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# CEO demographic characteristics and firm performance: an empirical study in the scientific research and technology development industry

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## Abstract

The purpose of this study is to analyze the impact of the chief executive officer (CEO) demographic characteristics including CEO age, CEO gender, and CEO education on the performance of firms in the scientific research and technology development (SRTD) industry context. The cross-sectional data employed are collected from the General Statistics Office of Vietnam's survey on corporations in 2017 with three samples, which include SRTD firms, certified SRTDs as CSRTD firms, and the SRTD industry as a whole. The least-squares analysis, robust regressions, statistical parametric and non-parametric tests are conducted to analyze the data. Firstly, it is found that the association between CEO age and firm performance is different between SRTD firms and CSRTD firms and statistically non-significant to the SRTD industry as a whole. Secondly, female CEOs of SRTD firms operate their businesses better than their male counterparts while the opposite is witnessed in CSRTD firms. For the whole SRTD industry, male CEOs outperform. Thirdly, for SRTD firms, the higher education of CEOs does not ensure higher performance. Nonetheless, CEOs with master's degrees do have better performance than CEOs with bachelor's degrees. These results are consistent in all estimation models being employed. The study is the first to examine factors affecting the performance of firms in the SRTD industry.

**Keywords:** CEO age, CEO gender, CEO educational background, Firm performance, Technology-based firms

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## 1. Introduction

Since the Upper Echelon Theory (UET) was introduced by Hambrick and Mason (1984), many empirical studies have been conducted to replicate and complement the theory in different contexts, including international, country-specific, and sector-specific circumstances. The authors have synthesized all the theories on the characteristics of top managers from an 'upper echelons perspective' and state that the outcomes of an organization are partly anticipated by characteristics of leading managers. Some examples of such studies include a study on the role of female executives in hospital performance in the healthcare sector of Ontario, Canada (Frankl and Roberts, 2018); a study about CEO characters as the determinant of technology adoption by small- and medium-sized enterprises (SMEs) in Nigeria (Awa *et al.*, 2011); a study on the foreign experience of top leading team and international diversification strategies of U.S. multinational firms (Sambharya, 1996); or the research on CEO characteristics and technology innovativeness from Canadian manufacturing firms (Kitchell, 2009). For technology-based SMEs in Spain, the impact of gender diversity, management capabilities of the leading team on product and process innovation is examined (Ruiz-Jiménez and Fuentes-Fuentes, 2016). Returnee entrepreneurs in Chinese high-technology industries and their learning style for firm management are investigated to see if there is any significant relationship with the firm's results (Liu *et al.*, 2015).

Nonetheless, the results found in different contexts have not been consistent and sometimes have been conflicting with each other. The influence of CEO age on firm performance is found positively significant in some studies (Awa *et al.*, 2011; Garcia-Blandon *et al.*, 2019) but negatively significant (Amran *et al.*, 2014) or has a non-linear relationship in other researches (Hoang *et al.*, 2019). CEO gender and performance of a firm are found to have no significant relationship (Amran *et al.*, 2014) while in other studies they are shown to be positively associated (Awa *et al.*, 2011; Frankl and Roberts, 2018; Ruiz-Jiménez and Fuentes-Fuentes, 2016). Similarly, CEO education and firm achievements are observed to be under no significant relationship (Amran *et al.*, 2014; Garcia-Blandon *et al.*, 2019). But in other studies, they are found to have a positive relationship (Jalbert *et al.*, 2011; King *et al.*, 2016) or a negative relationship (Awa *et al.*, 2011). It is, therefore, presumed that empirical findings under the UET theory in business practices are not consistent when the context changes.

This study investigates the role of CEO characteristics on the performance of firms in the scientific research and technology development (SRTD) industry in Vietnam[2] for three main reasons. Firstly, the SRTD industry is arguably characterized by an emphasis on research and development (R&D) and a focus on developing and utilizing new technology (Cooper and

[2] The firms in SRTD industry are coded as 72110, 72120, 72130, 72140, 72210, 72220, 74909 under the Vietnam 5-digit system of industry code (VSIC) 2018 or as 71100, 72200, 74909 under the VSIC 2007. They consist of 2 main firm groups, which are SRTD firms and certified SRTD firms. The SRTD firms are those operating in the SRTD industry as their major registered industry and the certified SRTD (CSRTD) firms are those operating in this business sphere but not as their major registered industry; however, they have their scientific research and technology development products and have filed them to competent authorities in their locality for being granted as CSRTDs.

Bruno, 1977), which is completely different from other industries in the economy. Secondly, there are potential benefits of UET theory in predicting organizational outcomes, predicting competitors' moves and countermoves, and suggestions for those in charge of selecting and developing senior executives in this industry-specific context. Finally, as long as the policy-making of the Vietnam government is concerned, these firms have been intensively supported for more than a decade but are still underdeveloped. Understanding determinants of their development has been desperately in need but received scant literature to date.

The remainder of the paper is structured as follows. Part 2 presents a literature review related to the study and proposes hypotheses. Part 3 explains the methodology applied and describes the data employed. Results and discussions are presented in Part 4. Part 5 concludes the paper.

## 2. Literature review and hypotheses

The CEO demographic characteristics under investigation are CEO age, CEO gender, and CEO educational background and qualifications as commonly found in previous studies thanks to their observability and measurability.

### *2.1 CEO age and firm performance*

Old people tend to change on aggregate when they are put under certain environmental pressure, but their change is more slowly than that of young people (Carlsson and Karlsson, 1970). This less change-prone of the older may prevent them from grasping new opportunities. Serfling (2014) argues that older CEOs tend to be more risk-averse leading to less risky investment strategies such as lower research and development (R&D), more diversifying acquisitions, diversified operation management, and applying lower leverage while firms in the SRTD industry are challenged every day with lots of R&D activities inherently associated with risk-taking and adaptability. It is, therefore, hypothesized that younger CEOs have got better firm performance than older CEOs (H1).

### *2.2 CEO gender and firm performance*

Feminine participation in top management positions in firms is no longer exceptional but their contribution to firm performance is probably of greater concern and interest. Seniority teams with more balanced gender diversity have a better impact on the management and innovation quality of technology-based SMEs (Ruiz-Jiménez and Fuentes-Fuentes, 2016). Increasing gender diversity is also found of significant association with a firm's performance (Erhardt *et al.*, 2003; Krishnan and Parsons, 2008). As a result, the authors advance a hypothesis that female CEOs achieve better firm performance than their male counterparts do (H2).

### *2.3 CEO education and firm performance*

Education is an asset that a CEO accumulates for himself/herself to undertake the role in the top management of any company. The impact of CEO education on firm performance is conjectured to be direct or indirect through his appointment of other well-educated managers to the leading team or higher capability in making rational decisions and coming up with creative ideas in complex problem solving (Papadakis and Barwise, 2002). According to

Wang *et al.* (2016), formal education of a CEO is chosen to be assessed under the UET concerning firm performance due to its representation of many decent criteria in support to the CEO's firm running like cognitive ability, novel concepts prone, new ideas welcome, ability in understanding and processing information about technologies and business environments and then predicted to enhance firm strategic actions. CEOs with higher education are, thus, postulated to gain better firm performance than CEOs of lower education do (H3).

## 3. Methodology

### *3.1 Data collection*

The cross-sectional data used in this study were collected by the General Statistics Office of Vietnam through a corporate survey conducted in 2017. The sample consists of 564 firms in the SRTD industry with a group of 327 SRTD firms and another group of 237 CSRTD firms. Therefore, three sample categories shall be investigated including the SRTD firms, the CSRTD firms, and all firms in the SRTD industry.

### *3.2 Research models*

Based on previous studies (Amran *et al.*, 2014; Awa *et al.*, 2011; Barker and Mueller, 2002; Bhagat *et al.*, 2010; Garcia-Blandon *et al.*, 2019), the econometric research model with ordinary least squares (OLS) estimation is built as follows:

$$PER_i = \beta_0 + \beta_1 \text{ (CEO Characteristics)} + \beta_2 \text{ (Control variables)} + \varepsilon_i \quad (1)$$

in which our focal variables of CEO characteristics are: CEO age, CEO gender, and CEO education; i denotes an individual firm; Control variables represent firm-specific characters; PER is firm performance, which is proxied by return on equity (ROE) serving as the benchmark of financial performance. Other measures including *TotalNetSales, log_TotalNetSales*, and *AssetTurnover* are used for robustness check. A description of these variables is presented in Table 1.

These variables have been used in previous studies. *Log_TotalNetSales* is chosen following Dang *et al.*, 2018, which takes the natural logarithm form to reduce heteroskedasticity. Return on equity (ROE) has been used in Lam *et al.* (2013) and other previous studies. *AssetTurnover* is a component of ROE under DuPont Analysis, which is selected to analyze the effectiveness of asset usage of firms (Gaurav, 2020). *TotalNetSales* is a continuous variable calculated from the data used for comparison (Hoang *et al.*, 2019).

Robustness checks are carried out to ensure the models do not suffer severe multicollinearity issues, heteroskedasticity, and the error terms are normally distributed. The variance inflation factor is used to check multicollinearity; the White test is used to check heteroskedasticity; the Jarque-Bera test is applied to check the error term's distribution. However, as the Jarque-Bera test is only appropriate for big datasets with thousands of observations, the results got from this study's dataset are only for reference due to its small number of observations. As long as the number of observations increases to sufficiently large, this assumption of OLS regression shall be automatically met.

**Table 1.** Variables description

| Variables | Variable code | Explanation |
|---|---|---|
| ***Dependent variables*** | | |
| Total Net Sales | TotalNetSales | TotalNetSales = Gross Sales – (Sales returns + Sales Discount). |
| Log_TotalNetSales | log_TotalNetSales | Logarithm of Total Net Sales. |
| Return on equity | ROE | ROE = Net Income (Income after-tax)/Average Total Equity.<br>Average Total Equity = (Equity at year start + Equity at year end)/2. |
| Asset Turnover | AssetTurnover | AssetTurnover = Total Net Sales/Average Total Assets.<br>Average Total Assets = (Total Assets at year start + Total Assets at year-end)/2. |
| ***Independent variables - CEO characteristics*** | | |
| CEO Age | CEOAge | Continuous variable - age of CEO of firm. |
| CEO Gender | CEOGender | Binary variable - 1 for male CEO/0 for female CEO. |
| CEO Education | CEOEdu | Education qualifications of CEO - Doctor, Master, UniDegree, College, Intermediate, OtherEdu.<br>Using dummy variables with UniDegree as baseline indicator. |
| ***Control variables*** | | |
| Firm Age | FirmAge | Years in the operation of the firm. |
| Leverage | Leverage | Leverage = Average Total Assets/Average Total Equity. |
| Log_Average Total Assets | Log_ AvTotalAssets | Logarithm of Average Total Assets of firm. |
| Log_Tax | Log_Tax | Logarithm of Tax of firm. Tax arose and to be paid by firm during one financial year. |
| Log-Labour Size | Log_LabourSize | Logarithm of Labour Size. (LabourSize = Number of employees in the firm at year-end). |
| Import - Export | ImportExport | Whether the firm has any import or export activity in the year - Binary variable - 1 for Yes/0 for No. |
| Special Zone | SpecialZone | Whether the firm runs in the industrial zone, manufacturing zone, economic zone, or high-tech zone.<br>Binary variable - 1 for Yes/0 for No. |
| Central City | CenCity | Whether the firm is based in 1 of 5 central cities in Vietnam (Hanoi, Haiphong, Danang, HCM City, Cantho) |
| Log_Fixed Assets | Log_FixedAssets | Logarithm of Fixed Assets (FA) of the firm.<br>FA = (FA at year start - accumulated depreciation at year start + FA at year-end - accum. dep. at year-end)/2 |

**Source:** Authors' compilation and proposition

Apart from OLS regressions, robust regressions (RR) are also conducted with the dataset of the study as this regression type is typically designed to cope with violations of OLS assumptions in terms of variance homogeneity. The results from both OLS and RR regressions shall be used for cross-checking to ensure the robustness of the findings.

Finally, robust regressions with interaction terms are also run to assess the joint effect of CEO demographic characteristics on firm performance. Two interaction terms are *CEOAge*CEOEdu* and *CEOGender*CEOEdu.*

The two models with interaction terms are as follows:

$$PER_i = \beta_0 + \beta_1 CEOGender + \beta_2\ CEOAge + \beta_3\ CEOEdu + \beta_4\ CEOAge*CEOEdu + \beta_5(\text{Control variables}) + \varepsilon_i \quad (2)$$

$$PER_i = \beta_0 + \beta_1 CEOAge + \beta_2 CEOGender + \beta_3 CEOEdu + \beta_4 CEOGender*CEOEdu + \beta_5(\text{Control variables}) + \varepsilon_i \quad (3)$$

Table 1 describes and explains the calculations of all the variables in the study.

## 4. Results and Discussion

### *4.1 Descriptive statistics of variables in the study*

Tables 2 and 3 illustrate the descriptive statistics of variables in the models distinguishing among the three samples, which are SRTD firms, CSRTD firms, and all firms in the SRTD industry.

**Table 2.** Descriptive statistics (continuous variables)

| | Obs | Mean | Std. Dev. | Min | Max | Sample |
|---|---|---|---|---|---|---|
| *Dependent Variables* | | | | | | |
| TotalNetSales | 324 | 7675.845 | 50215.79 | 0 | 803566 | S1 |
| | 237 | 478118.5 | 5285621 | 0 | 81200000 | S2 |
| | 561 | 206419 | 3439379 | 0 | 81200000 | S3 |
| log_TotalNetSales | 209 | 6.7651 | 2.2694 | -0.1054 | 13.5968 | S1 |
| | 219 | 9.5932 | 2.6214 | 0.3365 | 18.2126 | S2 |
| | 428 | 8.2121 | 2.8319 | -0.1053 | 18.2126 | S3 |
| ROE | 325 | 0.7303 | 15.0031 | -11.1642 | 270 | S1 |
| | 237 | 0.0437 | 0.3371 | -2.0740 | 2.6831 | S2 |
| | 562 | 0.4407 | 11.4089 | -11.1641 | 270 | S3 |
| AssetTurnover | 325 | 0.5596 | 1.4701 | 0 | 21.8824 | S1 |
| | 237 | 0.7202 | 0.7823 | 0.0000 | 4.3731 | S2 |
| | 562 | 0.6272 | 1.2296 | 0 | 21.8824 | S3 |
| *Independent variables - CEO characteristics* | | | | | | |
| CEOAge | 235 | 43.6596 | 12.5301 | 18 | 77 | S1 |
| | 225 | 49.60 | 11.51 | 22 | 80 | S2 |
| | 460 | 46.5652 | 12.3899 | 18 | 80 | S3 |

**Table 2.** Descriptive statistics (continuous variables) *(continued)*

| | Obs | Mean | Std. Dev. | Min | Max | Sample |
|---|---|---|---|---|---|---|
| *Control variables* | | | | | | |
| FirmAge | 327 | 3.8073 | 3.7657 | 0 | 24 | S1 |
| | 237 | 12.4177 | 11.2385 | 0 | 62 | S2 |
| | 564 | 7.4255 | 8.902 | | 62 | S3 |
| Leverage | 325 | 1.2813 | 9.1879 | -150 | 48.6851 | S1 |
| | 237 | 1.5792 | 12.5049 | -138.5080 | 49.4926 | S2 |
| | 562 | 1.4069 | 10.7032 | -150 | 49.4926 | S3 |
| log_AvTotalAssets | 325 | 7.5589 | 1.8153 | -0.6931 | 13.8351 | S1 |
| | 237 | 10.3717 | 2.0360 | 5.5741 | 17.9403 | S2 |
| | 562 | 8.745 | 2.3621 | -0.6931 | 17.9402 | S3 |
| log_Tax | 209 | 3.3920 | 2.4018 | -2.3026 | 11.1236 | S1 |
| | 216 | 5.5628 | 3.0008 | -2.3026 | 16.1052 | S2 |
| | 425 | 4.4952 | 2.9285 | -2.3025 | 16.1052 | S3 |
| log_LabourSize | 327 | 1.4786 | 1.0821 | 0 | 5.7366 | S1 |
| | 237 | 3.4247 | 1.7718 | 0.0000 | 8.1429 | S2 |
| | 564 | 2.2963 | 1.7083 | 0 | 8.1429 | S3 |
| log_FixedAssets | 112 | 5.7603 | 1.9479 | 1.9879 | 13.4135 | S1 |
| | 197 | 8.9043 | 2.461 | 0.8755 | 17.218 | S2 |
| | 309 | 7.7647 | 2.7409 | 0.8754 | 17.218 | S3 |

**Notes:** S1, S2, and S3 denote SRTD firms, CSRTD firms, and all firms in the SRTD industry, respectively.

**Source:** Authors' calculation

**Table 3.** Descriptive statistics (categorical variables)

| | | Proportion | Std. Err. | [95% Conf. Interval] | | Obs | Sample |
|---|---|---|---|---|---|---|---|
| *Independent Variables - CEO characteristics* | | | | | | | |
| CEOGender | Female/0 | 0.2875 | 0.0251 | 0.2408 | 0.3392 | 327 | S1 |
| | | 0.2194 | 0.0269 | 0.1709 | 0.2770 | 237 | S2 |
| | | 0.2630 | 0.0205 | 0.2246 | 0.3053 | 460 | S3 |
| | Male/1 | 0.7125 | 0.0251 | 0.6608 | 0.7592 | 327 | S1 |
| | | 0.7806 | 0.0269 | 0.7230 | 0.8291 | 237 | S2 |
| | | 0.7369 | 0.0205 | 0.6946 | 0.7753 | 460 | S3 |
| CEOEdu | Doctor | 0.0638 | 0.0160 | 0.0387 | 0.1035 | 235 | S1 |
| | | 0.0711 | 0.0172 | 0.0439 | 0.1133 | 225 | S2 |
| | | 0.0673 | 0.0117 | 0.0477 | 0.0943 | 460 | S3 |
| | Master | 0.1234 | 0.0215 | 0.0869 | 0.1724 | 235 | S1 |

**Table 3.** Descriptive statistics (categorical variables) *(continued)*

| | | Proportion | Std. Err. | [95% Conf. Interval] | | Obs | Sample |
|---|---|---|---|---|---|---|---|
| | | 0.1689 | 0.0250 | 0.1251 | 0.2241 | 225 | S2 |
| | | 0.1456 | 0.0164 | 0.1161 | 0.1810 | 460 | S3 |
| | UniDegree | 0.6894 | 0.0303 | 0.6269 | 0.7456 | 235 | S1 |
| | | 0.6044 | 0.0327 | 0.5386 | 0.6667 | 225 | S2 |
| | | 0.6478 | 0.0222 | 0.6028 | 0.6903 | 460 | S3 |
| | College | 0.0596 | 0.0155 | 0.0355 | 0.0984 | 235 | S1 |
| | | 0.0178 | 0.0088 | 0.0066 | 0.0467 | 225 | S2 |
| | | 0.0391 | 0.0090 | 0.0247 | 0.0613 | 460 | S3 |
| | Intermediate | 0.0383 | 0.0125 | 0.0199 | 0.0723 | 235 | S1 |
| | | 0.0489 | 0.0144 | 0.0272 | 0.0865 | 225 | S2 |
| | | 0.0434 | 0.0095 | 0.0281 | 0.0665 | 460 | S3 |
| | OtherEdu | 0.0255 | 0.0103 | 0.0114 | 0.0560 | 235 | S1 |
| | | 0.0889 | 0.0190 | 0.0579 | 0.1342 | 225 | S2 |
| | | 0.0565 | 0.0107 | 0.0387 | 0.0818 | 460 | S3 |
| *Control variables* | | | | | | | |
| ImportExport | Yes/1 | 0.0336 | 0.0100 | 0.0187 | 0.0599 | 327 | S1 |
| | | 0.2194 | 0.0269 | 0.1709 | 0.2770 | 237 | S2 |
| | | 0.1117 | 0.0132 | 0.0881 | 0.1405 | 564 | S3 |
| | No/0 | 0.9664 | 0.0100 | 0.9401 | 0.9813 | 327 | S1 |
| | | 0.7806 | 0.0269 | 0.7230 | 0.8291 | 237 | S2 |
| | | 0.8882 | 0.0132 | 0.8594 | 0.9118 | 564 | S3 |
| SpecialZone | Yes/1 | 0.0214 | 0.0080 | 0.0102 | 0.0444 | 327 | S1 |
| | | 0.1646 | 0.0241 | 0.1223 | 0.2177 | 237 | S2 |
| | | 0.0815 | 0.0115 | 0.0615 | 0.1072 | 564 | S3 |
| | No/0 | 0.9786 | 0.0080 | 0.9556 | 0.9898 | 327 | S1 |
| | | 0.8354 | 0.0241 | 0.7823 | 0.8777 | 237 | S2 |
| | | 0.9184 | 0.0115 | 0.8927 | 0.9384 | 564 | S3 |
| CenCity | Yes/1 | 0.9052 | 0.0162 | 0.8681 | 0.9327 | 327 | S1 |
| | | 0.3713 | 0.0315 | 0.3117 | 0.4351 | 237 | S2 |
| | | 0.6808 | 0.0196 | 0.6410 | 0.7181 | 564 | S3 |
| | No/0 | 0.0948 | 0.0162 | 0.0673 | 0.1319 | 327 | S1 |
| | | 0.6287 | 0.0315 | 0.5649 | 0.6883 | 237 | S2 |
| | | 0.3191 | 0.0196 | 0.2818 | 0.3589 | 564 | S3 |

**Notes:** S1, S2, and S3 denote SRTD firms, CSRTD firms, and all firms in the SRTD industry, respectively.

**Source:** Authors' calculation

Except for ROE, the mean performance of CSRTD firms is higher than that of SRTD firms and the average of all firms in the SRTD industry in terms of *TotalNetSales, log_TotalNetSales,* and *AssetTurnover*. This is probably because of the bigger size of CSRTD firms compared with that of STRD firms and the average of all firms in the SRTD industry in terms of total assets and number of employees. The mean age of CEOs of SRTD firms is lower than that of CSRTD firms while the mean age of CEOs of all firms in the SRTD industry is about 46 years old. Male CEOs dominate the industry with 73.69% on average while only 28.75% of CEOs in SRTD firms and 21.94% of those in CSRTD firms are female. The similar tendency of more men-led businesses is also witnessed in the study of Anh and Duong (2018) with male-dominated industries in Vietnam including metal, leatherwork, building, chemicals, motor vehicle, electric and electronic ones. The majority of CEOs have got university degrees with 64.78%, 68.94%, and 60.44% for all firms in the SRTD industry, SRTD firms, and CSRTD firms, respectively. Only a small number of CEOs have got a doctoral degree. About 14.5% of them have got master's degrees in the industry while CSRTD firms have more CEOs with master's degrees than SRTD firms. Generally, CEOs in this industry have high education with only 13.9% of them have got qualifications below a university degree.

Some firm-specific characters are also revealed such as 21.94% of CSRTD firms having import-export activity in the study year whilst only 3.3% of SRTD firms do have such activity. The rate of firms operating in an industrial zone, manufacturing zone, economic zone, or high-tech zone is 2.14% and 16.46% for SRTDs and CSRTDs, accordingly, in comparison with about 8% for all firms in the SRTD industry. The location of SRTD firms is mainly in central cities while only 37.13% of CSRTD firms are based in those cities. CSRTD firms are much more mature with mean firm age of about 12.4 years compared with 3.8 years old of SRTD firms and the average firm age in the whole SRTD industry of 7.4 years. The youngest firms in this industry were just established in 2017. The oldest firm is 62 years old. The mean leverage of CSRTD firms is higher than that of SRTD firms and the industry as a whole with 1.57, 1.28, and 1.40, respectively.

### *4.2 OLS regression results*

Table 4 shows the results of the OLS regressions for the three samples of firms.

*CEOAge* is found positively correlated with ROE of SRTD firms with a minuscule coefficient of 0.0063 but only significant at the 10% significance level. It is insignificant in other measures of performance for both CSRTD firms and SRTD industry. This result is not supportive of H1, in which young CEOs are more highly evaluated. This result coincides with the positive tendency among CEO age and Tobin's Q of firms as in the study of Gottesman and Morey (2010) or that of Jalbert *et al.* (2011), in which firm performance is proxied by return on assets (ROA). Higher age may support CEOs due to their on-the-job maturity and hands-on experience accumulated through their tenure in the firms. In this case, however, the impact is weak with the level of significance at only 10%.

**Table 4.** OLS regression results and adjustments

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | log_TNS | TNS | ROE | A.T. | log_TNS | TNS | ROE | A.T. | log_TNS |
| CEOAge | -561.6845 | 0.0063$^{*}$ | -0.0041 | 0.0019 | 899.78 | -0.0012 | -0.0065 | -0.0088 | -1178.239 | 0.0014 | -0.0039 | -0 |
| | (941.3961) | (0.0037) | (0.0084) | (0.0121) | (3659.642) | (0.0022) | (0.0048) | (0.0068) | (1728.707) | (0.0016) | (0.0043) | (0.0064) |
| CEOGender_Male | -38042.3$^{*}$ | 0.0679 | -0.4917$^{***}$ | -0.1703 | -72575.36 | 0.0231 | 0.2408$^{*}$ | 0.1492 | -42753.51 | 0.0408 | -0.0447 | -0.0202 |
| | (20125.43) | (0.0803) | (0.1807) | (0.2604) | (98051.32) | (0.0481) | (0.1274) | (0.1786) | (40312.6) | (0.0468) | (0.108) | (0.1434) |
| Doctor | -23922.22 | -0.1042 | -0.2589 | -1.2138$^{***}$ | -131551.2 | -0.064 | 0.1212 | 0.1163 | -48855.86 | -0.1106$^{*}$ | -0.0603 | -0.4921 |
| | (30967.28) | (0.1235) | (0.2781) | (0.4007) | (127814.3) | (0.0508) | (0.1949) | (0.2735) | (61441.67) | (0.0643) | (0.1684) | (0.3506) |
| Master | -29102.41 | 0.055 | -0.0432 | 0.2078 | -124825 | 0.0202 | 0.2147 | 0.4509$^{**}$ | -55821.41 | 0.0107 | 0.1258 | 0.3194$^{*}$ |
| | (28058.2) | (0.1119) | (0.252) | (0.363) | (87012.97) | (0.0613) | (0.1314) | (0.1841) | (45302.55) | (0.0672) | (0.123) | (0.1722) |
| College | 3866.473 | 0.0543 | -0.0324 | 0.5313 | -67068.93 | -0.5711 | 0.4886 | 0.6558 | 18772.46 | -0.1545 | -0.2166 | 0.1618 |
| | (43985.14) | (0.1755) | (0.3951) | (0.5692) | (316083.1) | (0.4555) | (0.6306) | (0.9114) | (121067) | (0.1) | (0.3296) | (0.2769) |
| Intermediate | 3925.219 | 0.0947 | 1.2958$^{*}$ | 0.5212 | -98011.32 | 0.0049 | -0.04 | 0.3362 | -79239.4 | 0.0015 | 0.1138 | 0.3033 |
| | (83333.88) | (0.3325) | (0.7485) | (1.0784) | (290083.9) | (0.0574) | (0.2371) | (0.332) | (148118.7) | (0.0437) | (0.2416) | (0.2961) |
| OtherEdu | -36192.17 | 0.1304 | -1.1775 | -0.064 | -138084.9 | -0.005 | 0.0068 | -0.0085 | -119899 | 0.0203 | -0.0658 | 0.0094 |
| | (82243.47) | (0.3282) | (0.7387) | (1.0642) | (175043.4) | (0.0751) | (0.1812) | (0.2594) | (103977.8) | (0.0736) | (0.1886) | (0.2459) |
| FirmAge | 2591.15 | 0.0075 | 0.007 | 0.0583$^{*}$ | 7603.944$^{*}$ | 0.0004 | 0.0052 | 0.0133$^{*}$ | 8735.779$^{***}$ | 0.0005 | 0.0015 | 0.0108$^{*}$ |
| | (2657.776) | (0.0106) | (0.0238) | (0.0343) | (3920.147) | (0.0021) | (0.0051) | (0.0071) | (2359.816) | (0.0018) | (0.0053) | (0.0061) |
| Leverage | 5925.225$^{*}$ | -0.0389$^{***}$ | -0.0384 | -0.057 | 700.1318 | -0.0125$^{***}$ | 0.0052 | 0.0288$^{***}$ | 1967.429 | -0.0114$^{***}$ | -0.0027 | 0.0195$^{***}$ |
| | (3141.15) | (0.0125) | (0.0282) | (0.0406) | (6392.009) | (0.0041) | (0.0057) | (0.0086) | (3874.369) | (0.0041) | (0.005) | (0.0038) |
| log_AvTotalAssets | 27888.54$^{***}$ | -0.0373 | -0.454$^{***}$ | 0.473$^{***}$ | 61988.74 | -0.0179 | -0.2701$^{***}$ | 0.4462$^{***}$ | 30662.37 | -0.0144 | -0.3471$^{***}$ | 0.5071$^{***}$ |
| | (8988.699) | (0.0358) | (0.0807) | (0.1163) | (44176.09) | (0.0404) | (0.0592) | (0.084) | (18633.84) | (0.0263) | (0.0491) | (0.0869) |
| log_Tax | 13674.18$^{**}$ | 0.089$^{***}$ | 0.2381$^{***}$ | 0.4815$^{***}$ | 59011.44$^{**}$ | 0.0116 | 0.1376$^{***}$ | 0.2823$^{***}$ | 27877.71$^{**}$ | 0.0331$^{**}$ | 0.1918$^{***}$ | 0.3605$^{***}$ |
| | (5493.474) | 0.0219 | (0.0493) | (0.071) | (26207.67) | (0.0135) | (0.0289) | (0.0405) | (10962.17) | (0.0135) | (0.026) | (0.0424) |
| log_LabourSize | -19132.55 | -0.0469 | 0.3852$^{***}$ | 0.3059$^{*}$ | 20742.82 | 0.0214 | 0.2052$^{***}$ | 0.3508$^{***}$ | 1026.17 | 0.0054 | 0.2522$^{***}$ | 0.3218$^{***}$ |
| | (12324.55) | (0.0491) | (0.1107) | (0.1594) | (41023.36) | (0.0222) | (0.0588) | (0.0827) | (21607.26) | (0.0222) | (0.0544) | (0.0777) |

**Table 4.** OLS regression results and adjustments *(continued)*

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | log_TNS | TNS | ROE | A.T. | log_TNS | TNS | ROE | A.T. | log_TNS |
| ImportExport | -51878.77 | -0.1361 | -0.0715 | 0.0037 | -169538.5* | 0.1797 | 0.0409 | 0.2134 | -111987.9* | 0.1544 | 0.0623 | 0.1653 |
| | (52680.23) | (0.2102) | (0.4732) | (0.6817) | (96960.53) | (0.1109) | (0.1299) | (0.1819) | (59411.29) | (0.0975) | (0.1328) | (0.1759) |
| SpecialZone | 66225.83 | 0.0241 | 1.5875** | 0.9103 | -33751.54 | -0.1247** | -0.0587 | -0.0693 | -18406.88 | -0.1067** | 0.0668 | 0.0795 |
| | (66990.94) | (0.2673) | (0.6017) | (0.8669) | (120920.1) | (0.0544) | (0.1354) | (0.1896) | (76675.35) | (0.0529) | (0.1424) | (0.1864) |
| CenCity | -71309.47* | 0.0213 | 0.2635 | 0.2569 | 0 | 0.0519 | -0.2388** | -0.1533 | 0 | -0.0058 | -0.1339 | -0.1964 |
| | (36460.71) | (0.1455) | (0.3275) | (0.4718) | (omitted) | (0.0596) | (0.109) | (0.1533) | (omitted) | (0.0415) | (0.1009) | (0.151) |
| log_FixedAssets | 6069.002 | 0.0126 | -0.0011 | -0.0795 | -39102.38 | -0.0104 | -0.0294 | -0.0325 | -1035.76 | -0.0114 | -0.0313 | -0.0871 |
| | (5633.266) | (0.0224) | (0.0506) | (0.0728) | (31172.13) | (0.0188) | (0.0393) | (0.0553) | (11828.07) | (0.0125) | (0.0316) | (0.0581) |
| _cons | -169642.1** | -0.3323 | 3.2626*** | 0.9822 | -635078** | 0.2424 | 2.4683*** | 2.4557*** | -324550.8*** | -0.0025 | 2.9756*** | 1.7281*** |
| | (76465.51) | (0.3051) | (0.6868) | (0.9895) | 279184.6 | (0.3405) | (0.4262) | (0.6044) | (122455.4) | (0.2138) | (0.3602) | (0.6029) |
| $R^2$ | 0.4967 | 0.3948 | 0.6827 | 0.8524 | 0.5108 | 0.2171 | 0.343 | 0.8593 | 0.437 | 0.1973 | 0.3809 | 0.8638 |
| *Adjusted $R^2$* | 0.3689 | 0.241 | 0.6922 | 0.815 | 0.3611 | --- | 0.2804 | 0.8459 | 0.3678 | --- | 0.3409 | --- |
| *f-statistic* | 0.0001 | 0.0041 | 0.0000 | 0.0000 | 0.0006 | 0.0177 | 0.0000 | 0.0000 | 0 | 0.0003 | 0.0000 | 0.0000 |
| *No. of Observations* | 80 | 80 | 80 | 80 | 65 | 185 | 185 | 184 | 138 | 265 | 265 | 264 |
| *Mean VIF* | 1.7 | 1.7 | 1.7 | 1.7 | 2.1 | 2 | 2 | 2.03 | 1.87 | 1.93 | 1.93 | 1.94 |
| *White's test - Pro>chi²* | 0.2968 | 0.2973 | 0.3797 | 0.3293 | --- | --- | 0.1646 | 0.0787 | --- | --- | 0.6843 | --- |
| *Jarque-Bera Test_Pro* | 0.0000 | 1.00E-32 | 9.00E-140 | 9.90E-05 | --- | --- | 2.60E-34 | 0.1652 | --- | --- | 4.00E-172 | --- |

**Notes:** *** indicates $p < 0.01$; ** indicates $p < 0.05$, * indicates $p < 0.10$. Abbreviations for measures of firm performance include TNS (for *TotalNetSales*), A.T. (for *Asset Turnover*); log_TNS (for *log_TotalNetSales*). Standard errors in parentheses except for the following cases in which robust standard errors are applied: ROE of CSRTD firms and ROE and *log_TNS* of SRTD Industry due to violations of homoskedasticity assumption of OLS regression. Weighted least squares regression (WLS) is applied for TNS of CSRTD firms and SRTD Industry as robust standard errors regression does not provide significant F statistics of the model.

**Source:** Authors' estimate.

Male CEOs of SRTD firms seem to under-perform compared to their female counterparts with negative coefficients for both *TotalNetSales* and *AssetTurnover* while the opposite exists with CSRTD firms with a positive coefficient of 0.2408 at the 10% level of significance for *AssetTurnover*. This finding supports the proposition of H2 only for SRTD firms where female CEOs are predicted to be more successful. It does not support the CSRTD case. The influence of *CEOGender* is not unearthed for the SRTD industry. The outperformance of SRTD firms' female CEOs might be originated from their gender characters that may encourage a working environment where new idea development is nurtured and knowledge is exchanged with better communication, trust, and more effective usage of resources to achieve better results (Ruiz-Jiménez and Fuentes-Fuentes, 2016).

For CEO education, SRTD firms witness some extraordinary results when compared with H2 such as CEOs with doctor's degrees perform not as well as those with a university degree. There is a negative coefficient of -1.21 for *log_TotalNetSales* at the 1% significance level. The CEOs with intermediate degrees outperform those with university degrees with a positive coefficient of 1.29 at the level of 10% significance. It seems that the doctoral degree does not support CEOs in their firm operations. Though doctor degrees are customarily earned by academia, a lot of doctorates end up with work in the industry. This contrary result coincides with the study of Jalbert *et al.* (2002) in which CEOs without an undergraduate degree or graduate degree outperform those that have such a degree. Firms with CEOs holding an undergraduate or graduate degree from Ivy League do not perform differently than other firms (Gottesman and Morey, 2010). To explain this seeming paradox, Hamori and Koyuncu (2015) argue that to be successful or to continue being successful as CEOs in a new organization, new skills and abilities need to be acquired by CEOs to meet the challenges. CEOs of CSRTD firms and all the firms in the SRTD industry with master degrees have better performance than those with a university degree with a coefficient of 0.45 and 0.31 for log_TotalNetSales at 5% and 10% levels of significance, respectively. This finding is in line with previous empirical studies and supports H3. In the literature, it is found that CEOs with university degrees do have better ROE than those without it (Jalbert *et al.*, 2011). The CEOs in the banking industry with better MBA qualifications get higher profitability than non-MBA CEOs (King *et al.*, 2016). In terms of business practices, a master degree seems to support CEOs of CSRTD firms and all firms in the SRTD industry than a doctor degree.

All the $R^2$ and adjusted $R^2$ from OLS regressions are found to be high with highly significant at less than 1% level F statistics, thus, confirming model fitting. The regressions do not encounter severe multicollinearity issues as the mean VIF is low, which is about two or less, and variance homogeneity assumption of OLS regression holds with probabilities under White tests.

### *4.3 Robust regression results*

**Table 5.** Robust regressions results

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS |
| CEOAge | -6.5624 | 0.0004 | -0.0038 | -0.006 | -541.3571$^{*}$ | 0.0004 | -0.0021 | -0.0071 | -26.149 | -0.00004 | -0.0006 | -0.0039 |
| | (27.9285) | (0.0012) | (0.0051) | (0.0106) | (317.555) | (0.0007) | (0.004) | (0.007) | (65.0891) | (0.0004) | (0.0031) | (0.0055) |
| CEOGender_Male | -1299.463$^{**}$ | -0.0324 | -0.3741$^{***}$ | -0.1647 | 12255.46 | -0.0065 | 0.1106 | 0.1935 | -2261.262 | 0.008 | -0.0491 | 0.0368 |
| | (614.1564) | (0.026) | (0.111) | (0.2271) | (8360.454) | (0.0199) | (0.1055) | (0.1837) | (1632.24) | (0.0109) | (0.0794) | (0.1393) |
| Doctor | 886.9272 | -0.0828$^{**}$ | -0.3592$^{**}$ | -0.6695$^{*}$ | -114.8915 | -0.0406 | -0.0925 | 0.0759 | 3079.588 | -0.0106 | -0.1779 | -0.1612 |
| | (919.179) | (0.0401) | (0.1709) | (0.3494) | (12786.1) | (0.0304) | (0.1613) | (0.2814) | (2545.069) | (0.017) | (0.1238) | (0.2171) |
| Master | 963.7908 | 0.0433 | 0.1537 | 0.3274 | 12824.49 | 0.0095 | 0.1454 | 0.3489$^{*}$ | 2472.199 | 0.0313$^{**}$ | 0.1107 | 0.2749$^{*}$ |
| | (836.5553) | (0.0363) | (0.1548) | (0.3166) | (8666.77) | (0.0205) | (0.1088) | (0.1894) | (1867.196) | (0.0124) | (0.0904) | (0.1585) |
| College | -185.9427 | 0.1021$^{*}$ | 0.2284 | 0.34 | 47552.11 | 0 | 0.455 | 0.5057 | 223.3483 | 0.0148 | 0.0756 | 0.0745 |
| | (1305.953) | (0.0569) | (0.2427) | (0.4963) | (41391.46) | (omitted) | (0.522) | (0.9377) | (4982.552) | (0.0338) | (0.2422) | (0.4264) |
| Intermediate | 388.3847 | 0.0159 | 2.1236$^{***}$ | 0.2623 | -1466.276 | -0.003 | 0.0207 | 0.26 | -3065.464 | 0.0103 | 0.0166 | 0.3131 |
| | (2472.208) | (0.1079) | (0.4599) | (0.9404) | (15552.97) | (0.037) | (0.1963) | (0.3415) | (3649.696) | (0.0244) | (0.1775) | (0.3114) |
| OtherEdu | -2898.479 | -0.0194 | -0.7617$^{*}$ | -0.4397 | 6515.101 | -0.0125 | 0.0363 | -0.0061 | -5256.843$^{*}$ | -0.0033 | 0.0175 | -0.0187 |
| | (2442.166) | (0.1065) | (0.4539) | (0.9281) | (11897.15) | (0.0287) | (0.15) | (0.2669) | (2850.114) | (0.0193) | (0.1386) | (0.2496) |
| FirmAge | 41.2396 | 0.0113$^{***}$ | 0.003 | 0.0585$^{*}$ | 3243.391$^{***}$ | 0.0032$^{***}$ | 0.0064 | 0.0111 | 530.9279$^{***}$ | 0.0023$^{***}$ | 0.0048 | 0.009 |
| | (78.8469) | (0.0034) | (0.0146) | (0.0299) | (341.3213) | (0.0008) | (0.0042) | (0.0073) | (81.3198) | (0.0005) | (0.0039) | (0.0068) |
| Leverage | -29.5631 | -0.0396$^{***}$ | -0.0405$^{**}$ | -0.0693$^{*}$ | 360.8385 | -0.0197$^{***}$ | 0.005 | 0.0272$^{***}$ | 60.3226 | 0.0025$^{**}$ | 0.0009 | 0.0219$^{***}$ |
| | (96.0532) | (0.004) | (0.0173) | (0.0354) | (380.1563) | (0.0015) | (0.0047) | (0.0089) | (75.9581) | (0.001) | (0.0036) | (0.0067) |
| log-AvTotalAssets | 422.7384 | -0.0199$^{*}$ | -0.259$^{***}$ | 0.3626$^{***}$ | 3906.268 | 0.0058 | -0.2071$^{***}$ | 0.5$^{***}$ | 1427.94$^{*}$ | -0.0067 | -0.2265$^{***}$ | 0.4315$^{***}$ |
| | (273.6769) | (0.0116) | (0.0496) | (0.1014) | (3929.668) | (0.0092) | (0.049) | (0.0864) | (748.1856) | (0.0049) | (0.0361) | (0.0638) |

**Table 5.** Robust regressions results *(continued)*

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS |
| log_Tax | 1009.733*** | 0.0323*** | 0.1917*** | 0.3974*** | 2861.539 | 0.0076* | 0.1186*** | 0.2645*** | 1217.461*** | 0.0088*** | 0.1488*** | 0.3285*** |
| | (167.5083) | (0.0071) | (0.0303) | (0.0619) | (1920.741) | (0.0045) | (0.0239) | (0.0416) | (397.7261) | (0.0026) | (0.0191) | (0.0336) |
| log_LabourSize | 602.3684 | 0.0022 | 0.1934*** | 0.3875*** | 15963.74*** | -0.0029 | 0.1393*** | 0.3741*** | 2020.659** | 0.0006 | 0.1359*** | 0.3578*** |
| | (371.7726) | (0.0159) | (0.068) | (0.139) | (3897.64) | (0.0091) | (0.0487) | (0.0851) | (827.3383) | (0.0055) | (0.04) | (0.0703) |
| ImportExport | 39183.49*** | -0.0292 | 0.0529 | -0.043 | 13015.88 | 0.0246 | 0.1229 | 0.2207 | 15392.83*** | 0.0455*** | 0.1435 | 0.1912 |
| | (1582.776) | (0.0682) | (0.2907) | (0.5944) | (8533.94) | (0.0203) | (0.1075) | (0.1871) | (2008.746) | (0.0134) | (0.0976) | (0.1711) |
| SpecialZone | -0.2149 | 0.1592* | 1.6927*** | 1.0049 | 9828.782 | -0.0196 | -0.078 | -0.1094 | -15.1409 | -0.0006 | -0.0396 | -0.0077 |
| | (1987.656) | (0.0867) | (0.3697) | (0.7559) | (8941.999) | (0.0211) | (0.1121) | (0.1951) | (2166.186) | (0.0143) | (0.1047) | (0.1836) |
| CenCity | 416.429 | 0.1322*** | -0.0056 | 0.3711 | -1176.774 | 0.0007 | -0.1187 | -0.1709 | -2536.766* | 0.0069 | -0.0744 | -0.1368 |
| | (1088.967) | (0.0472) | (0.2012) | (0.4114) | (7176.989) | (0.0172) | (0.0902) | (0.1577) | (1528.71) | (0.0102) | (0.0742) | 0.1306 |
| log_FixedAssets | 45.3022 | 0.0006 | -0.0127 | 0.0169 | -1110.683 | 0.0012 | -0.0315 | -0.0848 | 426.1193 | -0.0013 | -0.0256 | -0.0352 |
| | (168.1164) | (0.0072) | (0.031) | (0.0635) | (2580.719) | (0.0061) | (0.0325) | (0.0569) | (478.0181) | (0.0032) | (0.0232) | (0.0408) |
| _cons | -5088.092** | -0.0763 | 2.2833*** | 1.8757** | -88568.74*** | -0.0975 | 1.9059*** | 2.3543*** | -17880.12*** | 0.0011 | 1.9629*** | 2.3127*** |
| | (2306.253) | (0.099) | (0.422) | (0.8629) | (28464.3) | (0.0667) | (0.3528) | (0.6219) | (5489.976) | (0.0364) | (0.2647) | (0.4685) |
| $R^2$ | 0.3635 | 0.1344 | 0.5124 | 0.6923 | 0.2144 | 0.0317 | 0.2762 | 0.7339 | 0.1532 | 0.1175 | 0.2867 | 0.7309 |
| *Prob > F* | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| *No. of Observations* | 79 | 80 | 80 | 80 | 184 | 183 | 185 | 184 | 264 | 264 | 265 | 264 |
| *Jarque-Bera Test_Pro* | 0.0000 | 8.40E-97 | 0.0000 | 7.60E-29 | 0.0000 | 0.0000 | 2.70E-66 | 0.0081 | 0.0000 | 0.0000 | 2.00E-288 | 3.20E-38 |

**Notes:** Standard errors are in parentheses; *** indicates $p < 0.01$; ** indicates $p < 0.05$, * indicates $p < 0.10$;

**Source:** Authors' estimate

Table 5 provides the robust regression results of all three samples in the study.

Under robust regressions, *CEOAge* is only significant at a 10% level with a negative coefficient of -541.3571 for *TotalNetSales*, providing weak evidence to support H1. This result suggests that older CEOs underperform younger CEOs. The male CEOs of SRTD firms have consistently lower performance measured by *TotalNetSales* and *AssetTurnover* at 5% and 1% levels of significance, respectively. This finding lends support to H2 and consistently coincides with the OLS results in Table 4. The CEOs of SRTD firms with doctoral degrees have lower performance in ROE, *AssetTurnover*, and *log_TotalNetSales* compared to those with university degrees. No significant difference is, however, detected for CSRTD firms and all firms in the SRTD industry. The CEOs of SRTD firms with college and intermediate degrees outperform those with the university regarding ROE at 10% significance level and for *AssetTurnover* at 1% significance level. Nonetheless, the CEOs with other educational degrees have lower *AssetTurnover* than those with a university degree at a 10% level of significance. The effect of CEO education on the performance of SRTD firms is, therefore, a mixture compared with the proposition of H3.

For CSRTD firms and all firms in the SRTD industry, the CEOs with master degrees are found to have higher *log_TotalNetSales* at a 10% significance level. They also have higher ROE and *log_TotalNetSales* at 5% and 1% significance levels, respectively, than those with a university degree. In the SRTD industry, the CEOs with other educational levels perform not as well as those with university degrees with a coefficient of -5256.84 at a 10% level of significance. The results from robust regressions for SRTD firms reconfirm the OLS results, which are a mixture compared to H3. The results for CSRTD firms and all firms in the SRTD industry show that higher education of CEOs is in line with higher firm performance. This seeming paradox can be explained by the argument of Kitchell (2009) in which CEO education can be categorized into cognitive abilities and functional specialization. The degree that a CEO gets from school is just for higher cognition while running a firm specializing in research and technology may require other capabilities and skills that are more technically oriented.

***4.4 Robust regression results with interaction terms on CEO characteristics***

Table 6 provides robust regression results with interaction terms between *CEOAge* and *CEOEdu*.

**Table 6.** Robust regressions with interaction term (CEOAge*CEOEdu)

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS |
| CEOAge | -6.5624 | 0.0004 | -0.0038 | -0.006 | -541.3571* | 0.0004 | -0.0021 | -0.0071 | -26.149 | -0.00004 | -0.0006 | -0.0039 |
| | (27.9285) | (0.0012) | (0.0051) | (0.0106) | (317.555) | (0.0007) | (0.004) | (0.007) | (65.0891) | (0.0004) | (0.0031) | (0.0055) |
| CEOGender_Male | -1299.463** | -0.0324 | -0.3741*** | -0.1647 | 12255.46 | -0.0065 | 0.1106 | 0.1935 | -2261.262 | 0.008 | -0.0491 | 0.0368 |
| | (614.1564) | (0.026) | (0.111) | (0.2271) | (8360.454) | (0.0199) | (0.1055) | (0.1837) | (1632.24) | (0.0109) | (0.0794) | (0.1393) |
| Doctor | 886.9272 | -0.0828** | -0.3592** | -0.6695* | -114.8915 | -0.0406 | -0.0925 | 0.0759 | 3079.588 | -0.0106 | -0.1779 | -0.1612 |
| | (919.179) | (0.0401) | (0.1709) | (0.3494) | (12786.1) | (0.0304) | (0.1613) | (0.2814) | (2545.069) | (0.017) | (0.1238) | (0.2171) |
| Master | 963.7908 | 0.0433 | 0.1537 | 0.3274 | 12824.49 | 0.0095 | 0.1454 | 0.3489* | 2472.199 | 0.0313** | 0.1107 | 0.2749* |
| | (836.5553) | (0.0363) | (0.1548) | (0.3166) | (8666.77) | (0.0205) | (0.1088) | (0.1894) | (1867.196) | (0.0124) | (0.0904) | (0.1585) |
| College | -185.9427 | 0.1021* | 0.2284 | 0.34 | 47552.11 | 0 | 0.455 | 0.5057 | 223.3483 | 0.0148 | 0.0756 | 0.0745 |
| | (1305.953) | (0.0569) | (0.2427) | (0.4963) | (41391.46) | (omitted) | (0.522) | (0.9377) | (4982.552) | (0.0338) | (0.2422) | (0.4264) |
| Intermediate | 388.3847 | 0.0159 | 2.1236*** | 0.2623 | -1466.276 | -0.003 | 0.0207 | 0.26 | -3065.464 | 0.0103 | 0.0166 | 0.3131 |
| | (2472.208) | (0.1079) | (0.4599) | (0.9404) | (15552.97) | (0.037) | (0.1963) | (0.3415) | (3649.696) | (0.0244) | (0.1775) | (0.3114) |
| OtherEdu | -2898.479 | -0.0194 | -0.7617* | -0.4397 | 6515.101 | -0.0125 | 0.0363 | -0.0061 | -5256.843* | -0.0033 | 0.0175 | -0.0187 |
| | (2442.166) | (0.1065) | (0.4539) | (0.9281) | (11897.15) | (0.0287) | (0.15) | (0.2669) | (2850.114) | (0.0193) | (0.1386) | (0.2496) |
| FirmAge | 41.2396 | 0.0113*** | 0.003 | 0.0585* | 3243.391*** | 0.0032*** | 0.0064 | 0.0111 | 530.9279*** | 0.0023*** | 0.0048 | 0.009 |
| | (78.8469) | (0.0034) | (0.0146) | (0.0299) | (341.3213) | (0.0008) | (0.0042) | (0.0073) | (81.3198) | (0.0005) | (0.0039) | (0.0068) |
| Leverage | -29.5631 | -0.0396*** | -0.0405** | -0.0693* | 360.8385 | -0.0197*** | 0.005 | 0.0272*** | 60.3226 | 0.0025** | 0.0009 | 0.0219*** |
| | (96.0532) | (0.004) | (0.0173) | (0.0354) | (380.1563) | (0.0015) | (0.0047) | (0.0089) | (75.9581) | (0.001) | (0.0036) | (0.0067) |
| log-AvTotalAssets | 422.7384 | -0.0199* | -0.259*** | 0.3626*** | 3906.268 | 0.0058 | -0.2071*** | 0.5*** | 1427.94* | -0.0067 | -0.2265*** | 0.4315*** |
| | (273.6769) | (0.0116) | (0.0496) | (0.1014) | (3929.668) | (0.0092) | (0.049) | (0.0864) | (748.1856) | (0.0049) | (0.0361) | (0.0638) |

**Table 6.** Robust regressions with interaction term (CEOAge*CEOEdu) *(continued)*

| | SRTD firms | | | | CSRTD firms | | | | SRTD Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS | TNS | ROE | A.T. | Log_TNS |
| log_Tax | 1009.733*** | 0.0323*** | 0.1917*** | 0.3974*** | 2861.539 | 0.0076* | 0.1186*** | 0.2645*** | 1217.461*** | 0.0088*** | 0.1488*** | 0.3285*** |
| | (167.5083) | (0.0071) | (0.0303) | (0.0619) | (1920.741) | (0.0045) | (0.0239) | (0.0416) | (397.7261) | (0.0026) | (0.0191) | (0.0336) |
| log_LabourSize | 602.3684 | 0.0022 | 0.1934*** | 0.3875*** | 15963.74*** | -0.0029 | 0.1393*** | 0.3741*** | 2020.659** | 0.0006 | 0.1359*** | 0.3578*** |
| | (371.7726) | (0.0159) | (0.068) | (0.139) | (3897.64) | (0.0091) | (0.0487) | (0.0851) | (827.3383) | (0.0055) | (0.04) | (0.0703) |
| ImportExport | 39183.49*** | -0.0292 | 0.0529 | -0.043 | 13015.88 | 0.0246 | 0.1229 | 0.2207 | 15392.83*** | 0.0455*** | 0.1435 | 0.1912 |
| | (1582.776) | (0.0682) | (0.2907) | (0.5944) | (8533.94) | (0.0203) | (0.1075) | (0.1871) | (2008.746) | (0.0134) | (0.0976) | (0.1711) |
| SpecialZone | -0.2149 | 0.1592* | 1.6927*** | 1.0049 | 9828.782 | -0.0196 | -0.078 | -0.1094 | -15.1409 | -0.0006 | -0.0396 | -0.0077 |
| | (1987.656) | (0.0867) | (0.3697) | (0.7559) | (8941.999) | (0.0211) | (0.1121) | (0.1951) | (2166.186) | (0.0143) | (0.1047) | (0.1836) |
| CenCity | 416.429 | 0.1322*** | -0.0056 | 0.3711 | -1176.774 | 0.0007 | -0.1187 | -0.1709 | -2536.766* | 0.0069 | -0.0744 | -0.1368 |
| | (1088.967) | (0.0472) | (0.2012) | (0.4114) | (7176.989) | (0.0172) | (0.0902) | (0.1577) | (1528.71) | (0.0102) | (0.0742) | 0.1306 |
| log_FixedAssets | 45.3022 | 0.0006 | -0.0127 | 0.0169 | -1110.683 | 0.0012 | -0.0315 | -0.0848 | 426.1193 | -0.0013 | -0.0256 | -0.0352 |
| | (168.1164) | (0.0072) | (0.031) | (0.0635) | (2580.719) | (0.0061) | (0.0325) | (0.0569) | (478.0181) | (0.0032) | (0.0232) | (0.0408) |
| _cons | -5088.092** | -0.0763 | 2.2833*** | 1.8757** | -88568.74*** | -0.0975 | 1.9059*** | 2.3543*** | -17880.12*** | 0.0011 | 1.9629*** | 2.3127*** |
| | (2306.253) | (0.099) | (0.422) | (0.8629) | (28464.3) | (0.0667) | (0.3528) | (0.6219) | (5489.976) | (0.0364) | (0.2647) | (0.4685) |
| $R^2$ | 0.3635 | 0.1344 | 0.5124 | 0.6923 | 0.2144 | 0.0317 | 0.2762 | 0.7339 | 0.1532 | 0.1175 | 0.2867 | 0.7309 |
| *Prob > F* | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| *No. of Observations* | 79 | 80 | 80 | 80 | 184 | 183 | 185 | 184 | 264 | 264 | 265 | 264 |
| *Jarque-Bera Test_Pro* | 0.0000 | 8.40E-97 | 0.0000 | 7.60E-29 | 0.0000 | 0.0000 | 2.70E-66 | 0.0081 | 0.0000 | 0.0000 | 2.00E-288 | 3.20E-38 |

**Notes:** Standard errors are in parentheses; *** indicates $p < 0.01$; ** indicates $p < 0.05$, * indicates $p < 0.10$.

**Source:** Authors' estimate

As presented in Table 6, *CEO age* and *CEO education* do not have any significant relationship with firm performance whether being measured by *TotalNetSales*, *log_TotalNetSales*, ROE, or *AssetTurnover* in all firms in the SRTD industry. For CSRTD firms, CEO age is negatively related to *log_TotalNetSales*, which means the older CEOs have lower *log_TotalNetSales*. This relationship is, however, weak with a 10% level of significance and the coefficient is -0.0531. For SRTD firms, *CEOGender_Male* is statistically significant at 5% and 1% levels with negative coefficients of -1370.331 and -0.35668, suggesting that male CEOs run firms not as well as their female counterparts. This result supports H2 and consistent with results found from the OLS and robust regressions without the interaction term.

The interaction term of *CEOAge*CEOEdu* is significant for CSRTD firms but not significant for all firms in the SRTD industry and SRTD firms. The coefficient of 0.0513 at a 10% level of significance means a difference in *log_TotalNetSales* of CEOs with university degrees compared with other educational levels. The total difference of the impact of *CEOAge* on *log_TotalNetSales* for the CEOs with university degrees is -0.0018, which means that with the same university degree, older CEOs have 1.8% of *log_TotalNetSales* lower than young CEOs at a 10% level of significance. This result supports H1 with an appreciation for the capability of younger CEOs. The negative coefficient of -2.9466 shows that the CEOs of CSRTD firms with university degrees have lower *log_TotalNetSales* than the CEOs with doctor degrees at a 10% level of significance. When considering the effect of *CEOEdu* in combination with *CEOAge*, the total effect is only -2.8953 at a 10% level. This result matches with H3, which is highly evaluating CEOs' education.

Considering the baseline effect of *CEOEdu* in SRTD firms, those with intermediate education have higher *AssetTurnover* than those with university degrees with a positive coefficient of 2.1048 at a 1% significant level. This result is consistent with the estimation results from OLS and RR without interaction terms and opposes H3. CEOs are thus recommended to accumulate more functional specialization to support their work rather than the cognitive capability.

A new result found though weak from RR with interaction term of *CEOAge*CEOEdu* is that the CEOs with university degrees have lower *log_TotalNetSales* than those with doctor degrees, thus, supporting H3. For SRTD firms, the CEOs with intermediate education have higher *AssetTurnover* than the CEOs with university degrees with a coefficient of 2.1048 at a 1% level of significance. The underperformance of male CEOs in SRTD firms remains consistent through OLS, RR without interaction term, and RR with *CEOAge*CEOEdu*, suggesting the robustness of results.

Table 7 specifies robust regression results with *CEOGender*CEOEdu* as an interaction term.

**Table 7.** Robust regressions with interaction term (CEOGender*CEOEdu)

| | SRTD Industry | | | | CSRTD firms | | | | SRTD firms | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | Log_TNS | ROE | A.T. | TNS | Log_TNS | ROE | A.T. | TNS | Log_TNS | ROE | A.T. |
| | (13069.63) | (0.7386) | (0.0834) | (0.6256) | (106380.5) | (2.8476) | (0.0916) | (1.3529) | (2724.604) | (1.0175) | (0.1145) | (0.4548) |
| Master | 2054.851 | 0.1422 | 0.0551 | 0.1304 | -155301.7 | -2.4999 | 0.0353 | -1.7865 | 2326.172 | 0.8522 | 0.0585 | 0.5162$^{*}$ |
| | (12000.45) | (0.5992) | (0.0766) | (0.5743) | (104235) | (2.817) | (0.0714) | (1.3255) | (1653.105) | (0.6125) | (0.0699) | (0.2738) |
| OtherEdu | -3632.39 | -0.0689 | -0.0186 | -0.1474 | -117806.7 | -2.4516 | -0.0487 | -1.6805 | --- | --- | --- | --- |
| | (12504.44) | (0.6505) | (0.0798) | (0.5985) | (103682.1) | (2.8006) | (0.0758) | (1.3186) | --- | --- | --- | --- |
| UniDegree | 1340.487 | -0.0542 | -0.0115 | -0.0571 | -122996.1 | -2.7067 | 0.0091 | -1.8187 | 0 | 0 | 0 | 0 |
| | (11527.86) | (0.4785) | (0.0736) | (0.5517) | (102401.9) | (2.7999) | (0.0583) | (1.3023) | (base) | (base) | (base) | (base) |
| CEOGender*CEOEdu | | | | | | | | | | | | |
| Female*College | --- | 0 | --- | --- | 0 | 0 | 0 | 0 | 0 | 0 | | |
| | --- | (empty) | --- | --- | (empty) | (empty) | (empty) | (empty) | (empty) | (empty) | (empty) | (empty) |
| Male*College | --- | --- | --- | --- | --- | --- | --- | -- | | | | |
| | --- | --- | --- | --- | --- | --- | --- | --- | ---- | ---- | ---- | ---- |
| Male*Doctor | -10132.5 | -0.1403 | -0.0534 | -0.0415 | -7022.705 | -0.8953 | --- | -0.3281 | 1934.632 | 2.466$^{***}$ | 0.1466 | -0.1574 |
| | (13830.1) | (0.489) | (0.0886) | (0.662) | (28260.83) | (0.6196) | --- | (0.3594) | (2336.551) | (0.8725) | (0.0982) | (0.39) |
| Male*Inter | 3896.436 | -0.6356 | -0.0162 | -0.0247 | -11744.53 | -0.7761 | 0.0862 | -0.1119 | 0 | 0 | 0 | |
| | (14877.41) | (0.6789) | (0.0952) | (0.7121) | (37257.59) | (0.818) | (0.105) | (0.4738) | (empty) | (empty) | (empty) | (empty) |
| Male*Master | 307.9268 | 0.1165 | -0.046 | -0.1258 | 55504.06$^{**}$ | 0.1903 | 0.0242 | 0.1392 | -1644.658 | -0.6964 | -0.0061 | -0.5117 |
| | (13253.41) | (0.3963) | (0.0851) | (0.6343) | (24302.83) | (0.5315) | (0.0807) | (0.3085) | (1971.33) | (0.7336) | (0.0865) | (0.3279) |
| Male*OtherEdu | -2627.542 | -0.0023 | 0.0059 | 0.1313 | 4115.506 | -0.3447 | 0.1037 | -0.1 | --- | --- | --- | --- |
| | (14104.59) | (0.5485) | (0.0906) | (0.6751) | (28186.08) | (0.6257) | (0.088) | (0.3584) | --- | --- | --- | --- |
| Male*UniDegree | -2043.057 | 0 | -0.0037 | -0.0297 | 0 | 0 | 0.0445 | 0 | --- | --- | --- | - |
| | (12786.16) | (empty) | (0.082) | (0.612) | (empty) | (empty) | (0.0674) | (empty) | --- | --- | --- | --- |
| FirmAge | 564.3857$^{***}$ | 0.0091 | 0.0021$^{***}$ | 0.0048 | 3372.275$^{***}$ | 0.0093 | 0.0031$^{***}$ | 0.0054 | -4.4095 | 0.0463 | 0.0115$^{***}$ | 0.001 |
| | (84.4076) | (0.0069) | (0.0005) | (0.0039) | (349.2283) | (0.0075) | (0.0008) | (0.0043) | (87.3074) | (0.0326) | (0.0036) | (0.0145) |

**Table 7.** Robust regressions with interaction term (CEOGender*CEOEdu) *(continued)*

| | SRTD Industry | | | | CSRTD firms | | | | SRTD firms | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TNS | Log_TNS | ROE | A.T. | TNS | Log_TNS | ROE | A.T. | TNS | Log_TNS | ROE | A.T. |
| Leverage | 59.11517 | 0.0219*** | 0.0027*** | 0.001 | 767.7952 | 0.0414** | -0.0196*** | 0.013 | -58.1462 | -0.0697* | -0.0687*** | -0.0406** |
| | (79.15005) | (0.0068) | (0.0009) | (0.0037) | (653.7737) | (0.0185) | (0.0015) | (0.0083) | (104.7164) | (0.0379) | (0.0052) | (0.0169) |
| log_AvTotalAssets | 1530.014** | 0.4342*** | -0.0061 | -0.2254*** | 3582.504 | 0.4775*** | 0.0068 | -0.2098*** | 466.6455 | 0.3828*** | -0.016 | -0.2481*** |
| | (772.4792) | (0.0646) | (0.0049) | (0.0367) | (3998.46) | (0.0882) | (0.0094) | (0.0502) | (298.3502) | (0.1086) | (0.0122) | (0.0485) |
| log_Tax | 1240.675*** | 0.3306*** | 0.0082*** | 0.1499*** | 3991.561** | 0.2683*** | 0.007 | 0.1208*** | 1090.567*** | 0.4209*** | 0.0419*** | 0.2039*** |
| | (413.2614) | (0.0342) | (0.0026) | (0.0195) | (1987.289) | (0.043) | (0.0046) | (0.0249) | (188.4045) | (0.0688) | (0.0077) | (0.0307) |
| log_Labour | 2343.527*** | 0.3566*** | 0.0006 | 0.1316*** | 16339.37*** | 0.3961*** | -0.0039 | 0.1478*** | 431.0925 | 0.3312** | -0.0008 | 0.1506** |
| | (862.4347) | (0.072) | (0.0054) | (0.041) | (3965.779) | (0.0868) | (0.0093) | (0.0499) | (423.0567) | (0.1562) | (0.0175) | (0.0698) |
| ImportExport | 14786.31*** | 0.1815 | 0.0465*** | 0.1478 | 8911.067 | 0.1765 | 0.0273 | 0.1107 | 38884.2*** | -0.2132 | -0.0795 | -0.09 |
| | (2081.25) | (0.174) | (0.0133) | (0.0995) | (8753.165) | (0.1916) | (0.0208) | (0.1112) | (1777.579) | (0.658) | (0.0741) | (0.2941) |
| SpecialZone | -141.414 | 0.0141 | 0.0006 | -0.0394 | 9907.788 | -0.0838 | -0.0221 | -0.0799 | -5086.337** | 1.0737 | 0.1631* | 1.8311*** |
| | (2248.875) | (0.1869) | (0.0142) | (0.1069) | (9131.9) | (0.1987) | (0.0216) | (0.1153) | (2186.756) | (0.8167) | (0.0919) | (0.3651) |
| CenCity | -2253.62 | -0.1401 | 0.0076 | -0.0742 | 2094.086 | -0.1529 | 0.0028 | -0.1016 | 403.3427 | 0.3621 | 0.1473*** | -0.0402 |
| | (1580.878) | (0.1326) | (0.0101) | (0.0755) | (7363.028) | (0.1607) | (0.0175) | (0.0933) | (1186.481) | (0.4401) | (0.0495) | (0.1967) |
| log_FixedAssets | 327.4707 | -0.0379 | -0.0013 | -0.0249 | -2056.878 | -0.077 | 0.0014 | -0.0367 | 130.2031 | -0.0006 | 0.0022 | -0.0103 |
| | (496.2341) | (0.0415) | (0.0031) | (0.0237) | (2642.121) | (0.0579) | (0.0063) | (0.0335) | (185.4609) | (0.0688) | (0.0077) | (0.0307) |
| _cons | -20632.85 | 2.3452*** | 0.0075 | 2.0214*** | 40714.63 | 5.0229* | -0.1047 | 3.7116*** | -5604.935** | 1.7656* | -0.1175 | 2.1578*** |
| | (12682.33) | (0.6209) | (0.0809) | (0.6065) | (104238.8) | (2.8761) | (0.0893) | (1.3248) | (2550.977) | (0.9394) | (0.1058) | (0.4199) |
| *No. of obs.* | 264 | 263 | 264 | 265 | 183 | 183 | 183 | 184 | 78 | 79 | 78 | 79 |
| $R^2$ | 0.1529 | 0.7422 | 0.1204 | 0.2874 | 0.2218 | 0.7468 | 0.0386 | 0.2838 | 0.3964 | 0.7047 | 0.1626 | 0.5426 |
| *Prob > F* | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**Notes:** Standard error in parentheses; *** indicates $p < 0.01$; ** indicates $p < 0.05$, * indicates $p < 0.10$.

**Source:** Authors' estimate

*CEOAge* is not significant to any measures of firm performance for all three samples under RR with *CEOGender*CEOEdu*. For SRTD firms, the baseline effect of *CEOGender* is significant at 10% with negative coefficients of -0.0546 and -0.2548, which means male CEOs are less efficient than female ones. About *CEOEdu*, those with doctor degrees have lower *log_TotalNetSales* than those with university degrees. Those with intermediate and college education have higher *AssetTurnover* and ROE than those with university degrees with positive coefficients of 2.274 and 0.157. These findings do not support H3 but are consistent with results found from the OLS and the RR without the interaction term. Nevertheless, those with master degrees have higher *AssetTurnover* than those with university degrees with a coefficient of 0.5162 at a 10% significance level.

The interaction term of *CEOGender*CEOEdu* is not significant in all firms in the SRTD industry but significant for CSRTD firms and SRTD firms. For CSRTD firms, the male CEOs with master degrees have higher *TotalNetSales* than the female CEOs of the same degree with a coefficient of 55504.06 at a 5% level of significance. For SRTD firms, the CEOs with doctor degrees have lower *log_TotalNetSales* at a 1% significance level with a coefficient of -3.0169 but the coefficient of male CEOs is 2.466 at a 1% significance level. The total difference between the performance of male CEOs and female CEOs is only -0.5509. This result means that male CEOs of SRTD firms are less efficient than their female rivals, matching with what has been found from OLS, RR without interaction term and supporting H2.

### *4.5 Parametric and non-parametric testings*

Other tests are conducted for the SRTD industry as a whole as a cross-check with what has been found from OLS, RR, and RR with interaction terms for the association between CEOs' characteristics and firm performance. The purpose of these tests is to compare means among groups of *CEOGender* i.e. male vs. female, and those of *CEOEdu* i.e. six various educational qualifications.

Table 8 presents findings from both parametric and non-parametric tests for two categorical variables, which are *CEOGender* and *CEOEdu*.

Among four measures of performance, only *log_TotalNetSales* is normally distributed. The other three measures including *TotalNetSales*, ROE, and *AssetTurnover* do not follow the normal distribution. The tests are, therefore, chosen to meet the assumptions needed.

For *CEOGender*, t-test results show that there is a significant difference between means of *log_TotalNetSales* of female CEOs and that of male CEOs in the SRTD industry. The mean of *log_TotalNetSales* of female CEOs is significantly lower than that of male CEOs. For the other three measures of performance with Wilcoxon rank-sum tests, there is not any significant difference between the means of performance of male CEOs and female CEOs.

For *CEOEdu*, oneway ANOVA is conducted for *log_TotalNetSales* and Bartlett's test probability of 0.045, which is lower than 0.05 and has met the assumption for parametric ANOVA testing. The difference among various CEO educational types in terms of *log_TotalNetSales* is significant with the probability of 0.0114, which is smaller than 0.05. The Kruskal-Wallis rank test results show a significant difference among CEO educations for means of *TotalNetSales* and means of ROE but a non-significant difference for *AssetTurnover*.

**Table 8.** Parametric and non-parametric testing results (performance in SRTD industry among different CEO characteristics).

| | log_ TotalNetSales | TotalNet Sales | ROE | Asset Turnover | Testings |
|---|---|---|---|---|---|
| *Among CEOGender (Male vs. Female)* | | | | | |
| Ho: diff = 0, Ha: diff !=0 | 0.0026 | | | | t-test |
| Ho: diff = 0, Ha: diff < 0 | 0.0013 | | | | t-test |
| Ho: Performance(FemaleCEO)= Performance(MaleCEO) | | | | | |
| Prob > \|z\| | | 0.097 | 0.3631 | 0.4281 | Wilcoxon rank-sum test |
| *Among CEOEdu (6 educational types)* | | | | | |
| Probability ($chi^2$) | | 0.0036 | 0.0251 | 0.4643 | Kruskal-Wallis rank test |
| Probability ($chi^2$ with ties) | | 0.0035 | 0.0251 | 0.4599 | Kruskal-Wallis rank test |
| Prob > F (Between groups) | 0.0114 | | | | Oneway ANOVA |
| Bartlett's test for equal variances: Prob > $chi^2$ | 0.045 | | | | Oneway ANOVA |

**Notes:** *** indicates p < 0.01; ** indicates p < 0.05, * indicates p < 0.10.

**Source:** Authors' estimate

Table 9 shows the comparison of *log_TotalNetSales* by *CEOEdu* with the Bonferroni method.

**Table 9.** Comparison of log_TotalNetSales by CEOEdu (Bonferroni)

| Row Mean - Col Mean | College | Doctor | Intermediate | Master | OtherEdu |
|---|---|---|---|---|---|
| Doctor | 2.45 | | | | |
| | 0.18 | | | | |
| Intermediate | 1.39 | -1.05 | | | |
| | 1.00 | 1.00 | | | |
| Master | 3.13*** | 0.69 | 1.74 | | |
| | 0.01 | 1.00 | 0.49 | | |
| OtherEdu | 2.06 | -0.38 | 0.67 | -1.07 | |
| | 0.61 | 1.00 | 1.00 | 1.00 | |
| UniDegree | 2.32* | -0.12 | 0.93 | -0.81 | 0.256 |
| | 0.08 | 1.00 | 1.0 | 0.73 | 1.00 |

**Notes:** *** indicates p < 0.01; ** indicates p < 0.05, * indicates p < 0.10.

**Source:** Authors' estimate

The results reconfirm the proposition of H3 in which the CEOs with higher education are conjectured to get higher achievements than those with lower education. In this pairwise comparison, the CEOs with master degrees and university degrees have significantly higher means of *log_TotalNetSales* than those with college degrees at 1% and 10% levels of significance, respectively.

To summarize, the findings from these tests reconfirm what has been uncovered in OLS, RR, RR with interaction terms for this SRTD industry.

***4.6 Regression results for firm-specific characteristics as control variables***

Firm age is consistently and significantly positive in OLS and RR for all three samples and for various measures of firm performance, which means the more established the firm is the better achievements it gets. The age of a firm may influence its performance through intermediating means, namely, routinization, accumulated prestige, and rigidity (Coad *et al.*, 2018). In this case, higher firm performance means the benefits firms get from their aging are more than the drawbacks it may cause to them. Leverage is found to be supportive for CSRTD firms and all firms in the SRTD industry but is not for SRTD firms. The relationship between leverage and firm performance is positive in some regressions while it is negative or even not significant in others. These results can be explained with various theories such as signaling theory, agency costs theory, or pecking order theory. Nonetheless, it is conjectured that there might be an optimal firm size level at which leverage shall not harm firm performance (Ibhagui and Olokoyo, 2018). The effect found in this study is similar to the study by Fosu (2013) in which financial leverage has got a significantly positive influence on performance and the product market competition enhances such an effect.

*Log_AvTotalAssets* does assist for *TotalNetSales* and *log_TotalNetSales* under both OLS and RR for three samples but does not for ROE and *AssetTurnover*. The natural logarithm of total assets can be used as an empirical proxy of firm size together with the logarithm of total sales and market capitalization (Dang *et al.*, 2018). Using a threshold regression model, Ibhagui and Olokoyo (2018) claim that firm size may influence the effect that leverage has on firm performance. Small-sized firms may not benefit from that effect but as firms grow such an effect becomes more eminent. This may help to explain the results found in the study.

*Log_Tax* has a positive association with a performance at a 1% level of significance for all samples meaning the higher performance firms achieve the more tax is incurred and paid by them. *Log_LabourSize* is also consistently significant with all measures of performance. The relationship between firm size and its profitability is arguably examined under the control of other market and firm-specific characteristics such as market structure, barriers to market, and strategies of firms though a positive association is mostly evidenced in extant literature (Lee, 2009). This is true in business practices as firms expand and develop they need more human resources to support their operations. However, increasing the labor size is also claimed to force SMEs in Vietnam to provide their labor with more training to increase productivity due to specialization (Dao and Cao, 2020).

Import-export activities are helpful for firm performance only under RR though for the economy as a whole they are argued to provide more employment opportunities and accelerating growth (Banomyong *et al.*, 2017). Only SRTD firms have better results when operating in special zones. The influence of the location of firms in central cities of Vietnam on firm performance is not consistent and *log_FixedAssets* is of no significance under all regressions.

## 5. Conclusion

The paper has proved that CEO characteristics have a certain impact on the firm performance of SRTD firms, CSRTD firms, and all firms in the SRTD industry, thus, extending the UET theory to the Vietnam context with firms operating in scientific research and technology development. For SRTD firms, older CEOs outperform younger CEOs while the opposite is witnessed for CSRTD firms. For the SRTD industry, *CEOAge* does not affect firm performance. For SRTD firms, the results from various estimation models are consistently stating that female CEOs are more efficient than their male counterparts. This finding provides an interesting view on the role of female CEOs in firms where innovation is the key motivation for firm development. In contrast, male CEOs of CSRTD firms perform better than female CEOs though the statistical relationship is not strong. Female CEOs are less competitive than male CEOs for the SRTD industry as a whole when their means of *log_TotalNetSales* are compared with each other under parameter testing. The CEOs with master degrees of all three firm samples achieve higher performance than those with university degrees. For SRTD firms, some estimations show opposite results, suggesting that higher education is not always leading to higher firm performance. This finding implies that further investment of CEOs in functional specialization is needed rather than in improving cognitive capability. The interaction terms relating to demographic characters of CEOs help to investigate further the impact of each CEO character on firm performance among various subgroups of each character. The results are verified under various estimation methods including OLS, RR, RR with interaction terms, and appropriate tests are also applied to ensure their consistency and robustness.

The article has contributed to the literature by providing more empirical evidence for the Upper Echelon Theory in a new context and, to our understanding, is the first attempt in examining the firms in the SRTD industry in Vietnam and particularly the CSRTD firms with the influence of demographic characteristics of the top management on their performance. These findings suggest some implications for policymakers in Vietnam in identifying determinants of performance of firms in this industry to improve their support schemes and plan further steps of enlarging the community of CSRTD firms to meet the demand for economic growth relying on innovation and technology development.

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