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An empirical research on the influence of TMT characteristics on R&D investment

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ABSTRACT: Characteristics of top management team (TMT) are the key factors influencing R&D investment. This paper selects food & beverage companies and biological & pharmaceutical companies as samples. These companies are A-share listed companies in Shanghai and Shenzhen stock exchange. The aim of this article is to examine the influence of TMT characteristics on R&D investment using the relevant data disclosed in their annual reports, from 2011 to 2012. The results show that: (1) The average educational level of TMT members, and the proportion of members with "output function" experience and stock owned members in TMT are positively associated with R&D investment; (2) The average age of TMT members is negatively associated with R&D investment.

Keywords: top management team (TMT); R&D; investment

1 RESEARCH BACKGROUND

Nowadays, with the continuous development of science and technology and increasingly fierce competition between companies, shortening life cycle of production, and technological innovation based on R&D investment become more and more important for company's existence and development. Through R&D movement, company can bring in new product in order to better meet custom's demand, get rid of its position of price taker, and improve its product's competence in the market, compared to other company which gives up R&D investment. Meanwhile, R&D investment can also decrease the production cost, so as to elevate operation ability, bring new core competitiveness to the company, and provide sustaining development.

As knowledge and skills are limited, it is too hard for a single person to make R&D investment decisions, because R&D investment decision requires managers to comprehensively consider the strengths and weaknesses of the organization, and the opportunities and threats from the external environment. So it is the general trend that top management team consisting of managers from different departments and fields, makes decisions and chooses strategies. They use their own values and cognitive base to evaluate all kinds of information when making operating decisions and choosing strategies. Their values and cognitive base can be reflected by their characteristics, and examples of such characteristics are age, tenure in the organization, educational level and functional background. In other words, whether company invests R&D movement or not all depends on the decision of top management team, and is influenced by its characteristics.

In China, before the implementation of new Accounting Standard for Business Enterprises, Chinese enterprises disclose the information of R&D investment voluntarily. It is so difficult to collect relevant data of R&D investment that few scholars directly use R&D expenditure of listed company to study R&D investment. At the same time, studies on TMT are mainly concentrated in the mature market economy country (USA). The basic theory of TMT is based on the operational environment and management practice of enterprises in the mature market economy countries. The objects of empirical research are enterprises in the mature market economy countries. In China, where businesses is in the immature market economy, the way of TMT characteristics influencing firm performance is different from that in foreign countries where businesses under mature market economy (Zhang Ping, 2006)[1]. Therefore, it's necessary to study the way of TMT characteristics influencing R&D investment

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under the background of Chinese culture, which provides a unique perspective for theory study.

This paper selects food & beverage companies and biological & pharmaceutical companies as samples to examine the influence of TMT characteristics on R&D investment. This study may provide two major benefits. On one hand, the conclusion of this study can help enterprises to set up or optimize their TMT in order to promote technological innovation and improve the level of R&D investment. On the other hand, the conclusion of this study can help enterprises to predict competitors' R&D investment strategies according to their TMT characteristics in order to cope with the increasingly fierce competition among enterprises actively.

2 LITERATURE REVIEW AND HYPOTHESES

2.1 *Literature review*

Hambrick & Mason proposed the Upper Echelons Theory in 1984. According to the theory, organizational outcomes, both strategies and effectiveness, are viewed as reflections of the value and cognitive bases of powerful actors in the organization [2]. R&D investment decisions are also influenced by the TMT characteristics.

Theoretical and empirical studies on the average age of TMT members reached a consensus. Younger managers tend to be more speculative, and the older ones tend to be more conservative. Therefore, older managers will avoid risky projects such as R&D investment (Child, 1974[3]; Hart & Mellons, 1970[4]; Carlsson & Karlsson, 1970[5]; Wang Deying &Liu Jianhe, 2011[6]).

Studies on the average tenure of TMT members are contrary. Top managers with shorter tenure tend to increase R&D investment in order to certify his ability while top managers with longer tenure tend to avoid occupational risks by keeping stable R&D investment (Grinun & Smith, 1991) [7]. The opposed view is that the longer top managers service in the organization, the better they realize the benefit of R&D investment for the development of enterprises. The development of enterprises can bring them sense of achievement and interests, so they will increase the R&D investment (Liu Yunguo & Liu Wen, 2007) [8].

Scholars have different views and opinions on the average educational level of TMT members. One view is that the average educational level of TMT is positively associated with R&D investment (Wen Fang, 2008) [9]. Because educated top managers are more likely to accept innovation mentally (Batel & Jaskson, 1989) [10]. The other view is that there's no association between the educational background of top managers and R&D investment (Wei Xiaoke, 2006[11]; Li Huajing & Zhang Yuli, 2006[12]).

Daellenbach & McCarthy (1999) [13] divided top managers into six groups based on the occupational background. The more members with "output function" experience (production, engineering, R&D) in TMT, the more possibility they invest R&D movement.

2.2 *Hypotheses*

Firstly, the age influences the risk preference and decision-making ability of decision makers. R&D investment decision maybe threats the financial security and career security of older managers because R&D investment decision is complex and risky. Older managers tend to avoid risky strategy (Wiersema & Bantel, 1992) [14]. Secondly, older top managers have greater psychological commitment to the organizational status (Hambrick & Mason, 1984) [2] who more rely on past experience and refuse to change when making decisions. Thirdly, the development of new products and technology needs new managerial skills and abilities, so top managers must be constantly learning. However, older top managers have less physical and mental stamina or may be less able to grasp new ideas and learn new behaviors. Based on the above analysis, the following assumption has been taken.

H_1: The average age of TMT members is negatively associated with R&D investment.

Top managers with longer tenure in the organization, who are more familiar with the corporate environment, are more prone to emotional dependence and policy preferences and more likely to have relatively limited perspectives, rely on fixed reference model, and choose a conservative strategy (Hambrick & Mason, 1984) [2]. In addition, based on our country's Accounting Standards for Business Enterprises, the research expenditure for its internal research and development projects of an enterprise shall be recorded into the profit or loss for the current period, which may be confirmed as intangible assets when they satisfy the strict conditions. In other words, R&D investment maybe reduces the profit, and has hysteretic effect. As a result, top managers with different tenure use R&D investment as a tool to adjust profit of their own tenure. As economic man, top manager with shorter tenure wants to prove that he is qualified for the position, needs a long-term professional development, and tends to increase R&D investment. While top managers with longer tenure are especially close to retire and tend to avoid occupational risks and benefiting others after they retired by keeping or reducing R&D investment. Based on the above analysis, the following assumption has been taken.

H_2: The average tenure of TMT members is negatively associated with R&D investment.

With the uncertainty and risk of R&D investment, top managers' works become more and more complex and diverse. It is clear that top managers should be more competent. Education to some extent is an indicator of person's values and cognitive base will influ-

ence organizational strategy. First, well-educated top managers maybe have more open attitude towards innovation and have more confidence to meet challenges (Herrmann & Datta, 2005)[15]. Second, well-educated top managers maybe possess more knowledge and skills (Wiersema & Bantel, 1992) [14], collect more relevant information, adapt to more dynamic and complex environment, and make more effective decision. Based on the above analysis, the following assumption has been taken.

H_3: The average educational level of TMT members is positively associated with R&D investment.

The experience of top managers in different industries, enterprises and functional departments of the same enterprise influence their knowledge, attitudes and job orientation. Hambrick & Mason (1984) [2] see marketing and product R&D as "output functions", and regard production, process engineering, and accounting as "throughput functions". Top managers with "output functions" experience maybe pay more attention to the interest that R&D movement returns, so they will increase R&D investment (Datta, 2003) [16]. Top managers with "throughput functions" commonly use financial management methods to evaluate technical problems, so they will reduce R&D investment in order to decrease the cost. Based on the above analysis, the following assumption has been taken.

H_4: The proportion of "output function" experience members in TMT is positively associated with R&D investment.

R&D investment is benefit for the long-term interest of the enterprise, which has the characteristics of high risk and high profit. The different risk preference between the shareholders and the top managers make them choose different R&D investment strategies. The shareholders of the enterprise can spread risk by investment portfolio so they tend to increase R&D investment that can bring maximal return but minimal risk. Top managers give up R&D investment because income is not enough to cover their costs. Firstly, top managers will be faced with greater financial pressure because substantial capital is invested in the R&D movement. Secondly, top managers will lose their jobs because the decline of business performance is caused by the failure of risky R&D investment. Thirdly, shareholders gain maximum return after the success of R&D investment. Top managers have no motivation to increase the R&D investment because they take such a big risk but share nothing in the profit. Make top managers stock owned will encourage them to make decisions on the side of shareholders. Based on the above analysis, the following assumption has been taken.

H_5: The proportion of stock owned members in TMT is positively associated with R&D investment.

Females have unique characteristics compared to males, such as attentive, sensitive and good at emotional expression. Females involved in TMT can optimize the gender structure of TMT. The participation of females in TMT can bring their gender superiority in thinking into full play. Female participation in TMT can offer a variety of perspectives for managerial decision. In addition, based on the diversity of the TMT can match the diversity of potential customers, especially for the enterprises have more female customers, female participation in TMT can understand customer's psychology and behavior better, and grasp the change in demand more accurately. Based on the above analysis, the following assumption has been taken.

H_6: The proportion of female members in TMT is positively associated with R&D investment.

3 RESEARCH DESIGN

3.1 *Sample selection*

This paper selects food & beverage companies and biological & pharmaceutical companies from Shanghai stock exchange and Shenzhen stock exchange as samples in 2011-2012. As the effect of top management team (TMT) on corporate have hysteresis phenomenon, independent variables and control variables select from 2011and dependent variables select from 2012. This paper collects relevant data of R&D investment follows the following principles: (1) If the board of directors disclosed R&D expenditure in the reports, we use it directly. (2) If the board of directors didn't disclose R&D expenditure in the reports, we use the increase of research expenditure and development expenditure as R&D expenditure. (3) Companies are eliminated if their board of directors didn't disclose relevant data of R&D investment. According to the principles above, we collect data of 68 listed companies by manual in the annual reports of listed companies. The annual reports of listed companies were collected from CNINFO website and GTA-China Stock Market and Accounting Research Database. This paper use SPSS20.0 for data analysis.

3.2 *Variable definition*

We choose RDR and RDI as dependent variables and select average age, average tenure, educational background, occupational background, stockholding proportion, and female proportion as independent variables. Control variables include corporate assets, return on assets, asset-liability ratio, and corporate age. The main variables definition is shown in Table 1.

3.3 *Regression model*

We established regression model (1) and model (2) to test hypothesis H_1- H_6.

$$RDR = \beta_0 + \beta_1 AAGE + \beta_2 ATIM + \beta_3 AEDU + \beta_4 PBAC + \beta_5 PSTO + \beta_6 PGEN + \varepsilon \quad (1)$$

Table 1. Variable definition

Variable classes	Name	Code	Variable definition
Dependent variable	R&D intensity	RDR	R&D investment/revenue
	Ln (R&D investment)	RDI	Ln (R&D investment)
Independent variable	Average age	AAGE	The average age of TMT members
	Average tenure	ATIM	The average tenure of TMT members
	Educational background	AEDU	The average educational level of TMT members (Special=1, College=2, Undergraduate=3, master=4, Doctor=5)
	Occupational background	PBAC	The proportion of "output function" experience members in TMT
	Stockholding proportion	PSTO	The proportion of stock owned members in TMT
	Female proportion	PGEN	The proportion of female members in TMT

$$RDI = \beta_0 + \beta_1 AAGE + \beta_2 ATIM + \beta_3 AEDU + \beta_4 PBAC + \beta_5 PSTO + \beta_6 PGEN + \varepsilon \quad (2)$$

4 DATA ANALYSIS

4.1 *Descriptive statistics*

Table 2 shows the descriptive statistics for 68 samples. The mean of RDR (R&D Investment/Revenue) is 2.01%. It implies the R&D of corporate need to be further increased. The max of RDR is 10.73%, the min is 0.01% and St.D is 2.10%. In independent variables, the mean of average age is 46.17, average tenure is 5.25, educational background is 3.39, stockholding proportion is 22.24%, and female proportion is 14.72%.

Table 2. Descriptive statistics for variables

Index	Min	Max	Mean	St.D
RDR	0.01%	10.73%	2.01%	2.10%
RDI	11.54	20.10	16.97	1.56
AAGE	40	51	46.17	2.32
ATIME	1.75	9.00	5.25	1.46
AEDU	2.30	4.33	3.39	.42
PBACK	0.00%	75.00%	33.33%	20.83%
PSTOCK	0.00%	100.00%	22.24%	27.00%
PGEND	0.00%	66.67%	14.72%	15.38%

4.2 *Regression analysis*

This paper uses the average age, tenure and educational level of TMT members, and the proportion of "output function" experience members, stock owned members and female members in TMT as independent variable and the intensity of the R&D investment as dependent variable. We use multiple stepwise regression method to analyze the influence of TMT characteristics on R&D investment.

From Table 3, we can find that the correlation coefficient between the average age of TMT members and the intensity of the R&D investment is less than zero, the correlation coefficient between the proportion of "output function" experience members in TMT and the R&D investment intensity is more than zero, and the correlation coefficient between the proportion of stock owned members in TMT and the intensity of the R&D investment is more than zero. That is to say, the average age of TMT members is negatively associated with R&D investment, while the proportion of "output function" experience members and stock owned members in TMT are positively associated with R&D investment. The regression equation is:

RDR=0.386*PBACK-0.326*AAGE+0.278*PSTOCK

Using the same method, we find that the average educational level of TMT members and the proportion of "output function" experience members in TMT in are positively associated with R&D investment, as shown in Table 4. The regression equation is:

RDI=0.371*AED+0.311PBACK

Table 3. RDR coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	*Std. Error*	*Beta*		
1	Constant	.867	.458		1.893	.063
	PBAC	.034	.012	.339	2.928	.005
2	Constant	13.162	4.660		2.825	.006
	PBAC	.038	.011	.382	3.406	.001
	AAGE	-.269	.102	-.297	-2.650	.010
3	Constant	13.874	4.473		3.102	.003
	PBAC	.039	.011	.386	3.594	.001
	AAGE	-.296	.098	-.326	-3.019	.004
	PSTO	.022	.008	.278	2.606	.011

Table 4. RDI coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	*Std. Error*	*Beta*		
1	Constant	11.998	1.423		8.433	.000
	AEDU	1.467	.416	.398	3.524	.001
2	Constant	11.564	1.358		8.517	.000
	AEDU	1.366	.396	.371	3.446	.001
	PBAC	.023	.008	.311	2.893	.005

5 CONCLUSIONS

The average age of TMT members is negatively associated with R&D investment. Hypothesis H_1 is completely proven. Older top managers are more conservative on business strategy than younger top managers, so they will avoid the risky R&D investment. On the contrary, younger top managers have a

long-term occupational planning, so they will increase the R&D investment. The organization emphasizing innovation should make TMT younger.

The average educational level of TMT members is positively associated with R&D investment. Hypothesis H_3 is completely proven. Education provides top managers with more advanced knowledge, wider vision, richer social resource and greater insight. Therefore, well-educated top managers can grasp the development opportunity and gain competitive advantage in the fierce competition. The organization emphasize innovation cannot stress the importance of learning too much in order to make decisions of high quality in the dynamic environment.

The proportion of "output function" experience members in TMT is positively associated with R&D investment. Hypothesis H_4 is completely proven. "Output function" experience managers involved in TMT can increase R&D investment which is benefit for the long-term development of the company, especially for high and new technology companies. The organization emphasizing innovation should increase the proportion of "output function" experience members in TMT to gain long-term development.

The proportion of stock owned members in TMT is positively associated with R&D investment. Hypothesis H_5 is completely proven. Making top managers stock owned can reduce the agency cost caused by the separation of proprietorship and management power. The organization emphasizing innovation should make TMT members stock owned in order to avoid the externality of R&D investment and improve the level of technological innovation.

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