

8. TOP MANAGEMENT TEAM HETEROGENEITY, DIVERSIFICATION, AND CORPORATE PERFORMANCE: A PANEL SMOOTH TRANSITION REGRESSION MODEL¹

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Abstract

This empirical study uses a panel smooth transition regression (PSTR) model to investigate the nonlinear relationship between top management team (TMT) heterogeneity and corporate performance based on a sample of 117 publicly traded companies in China from 2000-2012. The results show that there is a nonlinear relationship between TMT heterogeneity and corporate performance that depends on the company's degree of diversification. Specifically, when the degree of diversification is lower than the threshold of 0.5647 (i.e., when a company uses a single business or dominant business strategy), heterogeneity in education level and educational background is negatively correlated with corporate performance. When the degree of diversification is higher than the threshold of 0.5647 (i.e., when a company uses a related or unrelated diversification strategy), education-level heterogeneity and corporate performance are positively correlated, whereas age heterogeneity and corporate performance are negatively correlated.

Keywords: heterogeneity, diversification, corporate performance, panel smooth transition regression model, nonlinear

JEL Classification: G34, M54

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1. Introduction

After Hambrick and Mason (1984) proposed the upper echelons theory in 1984, the focus of strategic leadership research gradually shifted from the individual level to the entire top management team (hereafter, TMT). The TMT comprises the highest ranking executives of a firm, i.e., executives at the vice president level or higher. TMT members are responsible for the most important strategic decisions of the organization, such as the formulation and implementation of corporate goals and policies (Hambrick *et al.*, 1996). The upper echelons theory is the theoretical basis for TMT research. Demographic variables, including gender, age, tenure, educational background and professional experience, among others, are important variables in TMT research because there is a close relationship between these variables and a TMT's values and cognitive abilities (Hambrick *et al.*, 1996). According to Carpenter (2002), the variances in demographic variables among TMT members – as opposed to the variables' average levels – can effectively indicate the TMT's communication and collaboration capabilities. Such variances can also directly or indirectly reflect a TMT's ability to acquire and filter market information (Finkelstein and Hambrick, 1996) and thus impact the strategy selection and execution capabilities of the TMT. TMT heterogeneity has two dimensions. The first dimension comprises differences in the TMT's demographic characteristics (e.g., gender, age, tenure and educational background). The second dimension encompasses differences in socio-psychological characteristics, including cognitive functions, values and experiences (Blau, 1977; Jackson *et al.*, 1991). The existing literature suggests that demographic characteristics are indicative of socio-psychological characteristics. For example, an individual's age reflects his or her social experiences and resources, and educational background reflects an individual's cognitive and professional capabilities. Accordingly, demographic characteristics have been used in the research of TMTs' socio-psychological characteristics. For example, Carpenter and Fredrickson used education-level heterogeneity to measure heterogeneity in cognitive processes in their study of the relationship between TMT characteristics and global strategic postures (Carpenter and Fredrickson, 2001).

The core issue of TMT heterogeneity is its relationship to corporate performance; however, a consistent conclusion about this relationship has yet to be drawn in the research. The resource-based view suggests that a firm is a collection of resources that can be transformed into unique capabilities; when effectively utilized, a firm's resources are the key ingredient in a company's competitiveness (Wernerfelt, 1984). Because TMT capability is the core resource of a firm, it has a direct impact on a firm's competitiveness. When TMT heterogeneity is high, i.e., there are vast difference among TMT members' background experiences, cognitive abilities and values, TMT members are more complementary to one another in terms of resources and capabilities. This complementary effect further enhances the firm's core resources and capabilities and thereby promotes the performance of both the TMT and the firm. Theories on information and decision making suggests that the quality of decision making depends on the quantity and quality of information available at the time the decision is made; more and better information leads to better decisions. TMT heterogeneity in areas such as educational background and tenure reflects differences

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in TMT members' knowledge, experience and capabilities, as well as differences in their perceptions and understandings of the firm's internal and external environments (Katz, 1982). In addition, there are differences in the relationship networks and methods of information acquisition among TMT members. Differences among TMT members can provide more diversified information for TMT decision making and improve the firm's knowledge utilization capabilities. Therefore, according to the information and decision-making theory, TMT heterogeneity enhances the TMT's capability to screen and understand information (Zhang Ping, 2006) and thereby promotes organizational improvement and development (Cox, 1994). However, the social identity theory suggests that team members tend to show in-group favoritism (that is, they give preferential treatment to individuals they perceive to be in the same social group) to satisfy their need for positive distinctiveness (Tajfel, 1981). According to the social identity theory, TMT members of homogeneous backgrounds and experiences tend to have better cooperation among them. Close similarities in values and cognition models among homogeneous TMT members enable the TMT to make quick and effective decisions, thereby enhancing corporate performance. On the contrary, TMT members of heterogeneous backgrounds have cognitive variances among them and tend to disagree about interpretations of and responses to strategic issues. Heterogeneous TMT members tend to form different social groups within the TMT and to develop prejudices against the other TMT groups of which they are not members, which decreases the cooperation effectiveness of the TMT.

Thus, contradictions are apparent among the different theories of the relationship between TMT heterogeneity and corporate performance, and a consensus has yet to emerge in the empirical research. On the one hand, Kathleen and Schoonhoven (1990) studied semi-conductor companies in the United States and found that TMT heterogeneity and corporate growth are positively correlated. Similarly, Nielsen's (Nielsen B.B. and Nielsen S., 2011) research indicated that a heterogeneous TMT possesses extensive knowledge and abilities that enable the firm to respond rationally to various challenges and to move effectively towards globalization. On the other hand, Knight's (1999) study of 76 high-tech corporations in the United States and Ireland found that heterogeneity in educational background and age is not conducive to the formation of strategic consensus and has a negative impact on decision-making efficiency and corporate performance. In addition, Velinov and Kubicek (2013) studied a sample of 37 IPOs in Europe between 2008 and 2012 and found no correlation between corporate performance and heterogeneity in age and tenure.

Based on these inconsistent conclusions, Carpenter (2002) suggested that the impact of some important moderator or mediating variables should be considered. Such variables come primarily from the social environment in which the organization is based. Furthermore, Hambrick and Mason (1984) noted that industry characteristics should be considered in TMT research because the relationship between corporate performance and the professional experience and tenure of TMT members is different for different industry environments. The latest research shows that TMT heterogeneity impacts corporate performance differently depending on the degree of diversification because diversification affects the specific resources and abilities required by the firm (He and Yang, 2010). In a diversified business environment, companies face competitive pressures from various types of businesses. The members of a TMT with

high heterogeneity in background and experience possess different cognitive styles and abilities; hence, they are capable of providing a variety of perspectives and can develop a greater variety of options to respond to competitive challenges. Consequently, the effective knowledge-utilization capabilities of a heterogeneous TMT enable the firm to secure a competitive edge in a dynamic environment. However, cognitive diversity in a heterogeneous group can lead to disagreements among TMT members. If these disagreements become emotional conflicts, productive arguments can degenerate into endless dysfunctional in-fighting and the firm will suffer as a result of missed opportunities in the ever-changing competitive environment. On the contrary, similar values and cognitive styles among homogeneous TMT members enhance mutual trust, resulting in a cohesive team (Lu *et al.*, 2013). Cohesion among TMT members is conducive to quick and unanimous decision making in a diversified business environment, which enables the company to grasp fleeting market opportunities. However, excessive homogeneity is likely to increase members' rejection of external forces, which will counteract TMT brainstorming and inhibit acceptance of new ideas.

A diversified firm is essentially a nonlinear feedback system because there is no fixed proportion or cause-and-effect relationship among the business units. Individual business units use this nonlinear feedback to adjust their respective business strategies in order to achieve sustained corporate growth and development (Zhang Ping, 2008). In a diversified operational environment, the relationship between TMT heterogeneity and firm performance does not remain constant but changes as the degree of diversification changes. Moreover, although the relationship between TMT heterogeneity and corporate performance should be characterized as nonlinear processes, previous research has been based on a linear relationship between them. This may explain the inconsistent findings of previous studies.

This study supplements previous research on TMT heterogeneity using data on TMT members' differences in education level, educational background, age and tenure at 117 publicly traded companies in Shanghai and Shenzhen between 2000 and 2012. This study uses the recently developed panel smooth transition regression (PSTR) model of Gonzales *et al.* (2005) to analyze the nonlinear relationship between TMT heterogeneity and corporate performance in a diversified operational environment. The PSTR model not only effectively portrays the cross-sectional change of heterogeneity in the panel data but also allows model parameters to change in a smooth, nonlinear manner as the transition variables change. Hence, it is possible to determine whether the relationship between TMT heterogeneity and corporate performance changes in a nonlinear manner when the degree of diversification changes.

2. The Panel Smooth Transition Regression Model

This study uses the PSTR model of Gonzales *et al.* (2005) to explore whether the relationship between TMT heterogeneity and corporate performance exhibits nonlinear changes in response to changes in the degree of diversification. The PSTR model not only effectively portrays the cross-sectional change of heterogeneity in the panel data

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but also allows model parameters to change in a smooth, nonlinear manner as the transition variables change. A PSTR model with a transition variable is defined as follows:

$$y_{it} = \mu_i + \beta_0'x_{it} + \beta_1'x_{it}g(q_{it}; \gamma, c) + \varepsilon_{it} \quad (1)$$

for $i=1, 2, \dots, N$, and $t=1, 2, \dots, T$, where N and T represent the cross-section and time dimensions of the panel, respectively.

Dependent variable y_{it} is a scalar; explanatory variable x_{it} is a k -dimensional column vector; μ_i is the fixed effect; and ε_{it} is the residual. The transition function $g(q_{it}; \gamma, c)$ is the continuous function of the transition variable q_{it} and is normalized to be bounded between 0 and 1. The logistic specification is:

$$g(q_{it}; \gamma, c) = (1 + \exp(-\gamma \prod_{j=1}^m (q_{it} - c_j)))^{-1} \quad (2)$$

where: $\gamma > 0$ and $c_1 \leq c_2 \leq \dots \leq c_m$.

Slope parameter γ determines the smoothness of the transitions; c is the location parameter; and m generally equals 1 or 2.

When $m=1$, the transition function $g(q_{it}; \gamma, c)$ is logistic, and it increases with the transition variable q_{it} . When $g(q_{it}; \gamma, c)=0$, the corresponding model (1) is called the low regime; when $g(q_{it}; \gamma, c)=1$, it is called the high regime. As the value of the transition function changes smoothly between 0 and 1, the model (1) changes smoothly between the high and low regimes at transition point c . The corresponding explanatory variable coefficient also changes between β_0 and $\beta_0 + \beta_1$ as q_{it} increases, where the change is centered at c . When $m=2$, the transition function $g(q_{it}; \gamma, c)$ is indexical. Model (1) is divided into two outer regimes and one middle regime, and the transition function $g(q_{it}; \gamma, c)$ has its smallest value at $(c_1 + c_2)/2$. When $g(q_{it}; \gamma, c)=1$, the model is in the outer regime. When $g(q_{it}; \gamma, c)=0$, the model is in the middle regime.

Before making estimations with a PSTR model, a homogeneity test must be conducted to determine whether the correlation among the variables is linear. If homogeneity is rejected, the PSTR model can be used for estimation; if homogeneity is not rejected, a linear model should be used. Although a homogeneity test is usually performed using the null hypothesis $H_0: \gamma=0$ or $H_0: \beta_1=0$, the PSTR model contains unidentified nuisance parameters under both of these hypotheses. Therefore, this study follows Luukkonen *et al.* to solve the identification problem. Specifically, the transition function $g(q_{it}; \gamma, c)$ is replaced by its first-order Taylor expression around $\gamma=0$, which leads to the following auxiliary regression after reparameterization:

$$y_{it} = \mu_i + \alpha_0 x_{it} + \alpha_1 x_{it} q_{it} + \varepsilon_{it} \quad (3)$$

Consequently, testing $H_0: \gamma=0$ is equivalent to testing $H_0: \alpha_0 = \alpha_1 = 0$. A rejection of the null hypothesis indicates that the model is a PSTR model with at least one transition function (Luukkonen *et al.*, 1988).

Because the null hypothesis of homogeneity is rejected, the value of m in the transition function $g(q_{it}; \gamma, c)$ must be determined. Generally, it is sufficient to consider $m=1$ or $m=2$, because these values cover most scenarios. To determine the final value of m , Terasvirta (1994) proposed conducting a first-order Taylor expansion to the model when $\gamma=0$ and constructing the following three test hypotheses:

$$\begin{aligned} H_{03}: \beta_3=0, \\ H_{02}: \beta_2=0 \mid \beta_3=0, \\ H_{01}: \beta_1=0 \mid \beta_2=\beta_3=0 \end{aligned}$$

If the rejection of H_{02} is the strongest one, $m=2$ is used; otherwise, $m=1$ is used. Based on the above analysis, the related coefficient β in the nonlinear relationship between TMT heterogeneity and corporate performance in the PSTR model can be expressed as:

$$\beta = \frac{\partial y}{\partial x} = \beta_0 + \beta_1 g(q_{it}; \gamma_j, c_j);$$

When $m=1$, the sign of the coefficient β_1 indicates the transition trend of the related coefficient β in the correlation between TMT heterogeneity and corporate performance as a function of transition variable value q_{it} .

3. Study Design

3.1. Sample Selection

This study uses a sample of firms with publicly traded A shares on the Shanghai and Shenzhen exchanges during the period 2000-2012. Financial firms, insurance companies and public utilities are excluded because the characteristics of those types of companies would jeopardize the research results. Also excluded from the sample were the companies that were delisted, had incomplete data sets, or experienced abnormal financial conditions during the study period. Ultimately, this study obtains a balanced panel data set with the number of cross-sections $N=117$ and the time series $T=13$ for a total of 1521 valid observed values. All data used in this study were obtained from GTA Data. In addition, to ensure data accuracy and completeness, the data obtained from GTA Data were verified using data from the annual reports of the listed companies, Gildata and SINA Finance.

3.2. Definition of Variables

The definition of TMT varies in existing literature. Hambrick *et al.* (1996) defined TMT as the group of managers with titles of vice president or higher. Elron (1997) limited TMT to senior management, including the CEO and senior vice presidents. Based on the regulations applicable to Chinese listed companies, this study defines TMT as the senior management of a firm, including vice presidents, deputy general manager, chief accountant, chief economist, chief financial officer and chief engineer, as well as any positions above those ranks.

China's stock market remains relatively unsophisticated; this makes it vulnerable to manipulation. Thus, the stock prices of publicly traded companies do not necessarily accurately reflect their actual operational performance. Therefore, this study uses

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return on assets (ROA) to measure corporate performance. This research uses differences in TMT members' education levels, educational backgrounds, ages and tenures to measure TMT heterogeneity. The Herfindahl-Hirschman coefficient (also called the Blau coefficient) is calculated for education-level heterogeneity (HEDU) and

educational-background heterogeneity (HMAJ) using the formula $H = 1 - \sum_{i=1}^n p_i^2$,

where p_i is the ratio of i-type members in the group, and the value of H is between 1 and 0. When the value of H approaches 1, a high level of heterogeneity is indicated; when the value of H approaches 0, close homogeneity among TMT members is indicated. After comparing various measures of inequality, Allison (1978), suggested that the coefficient of variation (the ratio of the standard deviation to the mean) is the best measure of heterogeneity when the demographic characteristics are measured using continuous variables (such as age and tenure). Accordingly, this study uses the coefficient of variation to measure age heterogeneity (HAGE) and tenure heterogeneity (HTEN).

Based on the subject classifications of the Chinese Ministry of Education and classifications used in the existing literature (Hambrick, 1996), this study divides educational background into the following 5 categories: science and engineering; economics and management; arts and literature; law; and other. The TMT education level is also divided into 5 categories: technical secondary school and below; junior college; undergraduate; graduate; and doctoral. This study employs the method of Yao *et al.* (2004) of measuring diversification (DIV) by using Standard Industrial

Classification (SIC) codes to calculate the entropy index, that is: $DIV = \sum_{i=1}^n P_i \ln \left(\frac{1}{P_i} \right)$.

This study uses the 4-digit SIC system to define industry categories. P_i is the ratio of the sales revenue of i^{th} industry to the company's total sales, and n is the number of industries in a company's business portfolio. The higher the value of DIV is, the higher the degree of diversification is.

This study chooses to use the ratio of state-owned shares (STA), firm size (SIZE) and debt ratio (DEBT) as control variables. The ratio of state-owned shares is calculated by dividing the number of state-owned shares by the total number of company shares. Total assets are used to measure the firm size. Because the heterogeneity of firms' total assets would be exaggerated if actual values were used, which would jeopardize the results of the final regression analysis, a natural logarithm of total assets is used to calculate firm size. The debt ratio is total debt divided by total assets.

Table 1 provides the descriptive statistics of the sample. As stated above, the sample comprises 13 years of data for 117 companies for a total of 1521 valid observed values. All variables rejected the null hypothesis of normal distribution under the Jarque-Bera test.

Table 1

Descriptive Statistics of Variables

Variables	Means	Median	S.D.	Skewness	Kurtosis	Jarque-Bera
ROA(%)	4.19	3.65	5.49	0.81	12.73	6167.61***
HEDU	0.51	0.53	0.16	-1.21	4.68	547.17***
HMAJ	0.41	0.44	0.14	-1.47	5.27	871.50***
HAGE	0.13	0.13	0.04	0.30	2.90	23.01***
HTEN	0.50	0.50	0.29	0.55	4.43	207.00***
DIV	0.23	0.12	0.28	1.54	5.08	875.12***
STA	0.29	0.29	0.26	0.16	1.50	148.86***
SIZE	21.81	21.72	1.08	0.43	3.12	48.51***
DEBT	0.47	0.48	0.18	-0.17	2.40	30.37***

Note: Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1, two-tailed tests.

3.3. Panel Data Unit Root Test

Gonzalez's PSTR model requires that variables in the model be stationary to avoid spurious regression. First generation unit root tests also hypothesize cross-sectional independence. However, these tests do not consider the possibility of structural change. If structural changes are ignored in a unit root test, the null hypothesis of a unit root is easily accepted. Therefore, structural changes should be considered. Therefore, we must consider using second generation unit root tests, which relax the assumption of cross-sectional independence, to test for stationarity. This study conducts the panel unit root tests of Moon and Perron (2004) and Choi (2002). As shown in Table 2, the null hypothesis of unit root is rejected for all variables. Therefore, all variables in this model are stationary.

Table 2

Panel Data Unit Root Test Results

	ROA	HEDU	HMAJ	HAGE	HTEN	DIV	STA	SIZE	DEBT
MP	-24.41	-26.08	-28.23	-25.35	-31.00	-26.47	-16.39	-17.07	-25.28
Choi	24.01	17.55	19.52	12.58	22.79	18.02	10.68	4.12	12.95

Note: All values significance levels: *** p < 0.01, two-tailed tests.

3.4. Homogeneity Test and Determination of the Value of M

To test for homogeneity and ensure the robustness, this study used the Lagrange multiplier test (LM) (chi-square distribution), Lagrange multiplier F-test (LMF) (F-distribution) and likelihood ratio test (LRT) (t- distribution). The results presented in Table 3 show that the LM, LMF and LRT tests all reject the null hypothesis of homogeneity at a significance level of 1% or above; that is, there is a nonlinear correlation between TMT heterogeneity and corporate performance. Thus, using model (1), the following PSTR model can be constructed to study the nonlinear correlation between TMT heterogeneity and corporate performance:

$$ROA_{it} = \mu_i + \beta'_0 x_{it} + \beta'_1 x_{it} g(DIV_{it}; \gamma, c) + \varepsilon_{it} \quad (4)$$

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where: x_{it} represents the explanatory variables (heterogeneity in education level, educational background, age and tenure) and control variables (ratio of state-owned shares, firm size and debt ratio).

Table 3

Homogeneity Test

H ₀ : linear model H ₁ : PSTR model that has at least one threshold value		
Transition variable: degree of diversification		
	statistics	P-value
Wald Tests (LM)	65.922***	0.000
Fisher Tests (LMF)	2.984***	0.000
LRT Tests (LRT)	67.393***	0.000

Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, two-tailed tests.

After confirming model heterogeneity, this study uses Granger and Terasvirta method to determine the value of m . Specifically, the transition coefficient $g(DIV_{it}; \gamma, c)$ is replaced by its first-order Taylor expansion in model (4) when $\gamma=0$. An auxiliary regression model is then constructed to perform equivalent estimations. The results are presented in Table 4.

Table 4

Determination of the Value of M in the Model

When the rejection of H ₀₂ is the strongest, select $m=2$; otherwise select $m=1$		
	statistics	P-value
H ₀₃ : $\beta_3=0$	1.813**	0.014
H ₀₂ : $\beta_2=0 \mid \beta_3=0$	0.688	0.848
H ₀₁ : $\beta_1=0 \mid \beta_2=\beta_3=0$	0.455	0.984

Note: Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, two-tailed tests.

According to Granger (1993) and Terasvirta (1994), it is generally sufficient to consider $m=1$ or $m=2$. When the rejection of H₀₂ is the strongest one, select $m=2$; otherwise, select $m=1$. As shown in Table 4, the rejection of H₀₂ is not the strongest one. Therefore, $m=1$ is selected for the PSTR model; that is, the transition function $g(q_{it}; \gamma, c)$ is related to the transition variable and q_{it} shows a monotonic increase. Model (4) is divided into high and low regimes. The explanatory variable coefficient changes as q_{it} changes between β_0 and $\beta_0+\beta_1$ at center c .

3.5. Parameter Estimation

Table 5 presents the estimation of the model parameters. The empirical results show that the model is divided into high and low regimes with threshold value $c=0.5647$ and transition slope $\gamma =274.7105$. The results indicate that a structural change occurs in the model when $DIV=0.5647$. The graph of the corresponding transition function is shown in Figure 1. Therefore, based on the results in Table 5, the complete PSTR model shows that the nonlinear correlation between TMT heterogeneity and corporate performance is as follows:

$$ROA_{it} = \mu_i + \beta_0 x_{it} + \beta_1 x_{it} g(DIV_{it}; 274.7105, 0.5647) + \varepsilon_{it} \quad (5)$$

$$\beta_0 = (-1.9000, -2.5503, 6.6545, -0.2221, 0.8908, 1.7408, -14.3224)$$

$$\beta_1 = (6.7757, 2.3865, -30.0240, 0.4279, -1.4918, -0.1782, 4.7066)$$

$$x_{it} = (HEDU_{it}, HMAJ_{it}, HAGE_{it}, HTEN_{it}, STA_{it}, SIZE_{it}, DEBT_{it})$$

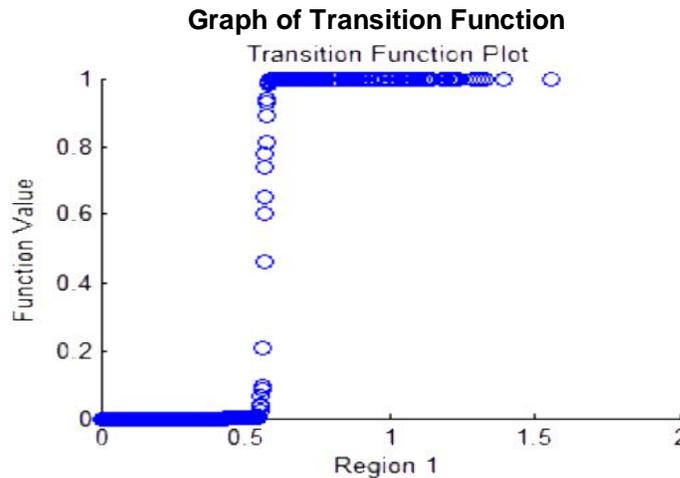
Table 5

PSTR Model Parameter Estimation Results

	β_0	T-value	β_1	T-value
HEDU	-1.9000**	-2.1450	6.7757**	2.4284
HMAJ	-2.5503*	-1.8717	2.3865	0.9126
HAGE	6.6545	1.5920	-30.0240***	-3.3390
HTEN	-0.2221	-0.4455	0.4279	0.3276
STA	0.8908	1.3903	-1.4918	-0.9974
SIZE	1.7408***	6.0298	-0.1782	-1.5341
DEBT	-14.3224***	-8.6677	4.7066*	1.7966
Threshold value c	0.5647			
Slope parameter γ (Transition slope)	274.7105			

Note: Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1, two-tailed tests.

Figure 1



When $DIV < 0.5647$, the model is in a low regime. When $DIV > 0.5647$, the model is in a high regime. In the low regime, there is a significant negative correlation between education-level heterogeneity and corporate performance ($\beta_0 = -1.9000$, $p < 0.05$); in the high regime, there is a significant positive correlation between education-level heterogeneity and corporate performance ($\beta_0 + \beta_1 = 4.8757$, $p < 0.05$). Thus, the correlation between education-level heterogeneity and corporate performance changes when $DIV = 0.5647$, demonstrating a nonlinear relationship. In the low regime,

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there is a significant negative correlation between educational-background heterogeneity and corporate performance ($\beta_0=-2.5503$, $p<0.1$); in the high regime, there is no significant correlation between the two, but they continue to show a nonlinear relationship. In the low regime, there is no correlation between age heterogeneity and corporate performance; in the high regime, there is a significant negative correlation between age heterogeneity and corporate performance ($\beta_0+\beta_1=-23.3695$, $p<0.01$). Although there is no significant correlation between tenure heterogeneity and corporate performance in the low or high regimes, a negative correlation exists in the low regime and a positive correlation exists in the high regime; thus, tenure heterogeneity and corporate performance are in a nonlinear relationship.

When the degree of diversification is lower than 0.5647, the firm's main business is prominent; thus, the primary focus of strategic decision making is on how to gain a competitive edge in the firm's main business. TMT with lower heterogeneity tends to have similar cognitive, learning and understanding capabilities, which contributes to greater cohesion among TMT members. Hence, emotional conflicts within the organization are alleviated, and strategic consensus is promoted. The accuracy and efficiency of strategic decisions are very high, which is conducive to improvements in corporate performance (Huang *et al.*, 2011).

When a company's degree of diversification is higher than 0.5647, the business environment is more complex. A firm with a diversified strategy must have greater awareness of numerous different industries and be able to make decisions accordingly. In addition, the coordination of resources among different industries is necessary, which is facilitated by high levels of cohesion and knowledge among TMT members. TMT with high heterogeneity in education level may be better equipped to handle complex decision-making situations. However, high age heterogeneity induces fights among team members during strategic decision-making, which can cause the firm to miss competitive opportunities and jeopardize the company's performance. When age heterogeneity is high, there are differences in TMT members' upbringing and approach to education; therefore, there are more significant differences in the values and behavior of TMT members. As a manager grows older, cognitive abilities, such as learning, deduction and memory, decrease, as does receptiveness to new ideas. An aging manager depends more on prior experience in his or her decision making and has a tendency to make conservative decisions in order to maintain the status quo. Younger TMT members are more open to new knowledge and ideas. Young TMT members also understand and adapt quickly to changing business trends and have a tendency to be innovative and adventurous.

4. Conclusion

This study uses the PSTR model developed by Gonzales *et al.* to study the nonlinear correlation between TMT heterogeneity and corporate performance. The PSTR model allows the regression coefficient to change in a nonlinear manner as the transition variable (degree of diversification) changes. The results of this study indicate that the model splits into low and high regimes at $DIV=0.5647$, which is consistent with the classification criteria for degree of diversification proposed by Wrigley (1970) and

Rumelt (1974). When $DIV < 0.5647$, the model is in a low regime (the share of total income represented by the company's primary business is greater than 70%; i.e., the company has a single-business or dominant business strategy). When $DIV > 0.5647$, model is in a high regime (the share of total income represented by the company's primary business is less than 70%, which is consistent with the related and unrelated diversification strategies proposed by Wrigley and Rumelt). In both low and high regimes, the type and number of industries in a company's business portfolio are different; therefore, the impact of TMT heterogeneity on corporate performance exhibits nonlinear changes.

Based on findings from our research, in a diversified operational environment, the relationship between TMT heterogeneity and firm performance does not remain constant but changes as the degree of diversification changes. Moreover, although the relationship between TMT heterogeneity and corporate performance should be characterized as nonlinear processes, previous research has been based on a linear relationship between them. This study uses the panel data of 117 publicly traded companies in Shanghai and Shenzhen over a period of 13 years and applies a PSTR model to investigate the nonlinear correlation between TMT heterogeneity and performance. This study not only provides a new perspective to TMT research, both theoretically and methodologically, supplements and enriches existing TMT research, and reveals the relationships among TMT heterogeneity, diversification and company performance, but also provides practical guidance to companies that seek to select TMT members who can adapt to diversified strategies.

However, this study has some limitations. The first limitation is that the use of TMT members' duration in their current positions to measure tenure does not accurately reflect the TMT's tenure characteristics. A TMT member may have had other senior positions in the company before assuming his or her current position. Therefore, measuring tenure based on a TMT member's duration in a current position does not accurately reflect the cooperation and cohesiveness among TMT members. Future research might consider total time at the company or total time at the decision-making level to measure tenure. The second limitation is that this study uses degree of diversification as the transition variable without including other variables. In reality, there are other factors that affect the correlation between TMT heterogeneity and corporate performance, including variances in the characteristics of the company's business environment or the external environment.

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