	0.0110	0.1260	0.1236	5.0697***
MedMLR	0.1617	0.0598			
MedBLR	0.1604	0.0186			
BIND	0.1876	0.1680	0.1745	0.1998	− 3.6033***
BShares	0.1895	0.1143	0.1826	0.1959	− 2.7790***
INSTOWN	0.1703	0.1593	0.1652	0.1750	− 1.4611

***1% significance level

firms. The *Vol* of 0.1247 suggests that, on average, uncertainties in the industry are relatively low, and the uncertainties are higher in the high *MLR* than in the low *MLR* at the 1% significance level. The median value of all firms' *MLR* and *BLR* is 16.17% and 16.04%, respectively. The value of 0.1876 for *BIND* indicates that 18.76% of the total directors are independent. Low *MLR* firms have a significantly higher number of independent directors vis-à-vis high *MLR* firms. On average, 18.95% of the common stock is held by the board of directors, and institutional shareholders own 17.03% of the shares. The mean difference test reveals that the independent directors and institutional ownership of low *MLR* firms are significantly larger than those of high *MLR* firms.

Correlation analysis

Table 6 summarizes the results of the Pearson correlation analysis. The results indicate that *MA1* is significantly positively correlated with *ROA* at 0.401, *TBQ* at 0.374, *MA2* at 0.534, *TANG* at 0.048, and *FAGE* at 0.213. Moreover, *MLR* is significantly negatively correlated with *MLR* at − 0.292, *BLR* at − 0.152, *Vol* at − 0.210, *MedMLR* at − 0.221, *MedBLR* at − 0.118, *BIND* at − 0.056, *BShares* at − 0.197, and *INSTOWN* at − 0.058.

The results also show that *MA2* is negatively correlated with *MLR, BLR, TANG, BIND, BShares, and INSTOWN* at the 1% significance level. Additionally, we ran the variance inflation factors (VIFs) to identify multicollinearity, all below 5, indicating no evidence of multicollinearity. Thus, all variables were included in the multivariate analysis.

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Table 6 Pearson correlation coefficients

	TBQ	ROA	MA1	MA2	MLR	BLR	TANG	FAGE	Vol	MedMLR	MedBLR	BIND	BShares
ROA	0.426***												
MA1	0.374***	0.401***											
MA2	0.106***	0.254***	0.534***										
MLR	−0.413***	−0.422***	−0.292***	−0.145***									
BLR	−0.228***	−0.365***	−0.152***	−0.125***	0.869***								
TANG	−0.126***	−0.151***	0.048**	−0.071***	0.333**	0.380***							
FAGE	−0.187***	−0.177***	0.213***	0.128***	0.072***	−0.002	0.025						
Vol	−0.267***	−0.075***	−0.210***	0.001	0.221***	0.027	0.046**	0.072***					
MedMLR	−0.267***	−0.085***	−0.221***	0.001	0.231***	0.042**	0.050**	−0.007	0.954***				
MedBLR	−0.086***	0.025	−0.118**	0.001	0.142***	0.081***	0.036*	−0.394**	0.401***	0.587***			
BIND	0.122***	0.120***	−0.056***	−0.055***	−0.087***	−0.052**	−0.095***	−0.472***	−0.015	−0.010	0.035*		
BShares	0.006	0.054**	−0.197***	−0.151***	−0.054**	−0.057***	−0.024	−0.215***	−0.019	−0.004	0.059**	0.085***	
INSTOWN	0.004	0.018	−0.058***	−0.091***	−0.030	−0.023	0.008	−0.065**	0.012	0.014	0.007	−0.002	0.424***

For brevity, the results offer three decimal points

*, **, ***Significance levels of 10%, 5% and 1%, respectively

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Table 7 Testing mediating effect of capital structure on the association between managerial ability and firm performance

	Y = TBQ, X = MA1, mediator = MLR		Y = ROA, X = MA1, mediator = MLR		Y = TBQ, X = MA1, mediator = BLR		Y = TBQ, X = MA2, mediator = MLR	
	Coefficient	t − statistics	Coefficient	t − statistics	Coefficient	t-statistics	Coefficient	t-statistics
Step 1: Total effect of X on Y (path c)								
MA1	0.2456***	21.0042	0.0398***	25.9137	0.2514***	21.4262	0.2376***	6.2049
Step 2: X to mediator (path a) and mediator to Y (path b)								
MA1 (path a)	−0.0433***	−16.3773	−0.0433***	−16.3773	−0.0225***	−10.1108	−0.0625***	−7.5006
MLR (path b)	−1.1333***	−12.6412	−0.1611***	−13.7811	−0.7064***	−6.4362	−1.5693***	−17.3061
Step 3: Direct effect of X on Y (path c')								
MA1 or MA2	0.1965***	16.4382	0.0328***	21.0269	0.2355***	19.8095	0.1396***	3.8291
Partial effect of control variables on Y								
TANG	−0.2465**	−2.3156	−0.0562***	−4.0520	−0.4553***	−4.1173	0.0593	0.5349
FAGE	−0.4300***	−11.3061	−0.0597***	−12.0352	−0.5313***	−12.2928	−0.3106***	−7.0904
Vol	7.1353	1.3529	3.3795***	4.9135	−10.0919***	−5.4970	−14.0303***	−7.5950
MedMLR or MedBLR	−3.4421***	−3.5441	−0.4450***	−3.5137	−5.1447***	−4.3999	−2.0173*	−1.6762
BIND	−0.0114	−0.1001	−0.0096	−0.6426	−0.0655	−0.5493	0.0951	0.7753
BShares	0.0224	0.1337	0.0828***	3.7968	0.0976	0.5693	−0.3922**	−2.2413
INSTOWN	0.0055	0.0478	−0.0121	−0.8016	0.0142	0.1194	0.0663	0.5418
R-squared	0.3124		0.3332		0.2788		0.2331	
F-statistic	114.5946***		126.0327***		97.4856***		76.6421***	

*, **, ***Significance levels of 10%, 5% and 1%, respectively

Managerial ability and firm performance: mediated by capital structure

Table 7 presents the association between managerial ability and firm performance by constructing a multiple mediation model with capital structure as the mediator. We employed the proper steps to test the mediating effect. First, we examined the total effect of managerial ability (*MA1*) on firm performance (*TBQ*; coefficient: 0.2456, $P < 0.01$). The coefficient of R-squared was 0.3124. The result in path c indicates that managerial ability positively affects firm performance. Robustness checks were performed for the total effect in different settings. First, we replace TBQ with *ROA*, measured as the ratio of net income to total assets. Second, we replaced *MLR* ([short-term debt + long-term debt]/[total debt + market capitalization) with *BLR* ([short-term debt + long-term debt]/ total assets) as in Huang et al. (2018). Next, we replaced *MA1* with *MA2*, a dummy variable equal to one if a CEO's annual salary is greater than the median of CEOs' annual salaries (Demerjian et al. 2012; Hayes and Schaefer 2009).

The results are the same when we replace *TBQ* with *ROA* (coefficient: 0.0398, $P < 0.01$), *MLR* with *BLR* (coefficient: 0.2514, $P < 0.01$), and *MA1* with *MA2* (coefficient: 0.2376, $P < 0.01$). This means that CEOs with high (low) abilities are associated with positive (negative) performance. This result is consistent with Demerjian et al. (2012) indicating that capable CEOs are associated with improvements in firm performance. The *R*-squared values were 0.3332, 0.2788, and 0.2331, respectively.

Next, we examined managerial ability in influencing capital structure decisions. The negative coefficient of managerial ability (Table 7, path a) confirms the negative relationship between *MA1* and *MLR* (coefficient: − 0.0433, $P < 0.01$). The findings corroborate our hypothesis that higher CEO ability implies a low level of debt financing. This result comports with Berger et al. (1997), Perry and Zenner (2001), and Milbourn (2003), who found that CEOs with increased abilities are likely to avoid risk, thus choosing less debt. The models were re-estimated by replacing *TBQ* with *ROA* (coefficient: − 0.0433, $P < 0.01$), *MLR* with *BLR* (coefficient: − 0.0225, $P < 0.01$), and *MA1* with *MA2* (coefficient: − 0.0625, $P < 0.01$). Table 7 (path a) reports the results that remain qualitatively the same, indicating that low (high) levels of debt are likely observed in firms with CEOs with high (low) ability.

Moreover, we investigate how the causal effect of managerial ability can be separated into an indirect effect on firm performance through the capital structure (path b) and a direct effect on firm performance (path c′). We found (see Table 7, paths b and c) that capital structure (*MLR*) partially mediated the relationship between managerial ability and firm performance (*TBQ*), implying that capital structure mediates the positive relationship between managerial ability and firm performance.

Table 8 Indirect effects of X on Y through proposed mediator: capital structure

	Observed coefficient	SE	Bias-corrected 95% CI		Percentile 95% CI	
			Lower limit	Upper limit	Lower limit	Upper limit
Preacher and Hayes (2004, 2008)	0.0491	0.0034	0.0432	0.0565		
(Sobel 1982, 1987)	0.0588	0.0053			0.0485	0.0692
Z-statistic					11.1587***	

Consequently, the positive effect of managerial ability on firm performance decreases when capital structure is included, with managerial ability as an explanatory variable of firm performance.

Additional robustness checks were conducted to ensure the consistency of the mediating effect of capital structure on the association between managerial ability and firm performance. To substantiate our findings, we performed a sensitivity test. We substituted the dependent variable *TBQ* with *ROA*, the mediating variable, *MLR* with *BLR,* and the explanatory variable, *MA1*, with *MA2.* All the results were quantitatively the same. The findings support the conceptualization of the mediating role of capital structure in the managerial ability-firm nexus. This is because managerial ability has a significantly negative influence on capital structure, and capital structure has a significantly negative influence on firm performance.

Table 8 presents the indirect effects of managerial ability on firm performance via the mediator, i.e., capital structure. Following Preacher and Hayes (2004), Preacher and Hayes (2008), and Sobel (1982), and Sobel (1987), we bootstrapped the indirect effects of managerial ability on firm performance using capital structure as the mediator. Table 8 shows the estimates and 95% confidence intervals (CIs) (bias-corrected and percentile). Consistently, the results explain that capital structure is a significant mediator in the managerial ability-firm performance nexus.

Conclusion

Findings and discussion

In the twenty-first century, with a fast-changing business climate, managers' abilities should not be the only focus for competitive advantage. The association between managerial ability and firm performance may be spurious, without the presence of a mediator. This study examines the association between managerial ability and firm performance, estimated via a direct distance function-based stochastic nonparametric envelopment of data, and investigates the mediating effect of capital structure on the managerial ability-firm performance nexus.

Our results show that managerial ability significantly affects firm performance; specifically, high-ability CEOs are associated with positive performance. As highlighted by Bellner (2014), CEOs with high managerial abilities are able to identify threats, opportunities, and competitive advantages. This result is consistent with Ng et al. (2015) who found that managerial ability with effective monitoring improves firm value.

Moreover, our findings suggest that managerial ability is substantiated by the pecking order theory regarding corporate decision-making, such as capital structure and corporate financial success. The negative relationship between managerial ability and capital structure implies that high-ability CEOs opt for low levels of debt financing. Our results indicate that capital structure is the primary mediating factor of the managerial ability-firm performance nexus. CEOs with higher abilities opt for low debt financing to avoid the risk of insolvency and bankruptcy, resulting in financial performance. Additionally, managerial efficiency is critical in enhancing organizational performance and influencing the capital structure and market value, affecting organizational success. In summary, managerial ability plays a significant role in capital structure and firm performance.

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Research implications

Our findings make significant theoretical and managerial contributions and implications for policymakers and managers. First, we theoretically extend the literature by demonstrating the mediating effect of capital structure on the managerial ability-firm performance nexus. We empirically show how a mediator can mitigate the relationship between the explanatory and dependent variables. Concerning theoretical implications, based on the upper echelons theory, a manager's ability leads to better business strategy (Hambrick and Mason 1984) because capable managers can effectively determine organizational decisions, strategic choices, and firm organizational performance (Nielsen 2010). The theory emphasizes that capable leaders can affect their decisions on strategy and structure, thereby directly affecting firm performance. This study suggests that policymakers create policies in the electronics industry by promoting more effective leadership programs to enhance managerial skills. This would build up the leader's ability and capability skills for a firm's performance. However, the upper echelons theory fails to acknowledge that the CEO's causal effect can be apportioned into an indirect effect on strategic choice through organizational performance.

Second, our study makes a managerial contribution. We argue that capital structure needs to be considered a mediator in examining the effect of managerial ability on firm performance. Instead, it is different from the usual practice in examining the direct effect of managerial ability on the capital structure or firm performance. High levels of managerial ability lead to effective decision-making, innovation, and increased investments, resulting in competitive advantage and good firm performance. Top management needs to introduce professionals and capable managers to run and manage companies. Therefore, specific managerial skills should be considered while hiring CEOs. Additionally, CEOs should understand and utilize their abilities to improve their performance. Moreover, the study primarily documents that CEOs with increased abilities are likely to avoid risk, thus choosing less debt. Therefore, CEOs should strive to enhance managerial skills in financial decisions reducing the debt burden, further improving firm performance.

Third, this study makes a methodological contribution. We improve the common measurement of managerial ability and employ different proxies for capital structure and firm performance. This ensures measurement accuracy and validity of our results. Our study offers important insights to investors. We suggest that investors buy and hold shares of companies with highly capable CEOs, as they are associated with better firm performance. In contrast, we propose that investors sell companies' shares with a high debt level as they underperform those with lower liabilities.

Limitations and suggestions for future research

This study has several limitations. First, we selected only Taiwanese-listed electronics companies in our sample. We suggest conducting studies in other industries and regions. For example, researchers may examine the same topic among small and medium-sized enterprises (see for example, Kou et al. 2021b) or even banks (see for example, Kou et al. 2021a). Second, future studies may consider the issue of firm financial sustainability or stock price crash risk (see for example, Wen et al. 2019) instead of firm performance. Studies could use the moderating effect instead of the mediating effect of capital

structure or apply opinion dynamics in finance and business (Zha et al. 2020) and clustering approaches (Li et al. 2021).

Authors' contributions
IWKT wrote the introduction, research framework, findings analysis and conclusion. IT, the literature review and theoretical discussion. W-ML, the data, data modelling, and running of tests. QLK, the data methodology and running of tests, and writing and editing. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration

Competing interests
The authors declare that they have no competing interests.

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