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The impact of CEO characteristics on firm innovation: Evidence from Saudi Arabia

Fadhila Hamza^{a*}, Souha Ben Gamra^a and Areej Essa Bin Dawood^a

^aDepartment of Accounting, Princess Nourah bint Abdulrahman University, Saudi Arabia

ABSTRACT

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This paper studies the effect of CEO attributes on firms' R&D spending in Saudi firms. Mainly, it examines the influence of CEOs' education (level and background), CEOs' experience (work experience, tenure and functional background), CEOs' origin and CEOs' ownership. These attributes are among the main CEO attributes that are not considered simultaneously by previous studies. Empirically, we use a sample of 63 listed Saudi companies on Tadawul stock exchange. The study uses a panel model employing data over the period from 2016 to 2019 with 252 observations and formulates five different equations using the ordinary least square regression. Findings show that companies employing CEOs with functional backgrounds in marketing and/or engineering will invest more in R&D. Similarly, R&D spending increases when the CEO is an insider and has a part in the firm capital. These results would help scholars and shareholders to understand what makes executives more willing to initiate innovation and thus, they can select and govern well the company's CEO.

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1. Introduction

The corporate innovativeness is indicated by the novelty in the different processes, services and products it offers (Giuliani & Bell, 2005). The innovation, although, requires important financial and human resources (Wu, 2013). Generally, two types of innovation have been identified: technological innovation and business model innovation (Helfat and Martin, 2015). Many studies have concluded that the corporate's R&D expenditure is one of the key activities that lead to firm innovativeness (Ahuja et al., 2008) and that the firm's investment intensity, newness in product and processes are stimulated by R&D activities (Carboni & Medda, 2020). For Barker and Mueller (2002), even if the R&D spending is not an assurance of innovativeness, it remains a significant engagement in the innovation enhancement. Considering the company's CEO as the greatest powerful performer, many studies have explored how the decision of investing in innovation and the firm performance are affected by certain executive characteristics, such demographics, beliefs, personality traits, and incentives (Hayward & Hambrick, 1997; Barker & Mueller, 2002; Hayward et al., 2004; Chatterjee & Hambrick, 2011; Al Shammari, 2018). Most of these studies fall under the Upper Echelon Theory "UET"; initiated by Hambrick and Mason (1984), Hambrick (2007); and Carpenter et al., (2004); which states that the top management team (TMT) has an important role in strategic decision-making. According to the UET, executives have the power to establish the direction of the firm and therefore, organizational outcomes, such as strategic choices and effectiveness would be considered as reflections of the top managers' values, cognitions, experiences, and risk preferences.

Studies examining how executives influence a firm's strategic decisions, (Hambrick & Finkelstein, 1987, Chatterjee and Hambrick, 2011, Hamza et al., 2014; Hayward & Hambrick, 1997; Hayward et al., 2004) suggested that wide decisional latitude is accorded to executives, and, that their characteristics affected their discretion toward risky decisions. Also, innovation has been investigated as a key moderating variable in the relationship between CEO characteristics (personality, demographics, experience, and compensation) and firm performance (You et al., 2020). More particularly, a successful CEO

* Corresponding author
E-mail address: fahamza@pnu.edu.sa (F. Hamza)

can achieve innovation by concentrating on new products and R&D which represent a key driver of firm performance (Yadav et al. (2007). According to Damanpour (1991), CEOs can influence the firm's capacity to enhance innovation in different ways. The CEO takes decisions regarding which resources to assign and choices to decide to enable corporate innovation (Wu, 2013). CEOs can also influence innovation through communicating information concerning forthcoming events inside the company (Yadav et al., 2007). According to Helfat and Martin (2015), managers at the top of the organizations may shape technological innovation by scanning the external environment for new technologies, by investigating in the pursuit of specific new technologies, by establishing an appropriate organizational structure to pursue technological innovation or by changing the existing structure.

In this paper, we are interested in scrutinizing how R&D spending differs with visible CEO attributes (education level and background, work experience, functional background, tenure, stock ownership and origin). Theoretically, this study contributes in scrutinizing the effect of various CEO characteristics on R&D spending and provides also a practical implication insofar as it identifies the profiles of top executives at innovative firms in the Saudi context.

The article is structured as follows: First, a review of literature on the relationship between certain visible CEOs' characteristics and R&D spending is presented, followed by the hypothesis development. Next, we present the employed methodology. We, then, discuss the study findings and their implications.

2. Literature review and hypotheses development

Since Carpenter et al. (2004); who introduced the notion of the CEO power and its dimensions (Structure, ownership, expertise, and prestige); most studies have concentrated on examining the effect of CEO power on financial firm performance. However, they haven't discussed theoretically and practically the impact of CEO power on corporate risk-taking. Thus, within existing studies, corporate risk-taking has not received important attention, precisely in the examination of how CEO power could impact this important variable. Do powerful CEOs take more risk and decide more corporate strategic choices by allocating more resources on R&D? Additionally, as mentioned earlier in Carpenter et al. (2004), previous studies aim to investigate various executives' attributes and characteristics independently of each other. However, there is a tendency for CEOs to simultaneously express a "bundle" of characteristics and display an interaction of various attributes and capabilities in the decision-making process.

Our study contributes to the existing literature by scrutinizing, individually, the effect of the CEO characteristics (education, ownership, origin, and experience) as proxies of the executive power and, also, studies the interactive effect of CEO attributes on the firm R&D spending as a strategic choice that indicate the company risk-taking.

2.1 CEO Education

As mentioned by You et al., (2020, p. 1236) "Education can be a signal of a person's knowledge, skill base, and cognitive ability". Several studies have inspected the relation between education and R&D spending. A number of these studies have been interested in the education level. According to Wally and Baum (1994), executives with a high level of education have higher cognitive complexity. The authors asserted that such cognitive complexity increases the executives' ability to obtain and process complex information and to decide faster which provides a higher capacity to consider new concepts and therefore raises the tendency toward proceeding innovations. Cheng et al. (2010) found that companies with executives possessing a postgraduate degree realize superior ROA than others. The authors argue that managers' intellectual capability, derived from their formal education, is an important element in engendering new executive skills, allowing them to realize competitive advantages for their firms and inducing consequently an increase of the cash flows. Other studies found that executives with higher levels of education invest greater in R&D than others (Camelo et al., 2010; Harymawan et al., 2020; Lin et al., 2011). According to Harymawan et al. (p. 29, 2020) "CEOs with higher education levels have stronger insights, higher cognitive abilities and a longer-term perspective, which result in greater investment in R&D activities". These findings are contrary to those of Barker and Mueller (2002) who show that there is no significant association between CEO level of education and R&D spending.

Accordingly, we hypothesize the following:

H₁. *Firm's R&D spending is positively related to the education level achieved by its CEO.*

Other studies have inspected the influence of educational background on R&D expenditure and have produced mixed results. Harymawan et al. (2020) found that executives with accounting qualifications decide less to spend in R&D, which is reliable with their risk-averse attitude. According to Hambrick and Mason (1984), education in MBA programs is generally linked with moderation given that the analytic tools learned in business are primarily employed to avoid losses and errors. However, Bertrand and Schoar (2003) found that managers who have an MBA education decide riskier investment plans and innovative projects (King et al., 2016).

Barker and Mueller (2002) found that important increases in R&D expenditure are observed at companies where executives have higher degrees in science/engineering fields. However, no significant relationship was found at companies where CEOs have higher degrees in business. These results join partially those of Tyler and Steensma (1998) who found that science and engineering education offers a wide comprehension of new technology and innovation to executives. More specifically,

executives with an engineering and science education perceived more opportunities in future technical alliances than executives with other education specialties, which reflects a positive attitude toward innovation.

Consistently, we hypothesize as follow:

H₂. *Firm's R&D spending is positively related to the science and engineering education achieved by its CEO.*

2.2 CEO Stock Ownership

Many studies concluded that, when managers are holding parts of the firm's capital, they aim to choose strategies that maximize shareholders' wealth such as R&D and innovation strategies (Latham and Braun, 2009; Barker and Mueller, 2002). These studies show that R&D expenditure is higher at companies where managers have larger property invested in firm capital. These results were confirmed by Ryan and Wiggins (2002) who suggested that executives with a significant part in capital may decide choices that diminish the performance volatility of the company to keep their personal benefits subsequent to less risky choices. Similarly, Chen and Huang (2006) concluded that many agency problems may be reduced due to the workers' participation in the firm capital. They found a positive association between workers ownership and R&D spending. Although Kim and Lu (2011) link the relation between CEO ownership and R&D expenditure with the effectiveness of governance mechanisms. They suggested that manager ownership can affect R&D expenditure when outside governance mechanisms are weak. Alessandri and Pattit (2014) found an important positive impact of stock ownership on R&D spending. Furthermore, the authors concluded the inexistence of inverted-U-shaped relationship between CEO ownership and R&D spending (e.g., Wright et al., 1996). Same as the above discussions, we propose the following hypotheses:

H₃. *Firm's R&D spending is positively related to CEO stock ownership.*

2.3 CEO origin

As defined by Kesner and Sebor (1994, p. 335), "outsiders are individuals who were not employed by the organization, while insiders are current or previous employees". However, literature examined different levels of "outsiderness": a low level of outsiderness consists of hiring an external CEO for the firm but inside the industry; and a high outsiderness level consists of hiring outside the industry as well as the firm. (Cummings and Knott, 2018). Many studies have investigated the performance consequences of hiring outside or inside CEOs. Their results, however, remain mixed. Zajac (1990) found that inside CEOs are more profitable. However, Bailey and Helfat (2003) found that the variance of firm performance is greater for external successors with a less full complement of transferable skills. Other studies have investigated the strategic reasons for hiring outside or inside CEOs. Harris and Helfat (1997) suggested that firms may recruit an inside CEO to capitalize on insider knowledge and networks. According to Zhang and Rajagopalan (2010 p. 343) "Because they have a deeper understanding of their firms' internal resource conditions and also because their visions tend to be constrained by their past experience within the firm, inside CEOs, are more likely to initiate and implement strategic changes that build upon existing organizational capabilities". On the other side, Virany et al. (1992) identified the desire to make organizational change as a key reason for firms to choose outside CEOs. Murphy and Zabochnik (2007) have identified an increasing prevalence of outside CEOs. They proposed that the increase in external managers would be, in part, the result of an improved spread of "general skills" which are fungible across firms. However, "Context-specific skills" were approved to be significant to managers' abilities (Bailey & Helfat, 2003), mainly dynamic executive abilities are critical for sustained organizational creativity and innovation (Helfat & Martin, 2015).

However, studies investigating the impact of CEOs' origin on innovation remain rare. Balsmeier and Buchwald (2014) found that companies with outside CEOs (with broader perspective) have fewer patent applications than firms with inside CEOs (with firm-specific skills). The authors introduced that internally promoted chief executives are related to a significant increase in innovative strategies compared with externally hired executives. Their results confirm the view considering the inside executives having more significant firm-specific knowledge than outside and, therefore, they are more willing to enhance innovative activities. Cummings and Knott (2018) found that R&D spending declines over the tenure of external managers compared to that of internal managers. They argue that the outside managers may lack the technical competences primarily to well direct the corporate's R&D. Yet, authors note that they don't recommend for boards to avoid outside managers, but they recommend considering technological expertise during CEO hiring and its implications for innovation. However, Wong and Chen (2018) show that returns and innovative activities are higher in family firms with outside managers, and they explain this by the diversity in experiences, relations, and capability to interrupt the status quo proved by the outside managers.

Consistently with the view suggesting that firm-specific knowledge of inside managers promote the firm innovation. Thus, we advance the following hypothesis:

H₄. *Firm's R&D spending is related positively to the insider CEO.*

2.4 CEO Experience

"Experience captures the background characteristics that provide much of the knowledge and values the CEO brings to bear on judgments and decisions that affect firm strategy" (You et al., 2020, p.1233). According to Cummings and Knott (2018), the ability to recognize technological opportunities, assess their returns, and decide and manage R&D spending, necessitates profound experience with the firm's technology. Many investigators have studied the impact of the CEO's experience on his

choices (Barker & Mueller, 2002; Cummings & Knott, 2018; Brower & Nath, 2018). Three main indicators of the CEO experience used by the researchers were: the CEO's work experience, his tenure and his functional expertise.

First, managers' work experience is an indicator of the professionalism and the skilled workforce the managers may have acquired, and which influence innovation positively and increase the opportunities to exploit knowledge (Cohen and Levinthal, 1990; Cuijpers et al., 2011). Moreover, managers with a skilled profile are more creative and innovative (Kang & Lee., 2017; Lepak & Snell, 1999). Thus, innovativeness depends on managers' long experience, because he can direct more the exploitation and development of newest and advanced technologies (Abrunhosaand Sá, 2008; Santos-Vijandeand Álvarez-González, 2007). Accordingly, we propose the following hypothesis:

H₅. *Firm's R&D spending is related positively to the CEO's work experience.*

Second, according to Talke et al.(2011), TMT's functional background variety is significantly and positively related to the firm's R&D. Moreover, Hambrick and Mason (1984), concluded that, managers with background in throughput positions focus more on cost-management approaches to accomplish efficiency advantages than on growth through innovations. Similarly, Saboo et al. (2017) show that executives with output background are more able, than executives with "throughput" background (accounting, finance, production, administration, legal, etc.), to envisage a well exploitation of associated R&D resources to increase competitive advantage compared to competitors. Barker and Mueller (2002) show that innovation is superior at companies in which managers have an important background in marketing or engineering. Accordingly, the next hypothesis is proposed:

H₆. *Firm's R&D spending is positively related to CEOs' functional background in marketing and/or engineering.*

Third, studies on CEO tenure as a determinant of R&D spending provided mixed results. According to Barker and Mueller (2002), R&D expenditure is higher at companies in which managers have longer tenure. Simsek (2007) concluded that an increase in CEO's tenure positively affects his risk-taking tendency and the firm's innovativeness. The authors suggested that executives with short tenure are less likely to engage in risk-seeking activities until they reach a satisfactory level of the firm and environment knowledge, sufficient experience and necessary leverage through strong networks with key stakeholders. These suggestions were confirmed by Balsmeier and Buchwald (2014) who argued that, with more years of tenure, executives increase their knowledge and competencies, protecting the shareholders' interests, and therefore may be capable of enhancing innovative activities. These results were approved by He et al. (2021) who concluded that CEO's tenure positively affects the firm's willingness to invest in R&D. The authors suggested that CEO's with short tenures are more interested in profits to protect their job in the firms and are therefore less willing to execute high-risk projects. As their tenure increases, they accumulate social capital, knowledge, and power which enables them to use the available resources optimally and makes them more confident and consequently increases their willingness to invest in high-risk projects.

Contrary to these findings, Kor (2006) found that innovation is superior in companies with executives with shorter tenure. This finding is confirmed by Li and Yang (2019) who concluded that, in their advanced career stage, CEOs achieve less proportion of exploratory innovations. Hambrick and Fukutomi (1991) concluded that the lack of interest in implementing organizational changes occurs with each additional year of tenure, because executives became more oriented to achieve their own interests and to employ their own management model. According to Luo et al. (2014), new CEOs aim to learn from and align with environmental and social norms by implementing and developing product innovations. These suggestions were confirmed by Hsu et al. (2020) who found that executives during the advanced levels of their tenure, they spend less in R&D. The authors argued that, with increasing tenure, CEOs lose their relationship with the environment and limit themselves to approaches that have carried them success in the past.

Although Chen (2013) found an inverted U-shaped relationship between the executive tenure and the firm's R&D spending. He argued that, at middle levels of tenure, executives are less willing to risk-taking and are constrained by previous successful practices, and consequently, they have less tendency to decide R&D. Consequently, we hypothesize the following:

H₇. *The CEO tenure is negatively related to the firm's R&D spending.*

2.5 Interaction

As innovation is a high-risk activity, it necessitates pledge of a firm's resources and executive capabilities in the long term (Holmstrom, 1989; Aghion & Tirole, 1994; Manso 2007). Innovation is a risky, durable and specific activity, thus, managers, whose reputation is related to firm-value, may become risk-averse and myopic and search out temptations to choose investments that assure certain short term returns instead of investing in innovation (Hamza et al., 2013).

Although, following Hambrick and Mason (1984), researchers interested in studying human innovativeness, have settled various literature in the strategic choice theory. These scholars in strategic choice theory aim to highlight the impact of executive discretion as the power of performing inside the company but it proceeds under the pressure of the environment.

One of the important features of managerial latitude announced by the UET is the locus of control. Executives with internal locus of control view themselves as powerful as they are responsible for their choices and achievements. They believe in their capabilities to influence the environment and think they are skilled to monitor and control the events in their lives (Rotter, 1966). Similarly, the UET theory discusses the notion of power which is advanced as a moderating variable by Carpenter et al. (2004) and Finkelstein (1992). The CEO's power is determined as the ability of an individual to exercise his

will. Four dimensions of power are identified: Structural power, power associated with property, power associated with expertise, and power associated with prestige (reputation). Powerful CEOs consider themselves able to decide risky and key decisions based on their background, expertise, property and origin.

Carpenter et al. (2004) show that while the popular UE studies aim to investigate various executives' characteristics separately, current analysis has concluded the failure of this method. It mentions the tendency for managers to express a "bundle" of characteristics and recommends the importance of considering the interaction of various characteristics and capabilities rather than reflecting separate and individual attributes. This emphasizes that the interaction between the determinants of the CEO power increases the CEO power and consequently affects the R&D spending as a strategic choice.

Considering the above review of literature, this study reflects the interaction of some CEO attributes as a factor that increases the CEO power and consequently affects the R&D spending as a strategic decision. Thus, we introduce the following hypothesizes:

H₈. *The interaction between CEO education level and education background influence positively R&D Spending.*

H₉. *The interaction between CEO functional background and tenure positively R&D Spending.*

H₁₀. *The interaction between CEO education background and functional background positively R&D Spending.*

H₁₁. *The interaction between CEO ownership and CEO origin positively R&D Spending.*

3. Research design

The study investigates the effect of CEO attributes, especially, education (level and background), experience (work experience, functional background, tenure), ownership and origin, on a firm's R&D spending. The data were obtained from the annual reports of listed firms on Saudi stock exchange Tadawul. Financial and financial service firms were excluded from the sample. The final sample of the study contains 63 firms. The study includes panel data for a period of 4-years from 2016 to 2019 a total of 252 firm-year observations.

3.1. Variable measurement

As mentioned earlier, the objective of this study is to investigate an empirical association between CEO characteristics and firm innovation. The endogenous variable "firm innovation" is proxied by R&D spending. Following Baysinger et al. (1991); and Scherer, (1984); this variable is measured as the ratio of R&D expenditure divided by firm sales. The independent variables correspond to the CEO characteristics relating to the CEO education (level and background), CEO experience (work experience, functional background and tenure), CEO ownership, and CEO origin. Both education level attained by the CEO and education background are operationalized as dummy variables. The education level takes 1 if the manager has postgraduate education (Master, MBA, or Phd) and 0 if not (Saidu, 2019; Darmadi, 2013; Ujunwa, 2012). Similar to Zhang (2008), the CEO education background is measured by a dummy variable. It takes 3 for a CEO who has graduated in marketing, science, or engineering; 2 for a manager who has graduated in finance, accounting, or business; and 1 for CEOs who have graduated in other disciplines (philosophy, literature, history, law and other).

On the other hand, a CEO's experience is divided into three variables. The first is the CEO's work experience, measured by the period of time a CEO has functioned as a manager (McEnrue, 1988). The second is the executive tenure and is operationalized by the length of time (in years) since its appointment by the company (Murphy & Zimmerman, 1993). The third variable is the CEO functional background, operationalized as a dummy variable. Similar to Liu et al. (2016), the variable is coded from 0 to 3 respectively into four categories: 0 for expertise in law and other categories; 1 for expertise in production and/or operation; 2 for expertise in finance, economic, accounting, and/or business administration, and 3 for expertise in marketing and/ or engineering. Following Saidu, (2019), executive ownership is measured by the proportion of direct and indirect manager stock ownership in the company. The direct properties are defined as the part of capital held by the manager, while the indirect holdings are all shares held by the manager in other companies that have weighty ownership in the company he manages. Finally, the study scrutinizes the role of the manager origin on firm innovation and looks at the CEO origin before nomination. The CEO is considered an insider and the variable takes 1 if he is nominated within the firm (Zhang & Rajagopalan, 2010); and it takes 0 otherwise.

3.2. Control variables

As discussed by previous studies (Datta and Guthrie 1994), the CEO attributes can systematically vary with firm characteristics and thus we must control for the firm attribute by employing some variables. Many variables are previously used in firm innovation investigation to control for the company-specific effect on the model finding. The study employs firm past performance measured by the ROA ratio; the firm size operationalized as the log of the total assets, and the firm financial leverage which is the percentage of the total debt to total assets.

3.3. Model

To investigate the relationships hypothesized earlier, an OLS regression is used. The dependent variable is the firm innovation proxied by R&D spending. The independent variables are: the CEO education level, education background, work experience, tenure, functional background, ownership, and origin. The basic model is definite as follows:

Firm innovation = f (CEO attributes)

$$\text{R\&D spending} = \alpha + \beta_1 \text{EL}_{it} + \beta_2 \text{EB}_{it} + \beta_3 \text{Exp}_{it} + \beta_4 \text{FB}_{it} + \beta_5 \text{Tenure}_{it} + \beta_6 \text{OWN}_{it} + \beta_7 \text{Origin}_{it} + \beta_8 \text{ROA}_{it} + \beta_9 \text{Size}_{it} + \beta_{10} \text{LEV}_{it} + \varepsilon_{it}$$

where:

α = intercept; EL= CEO Education Level; EB= CEO Education Background; Exp= CEO Work experience; FB= CEO Functional Background; Tenure= CEO Tenure; OWN = CEO ownership; Origin= CEO origin; ROA = return on assets; SIZE = firm size; LEV = leverage ratio; ε = error term

Furthermore, to test the different interactions discussed earlier in the literature review, we have developed four additional models (cited in Table 3).

3.4 Results

Descriptive statistics

The descriptive statistics of the model variables are presented below in table 1. Mainly, we observe that 50% of the CEOs in our sample have a postgraduate education diploma. Also, 61% of the managers are firm insiders. Our result is similar to Saidu, (2019), and it shows that recruiting outsider managers is not a practice in the Saudi firms, and the majority of managers are promoted. Moreover, 65% of the CEOs have an educational background in science/engineering fields. The mean of the functional background variable is 2.829365 with a standard deviation of 0.3769383 which shows that the majority of the managers have an important experience in marketing and/or engineering. The maximum value for the CEOs' experience and tenure in the data set for all firms is, respectively, 43 and 31 years and the minimum experience and tenure is, respectively, 10 and 1 years. The mean of the experience and tenure is respectively, 26.32937 and 5.448413; and the standard deviation of the experience and tenure is respectively 7.630319 and 4.948471.

Table 1

Descriptive statistics

Variable	Observation	Mean	Std.Dev.	Min	Max
RD_Sp	252	.0020927	.0056916	0	.0318288
EL	252	.4920635	.5009319	0	1
CEO_own	252	.1408504	.7777682	0	6.04
CEO_Or	252	.6071429	.4893574	0	1
EB	252	.6507937	.477668	0	1
Exp	252	26.32937	7.630319	10	43
FB	252	2.829365	.3769383	2	3
Tenure	252	5.448413	4.948471	1	31
ROA	252	.0076402	.3769128	-5.815867	.3092668
Size	252	14.74205	1.804504	9.856606	21.12481
FL	252	.4201253	.2408786	.0122635	.9244046

Correlation matrix

The correlation between the independent variables and the dependent variable using the Pearson correlation is presented in Table 2. The table displays a negative correlation between the tenure and R&D spending. Also, the result highlights that the level of CEO education, his education background, ownership, origin, experience and functional background are positively related to R&D spending. Similarly, we can learn from the correlation matrix that correlations among all explanatory variables are weak which justifies their inclusion in the same model.

Table 2

Pearson's correlation matrix

	RD_Sp	EL	CEO_own	CEO_Or	EB	Exp	Exp	FB	Tenure	ROA	Size	FL	vif
RD_Sp	1.0000												
EL	0.1066	1.0000											1.12
CEO_own	0.1221	-0.1336	1.0000										1.15
CEO_Or	0.2346	0.0766	0.1257	1.0000									1.11
EB	0.0768	0.0383	-0.2344	0.0073	1.0000								1.56
Exp	0.1139	0.0137	0.0207	0.0743	0.2000	1.0000							1.15
FB	0.1433	0.0455	-0.2465	0.0455	0.5086	0.0556	1.0000						1.48
Tenure	-0.2000	-0.0090	-0.0798	0.0829	0.1036	-0.0140	-0.0314	1.0000					1.04
ROA	0.0560	0.0644	-0.0103	0.0734	0.1143	0.0967	-0.0301	0.0704	1.0000				1.09
Size	0.6144	0.2799	-0.0735	0.1971	0.2142	0.2969	0.0032	0.0453	0.2056	1.0000			1.42
FL	0.0973	0.1433	0.0717	0.1796	0.0634	-0.0132	-0.0993	0.0524	-0.0763	0.2909	1.0000		1.19

Regression

This study scrutinizes the effect of executives' attributes including the ownership, education (level and background), experience (work experience, tenure and functional background) CEO origin on R&D spending. OLS regression is employed to test the hypothesis and five equations were developed. The first equation tested the basic and direct relationship between CEO education level, background, ownership, origin, experience, functional background and tenure on firm innovation. The second equation is used to consider the interactive impact of the education level and background on the R&D spending. The third equation is used to consider the interactive effect of the functional background and tenure on the innovation. The fourth equation is used to consider the interactive effect of the education background and functional background on the R&D spending. The fifth equation is used to consider the interactive impact of the ownership and origin on the R&D spending. The regression results for all the five equations is presented in Table 3.

Table 3
Regression Results

Variables	Equation 1		Equation 2		Equation 3		Equation 4		Equation 5	
	Coef.	P> t	Coef.	P> t	Coef.	P> t	Coef.	P> t	Coef.	P> t
El	-0.6056029	0.139			-0.4962805	0.244	-0.5197958	0.217	-0.5784578	0.162
CEO_own	.9913137	0.000***	1.073525	0.000***	.8405405	0.002***	.8267801	0.003***		
CEO_Or	1.01276	0.016**	1.092479	0.009***	1.261339	0.004***	1.2265	0.004***		
EB	-0.8089802	0.110			.3779642	0.411			-0.9226485	0.070*
Exp	-0.0602461	0.027**	-0.063054	0.020**	-0.0639485	0.025**	-0.0632081	0.025**	-0.0575231	0.037**
FB	2.482845	0.000***	2.117413	0.000***					2.6947	0.000***
Tenure	-1.801265	0.000***	-1.851833	0.000***			-1.972292	0.000***	-1.171085	0.000***
ROA	-0.7219957	0.179	-0.8439031	0.116	-0.9771377	0.080*	-0.9317474	0.091*	-0.6418082	0.236
Size	1.755791	0.000***	1.721509	0.000***	1.690993	0.000***	1.708541	0.000***	1.795438	0.000***
Lev	-1.914843	0.030**	-2.234826	0.011**	-2.521151	0.006***	-2.39839	0.008***	-1.660321	0.060*
EL_EB			-0.4819009	0.295						
FB_Tenure					-0.0583874	0.000***				
EB_FB							0.074041	0.623		
Ow_Origin									1.092849	0.000***
_cons	-27.41135	0.000***	-26.36091	0.000***	-20.11774	0.000***	-20.13238	0.000***	-28.15414	0.000***
Observations		252		252		252		252		252
Firms		63		63		63		63		63
R-squared		0.5265		0.5199		0.4825		0.4954		0.5152

Note: The codes in the p values' columns ***, **, * mean the coefficients are significant respectively at 1%, 5%, and 10%.

3.5. Discussion

For all the five models testing hypothesis 1 to 11, F statistics are significant at the level of 1%. Also, the value of the R-square of the five equations is around 0.5 which specifies that the models are statistically appropriate.

Concerning the CEO education level (H1), the results in all models show a negative and non-significant effect on R&D spending. This result confirms the finding of Barker and Mueller (2002) and He et al. (2021) and shows that the level of the executives' education had weak relationship with R&D spending. However, it contradicts others previous studies suggesting that CEOs with a higher education may have a large amount of knowledge, greater cognitive complexity and higher abilities that positively affect his ability to carry out innovative activities (Camelo et al., 2010; Harymawan et al., 2020; Lin et al., 2011).

For the CEO education background (H2), the results in models 1 and 3 demonstrate that the impact of education background is not significant. However, in model 5 this variable has a marginally significant negative impact. These findings are contrary to those of Barker and Mueller (2002) who concluded that firms with highly educated CEOs in science and engineering fields invest greater in R&D. The results are also contrary to those of King et al. (2016) who found that managers with a master education choose risky choices and R&D projects.

Yet, as discussed by Barker and Mueller (2002), the fact that CEO educational background either has a non-significant or a negative relationship with R&D expenditure expectedly weakens the association of the education level with R&D expenditure. To more examine the executive education impact, we tested in the model 2 and 4, respectively, the interactive effect of education level and education background "H8" and the interactive effect of education background and functional background "H10". The results show, respectively, a negative and non-significant impact and a positive and non-significant effect. These results contradict hypothesis 1, 2 and 8 and are online with many studies that concluded the existence of negative and non-significant association between CEO education (level and background) and R&D spending such as Barker and Mueller (2002).

As H3 predicts a positive relation between CEO ownership and innovation, the result of all models confirms this prediction. This result, which is reliable with the agency theory arguments, joins those of Barker and Mueller (2002) and Alessandri and Pattit (2014) suggesting that the CEO feels more engaged when his personal interests and wealth are linked with the firm's wealth; therefore, he decides to invest more on R&D and invest in long-term and specific investment.

The results of all the five models confirm, also, the H4 and show a linear and significant relation between executive insider and R&D spending. This finding is online with those of Balsmeier and Buchwald (2014) and Cummings and Knott (2018) and suggests that the inside CEOs have more significant specific knowledge and are more willing to enhance innovative activities than outside CEOs. The external CEOs may lack the adequate expertise to effectively manage the company-specific R&D spending.

Furthermore, the study tested the H11 which predicted that the interactive effect of the CEO ownership and origin on R&D spending is positive. Results confirm the predicted relationship and show that both the ownership and the origin of the manager increase his cognitive and personal engagement in the firm as shown in Hamza et al. (2013) and Saidu (2019).

In H5 we anticipated a positive relation between the CEO work experience and R&D. The results of the study show a negative significant association in all models. These findings are contrary to those of Santos-Vijande and Álvarez-González (2007) and Abrunhosa and Sá (2008) and suggest that the total period a CEO has worked as a manager affects negatively his interest in implementing innovative activities.

Concerning the CEO functional background, the H6 which predicted a positive relation between the CEO functional background in marketing and/or engineering and R&D spending is confirmed in all models. These findings join those of Barker and Mueller (2002) who concluded that a functional background on marketing and/or engineering reinforces the CEOs' willingness to increase the R&D spending. Concerning the functional background on marketing, the results join also those of Thomas et al. (1991) who concluded that firms in the technology field ensuing activities of product novelty had executives with a main functional experience in output positions (marketing, sales, and product R&D). In fact, referring to Hambrick and Mason (1984, p.199), output functions "emphasize growth and the search for new domain opportunities and are responsible for monitoring and adjusting products and markets" which led them to suggest that the length of output position expertise of TMT affects positively the degree to which the company accentuates outputs in its plans including: product R&D, diversification, marketing, and integration.

Concerning the functional background on engineering, the results join those of Wiersema and Bantel (1992, p.100) who attested that "executives with backgrounds in R&D or engineering are arguably consistent with 'progress, invention, and improvement". In fact, according to Hambrick and Mason (1984), production, process engineering, and accounting, which represent "Throughput functions", "work at improving the efficiency of the transformation process" which led to suggest that the amount of throughput-career experience of TMT affects positively the degree to which the firm accentuates throughputs in its plans including: automation, assets newness, and backward integration. Furthermore, according to Tyler and Steensma (1998), managers with technical career experience (engineering, R&D) were less likely to perceive risks and more expected to assess opportunity in high-tech alliances insofar as their technical background and education teach them to personally assess innovation.

The results also confirmed H7 which anticipated a negative relation between the CEO tenure and R&D spending. These findings are contrary to those of Barker and Mueller (2002); Balsmeier and Buchwald (2014) and He et al. (2021); however, they confirm those of Kor (2006) and Li and Yang (2019) suggesting that with each additional year of tenure, the CEOs became less willing to assume risks and therefore less interested in implementing innovative activities. Furthermore, to investigate more the CEO experience impact, we tested in model 3, the interactive influence of the CEO functional background and tenure. Contrary to H9 anticipating a positive impact, the results show a significant negative association. These results consolidate those of H5 showing a negative relationship between the CEO's work experience and innovative activities.

3.6 Robustness check

In this section, we aim to provide supplementary evidence of the robustness of the study's findings by reviewing some variables measurement.

Table 4
Robustness check

RDSpending	Coef.	Std.Err.	t	P> t	[95%Conf.	Interval]
El	.3090045	.4712867	0.66	0.513	-.6193625	1.237372
CEO_own	.8757938	.3143116	2.79	0.006	.2566451	1.494942
CEO_Or	1.38568	.4868012	2.85	0.005	.4267513	2.344608
EB	.143015	.5878378	0.24	0.808	-1.014941	1.300971
Exp	.0064163	.0311163	0.21	0.837	-.0549703	.0678029
FB	1.938805	.7286358	2.66	0.008	.5034972	3.374113
Tenure	-.1809836	.0474181	-3.82	0.000	-.2743904	-.0875768
ROE	.2990644	.3419673	0.87	0.383	-.3745619	.9726908
Lev	.5281818	.2800425	1.89	0.060	-.0234617	1.079825
Size	.0001924	.0000238	8.08	0.000	.0001455	.0002393
_cons	-4.775456	2.143544	-2.23	0.027	-8.99793	-.5529829

Table 4 shows the findings of model 1 (the basic model) regression tested using alternative measures of control variables. For firm past performance we use return on equity (ROE) instead of ROA. The measurement of financial leverage is replaced

by the ratio of long-term liability to total equity as an alternative of total debt to total assets. Finally, firm size is measured by the Ln (number of employees) instead of Ln (total assets).

The results demonstrate the non-variability of the relationship R&D spending and CEO characteristics to the various control variables, which confirm our main findings.

4. Conclusion

This paper aims to study the firm's innovation and to understand some of its determinants in light of the CEO power dimensions. The main objective of this study is to investigate the effect of some CEO attributes on the R&D spending in the firm. The empirical results show that some CEO attributes are key determinants of the differences in R&D spending between Saudi firms. CEO origin, functional background and ownership does matter. The study results have important implications for firms relying on R&D and risk-taking decisions. They demonstrate that it is better to hire an insider CEO since his firm-specific knowledge will enhance his ability to promote innovative activities more than the experiences of an outsider CEO who may lack the adequate proficiency in effectively managing the firm-specific R&D spending. Insider CEOs are more likely to understand and appreciate the firms' internal resource conditions and consequently they are greater able to decide and perform long-term changes that outline the company's organizational capabilities. Additionally, findings support that firms should consider the domain expertise when hiring CEOs by selecting those with career experience in marketing and/or engineering insofar as, those with career experience in marketing are more able to explore new opportunities and to monitor and adjust products and markets, while those with career experience in engineering are more able to improve the efficiency of the transformation process. The results, however, do not refute the possibility that companies could hire CEOs with another area of expertise. Nonetheless, in this case, firms should invest more time and effort of CEOs in marketing and/or technology. Although, firms should improve the CEO incentives by stock ownership, as they lead CEOs to choose strategies that maximize shareholders' wealth such as innovation strategies based on R&D spending. Furthermore, since CEOs with longer tenures became less willing to assume risks and therefore less interested in implementing innovative activities, it is better to hire a CEO with short tenure.

Given that for the year 2020, Saudi Arabia ranks 50th by the Global Innovation Index in innovation inputs, lower than last year and lower compared to 2018, this study would be substantive, also, for both the country governors to improve the country ranking. It provides valuable insights and guides shareholders and directors when selecting CEOs to choose the most one willing to decide research and development.

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