The Stability of Top Management Team and Dual Innovation—A Moderating Role Based on Environmental Uncertainty

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Abstract: The external environment facing enterprises is becoming increasingly turbulent, leading to intensifying competition among them. In this context, innovation has become the key to the survival and development of enterprises, with the top management team being the main body responsible for formulating and executing innovative strategies. The stability of top management team directly affects the formulation and execution of innovative strategies, ultimately impacting the development of the enterprise. Based on this, this paper uses data from A-share listed companies from 2009 to 2020 to empirically test the relationship between the stability of top management team and dual innovation, and further examines the moderating effect of environmental uncertainty between the two. The study found that the stability of top management team can significantly promote the output performance of dual innovation, while environmental uncertainty has a suppressing effect on the relationship between the stability of top management team and the performance of dual innovation in enterprises.

Keywords: TMT stability, Dual innovation, environmental uncertainty

1. Introduction

In recent years, influenced by the COVID-19 pandemic and the international situation, the external environment has become increasingly turbulent and uncertain, posing significant challenges to the survival and development of enterprises. In order to cope with this volatile external environment and fierce competitors, innovation has become the core of enterprise survival and development; and the stability of the top management team, as the most important human resource of the enterprise, plays a crucial role in the formulation and implementation of enterprise innovation decisions.

Throughout the existing studies, although scholars have accumulated research on the relationship between TMT stability and innovation, there are still deficiencies that need to be examined urgently. Firstly, the existing literature mainly focuses on the study of the impact of TMT stability on the innovation input aspect of enterprises, ignoring the role of TMT stability on the innovation output of enterprises. Secondly, few scholars have subdivided innovation into exploratory innovation and exploitative innovation to further explore the impact of TMT stability on exploratory innovation and exploitative innovation. Therefore, it is of great significance to clarify the impact of TMT stability on dual innovation.

In view of this, this paper explores the impact of TMT stability on dual innovation by utilizing detailed data on top management team size change and member turnover as well as patents of A-share listed companies in China from 2009 to 2020. Meanwhile, the study demonstrates through empirical tests that environmental uncertainty has a dampening effect on the above relationships.

2. Theoretical foundation and research hypotheses

2.1 TMT Stability and Dual Innovation

Referring to the studies of Crutchley et al. [1], Zhang et al. [2], and Zheng et al. [3], this paper defines TMT stability as the extent to which the size of the top management team and the team members remain unchanged over time. In this context, the top management team includes the board of directors, the supervisory board and senior management, excluding independent and outside directors.

According to the upper echelon theory, the top management team is responsible for formulating and implementing innovation strategies that are conducive to the survival and development of the enterprise. Therefore, TMT stability also has a significant impact on the company's innovation activities. Previous studies have shown that a stable top management team can promote corporate R&D investment, accelerate the pace of corporate innovation [4], and form a competitive advantage [5]. Furthermore, based on agency theory, a stable top management team with a high degree of trust, tacit understanding, and consensus among its members can avoid the interruption of the strategic decisions of the top management team and ensure the formulation and implementation of the strategic decisions of the top management team [6]; and innovation activities are divided into exploratory innovation and exploitative innovation. Therefore, synthesizing the above analysis, the study proposes the following hypotheses:

H1: TMT stability has a positive effect on exploratory innovation.

H2: TMT stability has a positive influence on exploitative innovation.

2.2 The moderating role of environmental uncertainty

Environmental uncertainty refers to the degree of unpredictability of the enterprise's external operating environment, such as economic policies, political conflicts and social environment [7], all of these external factors will affect the judgment of the enterprise's top management team, thereby affecting the formulation and implementation of strategy. Firstly, when the performance of an enterprise has a large fluctuation, creditors and shareholders are more inclined to recover capital to avoid risky losses caused by environmental uncertainty, thus making it more difficult for the enterprise to raise funds, leading to an insufficient supply of funds for the enterprise's innovation projects, and ultimately inhibiting innovation output. Secondly, when the more unstable the external business environment of the enterprise, the enterprise will face greater survival pressure, and the difficulty of the management of the top management team increases; under great pressure, it may lead to the loss of team members, so that the stability of the top management team decreases. In addition, in an uncertain business environment, the overall risk-taking level of the enterprise will decline, and since innovation activities are inherently risky, the enterprise will scale down its investment in innovation projects, leading to a decline in innovation performance. In view of this, this paper proposes the following hypothesis:

H3: Environmental uncertainty plays a negative moderating role between TMT stability and exploratory innovation.

H4: Environmental uncertainty plays a negative moderating role between TMT stability and exploitative innovation.

3. Research Design

3.1 Data sources

In this article, Chinese A-share listed companies from 2009 to 2020 are used as the research sample, and the data are processed as follows: (1) ST, *ST, missing data, and financial firms are excluded; (2) all continuous variables have been shrunken up and down by 1%, a final sample of 21,059 observations is obtained. All data for the article were obtained from the CSMAR database and organized and analyzed using Excel and Stata16.

3.2 Definition of variables

Dual innovation: exploratory innovation (Explor) and exploitative innovation (Exploi).With reference to existing research by Xu et al. [8], Victor et al. [9], Liu et al. [10], Zeng et al. [11], and Cai et al. [12], exploratory innovation is measured by adding 1 to the number of invention patents and taking the natural logarithm, while exploitative innovation is measured by adding 1 to the total number of utility model patents and design patents, and then taking the natural logarithm.

Stability of the top management team (STMT): this paper draws on Crutchley et al. and Zhang et al. to calculate the stability of the top management team based on the size of the top management team and changes in the team members, with the following formula:

$$SI_{t,t+1} = \frac{M_t - *(S_t/S_{t+1})}{M_t} \times \frac{M_{t+1}}{M_t+M_{t+1}} + \frac{M_{t+1} - *(S_{t+1}/S_t)}{M_{t+1}} \times \frac{M_t}{M_t+M_{t+1}} \tag{1}$$

Where $SI_{t,t+1}$ denotes the stability of the top management team in year t+1; M_t and M_{t+1} represent the number of top managements of a company in year t and year t+1, respectively; $*(S_t/S_{t+1})$ denotes the number of top managements who are in office at the end of year t but not in office at the end of year t+1; and $*(S_{t+1}/S_t)$ denotes the number of new top managements who are not in office at the end of year t but are in office at the end of year t+1.

Environmental uncertainty (ΔEU): in this paper, we refer to the literature studies of Ghosh & Olsen [13] and Shen et al. [14], and construct the following model to calculate the environmental uncertainty with the past 5 years as the window period.

$$Sale = \varphi_0 + \varphi_1 Year + \varepsilon \quad (2)$$

$$EU = \sigma/MS \quad (3)$$

$$\Delta EU = EU/MEU \quad (4)$$

First, model (2) is run with ordinary least squares to get the abnormal sales revenue, and then the environmental uncertainty is calculated based on model (3) and model (4). Where Sale is the sales revenue and Year is the year variable taking values 1,2,3,4,5, i.e., if the observation is for the current year, Year is equal to 5 and so on. ε is the abnormal sales revenue, σ is the standard deviation of ε, MS is the mean value of Sale, EU is the un-industry-adjusted environmental uncertainty, MEU is the median of EU which represents industry-level environmental uncertainty, and ΔEU represents company-level environmental uncertainty adjusted for industry factors.

Control variables: With reference to relevant studies in the field of dual innovation, the following control variables are selected from the firm characteristics and corporate governance level: nature of property rights (Soe), profitability (ROA), firm size (Size), proportion of shareholding by the first largest shareholder (Top1), two positions (Dual), proportion of shareholding by the management (Managerhold), management compensation incentives (Salary), Board Size (Boardsize), Share of Sole Director (Indept), Enterprise Value (TobinQ), Gearing Ratio (Lev), Enterprise Age (Age), Enterprise Growth (Growth), Enterprise Cash Flow (Cash).

3.3 Model construction

In order to study the relationship between TMT stability and firms' dual innovation, and to further explore the moderating effect of environmental uncertainty on the relationship between top management team stability and dual innovation, this paper constructs the following two regression models:

$$Y_{i,t} = \alpha_0 + \alpha_1 STMT_{i,t} + \alpha_2 Control_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (5)$$

$$Y_{i,t} = \beta_0 + \beta_1 STMT_{i,t} + \beta_2 \Delta EU_{i,t} + \beta_3 STMT_{i,t} \times \Delta EU_{i,t} + \beta_4 Control_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (6)$$

where $Y_{i,t}$ is a measure of bimodal innovation, including exploratory innovation and exploitative innovation, and STMT×ΔEU denotes the cross-multiplier term between top management team stability and environmental uncertainty.

4. Empirical Analysis

4.1 Descriptive statistics

As shown in Table 1, in the descriptive statistics, the mean values of exploratory innovation and exploitative innovation are 0.771 and 1.219, respectively, the maximum values are 4.595 and 5.591, respectively, and the minimum value is 0, indicating that there are differences in innovation performance resulting from the two different types of innovation. The mean value of TMT stability is 0.819, indicating that the stability of the top management team of each firm is high and the turnover of top managements is low.

Table 1: Descriptive statistics

variable	sample	mean	median	standard deviation	minimum	maximum
Explor	21059	0.771	0	1.057	0	4.595
Exploi	21059	1.219	0.693	1.458	0	5.591
STMT	21059	0.819	0.886	0.200	0	1
ΔEU	21059	1.377	1.002	1.390	0.0130	24.54
Soe	21059	0.399	0	0.490	0	1
ROA	21059	0.0380	0.0370	0.0580	-0.258	0.196
Size	21059	22.15	21.98	1.252	19.86	26.10
Top1	21059	34.85	32.83	14.60	9.170	74.82
Dual	21059	0.259	0	0.438	0	1
Managerhold	21059	12.50	0.249	19.28	0	67.43
Boardsize	21059	2.139	2.197	0.195	1.609	2.708
Indept	21059	0.374	0.333	0.0550	0	0.800
TobinQ	21059	2.052	1.646	1.283	0.858	8.804
Lev	21059	0.429	0.424	0.205	0.0560	0.884
Age	21059	2.651	2.639	0.534	0.693	3.367
Cash	21059	0.0480	0.0460	0.0690	-0.159	0.246
Salary	21059	14.41	14.39	0.698	12.73	16.47
Growth	21059	0.180	0.112	0.414	-0.566	2.724

4.2 Benchmark regressions

Table 2 shows the results of the multiple regressions of top management team stability on firms' dual innovation. Columns (1) and (2) denote the effect of top management team stability on exploratory and exploitative innovation without the inclusion of control variables, controlling for year and industry fixed effects, respectively. The results show that the effect of top management team stability on exploratory innovation and exploitative innovation are both significantly positive at the 1% level, with regression coefficients of 0.1386 and 0.1883, respectively. Columns (3) and (4) indicate the effect of top management team stability on the two innovation approaches with the inclusion of control variables. The results show that the effect of top management team stability on exploratory and exploitative innovation is still significantly positive at the 1% level, only the regression coefficients have decreased, which are 0.09111 and 0.09921, respectively. All of the above results indicate that top management team stability has a facilitating effect on exploratory and exploitative innovation, i.e., Hypotheses 1 and 2 have been verified.

Table 2: Top management Team Stability and Dual Innovation

variable	(1)	(2)	(3)	(4)
	Explor	Exploi	Explor	Exploi
STMT	0.1386***	0.1883***	0.09111***	0.09921***
	(4.6141)	(4.8020)	(3.2494)	(2.6710)
Control	No	No	Yes	Yes
Year /Industry	Yes	Yes	Yes	Yes
Constant	0.6580***	1.0644***	-6.8701***	-5.6737***
	(22.4611)	(28.2454)	(-12.0438)	(-8.6160)
N	21056	21056	21056	21056
R²	0.1979	0.3133	0.2801	0.3670

t statistics in parentheses, $^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$

4.3 Regulatory mechanism test

The results of the role of environmental uncertainty on the relationship between top management team stability and dual innovation are shown in Table 3, where column (1) represents the effect of environmental uncertainty on top management team stability and exploratory innovation, and the results show that the cross-multiplier term between top management team stability and environmental uncertainty is significantly negative at the 5% level and its regression coefficient is -0.03859, which suggests that environmental uncertainty dampens the positive effect of top management team stability on exploratory innovation. Column (2), on the other hand, indicates that the effect of environmental

uncertainty on top management team stability and exploitative innovation is significantly negative at the 10% level, where the coefficient of the cross-multiplier term of top management team stability and environmental uncertainty is -0.03475. It can be seen that environmental uncertainty has a negative moderating effect on the stability of top management team and exploitative innovation. Hypotheses 3 and 4 are supported.

4.4 Robustness test

The research conducted two robustness tests in the following aspects: (1) Tobit model test. Due to the presence of data clustering at the minimum value of 0 in the dependent variable of dual innovation, indicating a clear left-censored distribution characteristic, this study re-estimated using the Tobit model. The results, as shown in Table 4, indicate that the regression coefficients of top management team stability on exploratory innovation and exploitative innovation are 0.1818 and 0.2085, respectively, both significant at the 1% level. This suggests a significant positive impact of top management team stability on dual innovation, consistent with the previous findings. (2) Considering the impact of the COVID-19 pandemic, the outbreak of the pandemic led to the inability of major enterprises to work in a short period, and even if they could work online, there were still significant difficulties in conducting scientific research and development. As a result, the research was re-estimated by excluding the data from 2020. The results, as shown in Table 5, indicate that the impact of top management team stability on exploratory innovation and exploitative innovation is significantly positive at the 1% level, with regression coefficients of 0.1041 and 0.1170, respectively, consistent with the previous findings, suggesting that top management team stability promotes dual innovation.

Table 3: The effect of environmental uncertainty on top management team stability and dual innovation

variable	(1)	(2)
	Explor	Exploi
STMT×ΔEU	-0.03859**	-0.03475*
	(-2.5435)	(-1.6872)
STMT	0.1398***	0.1397***
	(3.6746)	(2.7298)
ΔEU	-0.01593	-0.03300*
	(-1.1945)	(-1.7889)
Control	Yes	Yes
Year/Industry	Yes	Yes
Constant	-6.8038***	-5.5688***
	(-11.9500)	(-8.4507)
N	21056	21056
R^2	0.2829	0.3694

t statistics in parentheses,* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Tobit model test

variable	(1)	(2)
	Explor	Exploi
STMT	0.1818***	0.2085***
	(2.9457)	(2.8800)
Control	Yes	Yes
Year/Industry	Yes	Yes
Constant	-15.211***	-13.159***
	(-15.9182)	(-12.1860)
N	21059	21059

t statistics in parentheses,* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Research Conclusion

This paper tests the effect of TMT stability on dual innovation and further explores the moderating effect of environmental uncertainty on the relationship. The empirical results show that: (1) TMT stability can significantly promote exploratory and exploitative innovation, indicating that a stable top management team will increase team members' concern for the long-term development of the enterprise,

which will be conducive to the development of corporate innovation activities, and ensure the sustainability of the innovation strategy, which will in turn promote the output of innovation. (2) Environmental uncertainty will weaken the positive impact of TMT stability on dual innovation, indicating that when the external environment is more uncertain, the stable top management team will pay more attention to the current survival of the enterprise, will maintain more cash flow, and will pay less attention to the long-term development of the enterprise, so the top management team will reduce the investment in innovation projects, resulting in a reduction of innovation performance.

Table 5: Regression results after accounting for the effect of the COVID-19 Pandemic

variable	(1)	(2)
	Explor	Exploi
STMT	0.1041***	0.1170***
	(3.6307)	(3.0196)
Control	Yes	Yes
Year/Industry	Yes	Yes
Constant	-6.7398***	-5.5938***
	(-11.7231)	(-8.4035)
N	20024	20024
R^2	0.2803	0.3677

t statistics in parentheses,* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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