An empirical analysis of the influence of human capital on enterprise innovation performance: A focus on the nature of enterprise ownership and enterprise scale

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ABSTRACT

Purpose: This research examines how the heterogeneity of enterprise ownership nature and scale influences the relationship between human capital and innovation performance.

Design/Methodology/Approach: This study makes use of data from the list of companies on China's expanding enterprise market from 2009-2020 through regression analysis using the panel data least squares approach.

Findings: Higher levels of human capital and staff training have a positive impact on innovation performance but employee salaries and welfare levels have a negative impact on innovation performance. The effect of human capital stock and employee training on the performance of innovation in companies is more pronounced in state-owned enterprises or small companies. The nature of ownership or enterprise size has no significant effect on employee wage and welfare levels or the innovation performance of enterprises.

Conclusion: The study's findings suggest that the relationship between human capital and innovation performance is complex and closely correlated with the type of ownership and size of the business.

Research Limitations: More factors of firm heterogeneity such as firm age, industry and region were not verified.

Practical Implications: It provides a new way for enterprises to improve innovation performance.

Contribution to Literature: The purpose of this paper is to broaden the research viewpoint on how human capital investments affect the performance of enterprise innovation from two perspectives: the nature of enterprise ownership and the size of the enterprise.

Keywords: *Employee training, Employee wage and welfare level, Enterprise scale, Human capital stock, Human capital, Innovation performance, Nature of enterprise ownership.*

1. INTRODUCTION

Human capital has become a popular research topic with the rise of the information economy. Human capital is made up of an individual's internalized human knowledge, skills and capabilities. It has taken the place of conventional production factors and assumed a progressively significant role in the enterprise's technological innovation process. After six decades of human capital theory development, considerable attention has been devoted to the relationship between company human capital and company innovation performance. Most businesses in China have not yet developed their own methods for innovation which has led to a relatively underdeveloped autonomous innovation capability where people are the main innovators. Therefore, businesses must design an enterprise growth model that is based on human capital and focused on autonomous innovation to maintain a competitive edge in the face of intense global competition.

There are two main effects of human capital on innovation performance: First, it is believed that the human capital of enterprises significantly affects their innovation performance. Second, it is believed that the influence of human capital on innovation performance could be more readily apparent (Cao, Su, & Zhao, 2010; Feng, 2010). Several researchers have researched the human capital innovation effect's influencing variables considering the

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significance of the dual nature of this effect. Some scholars focus their research on the heterogeneity of countries and industries. A few studies at the enterprise level believe that the effect of human capital on the innovation of different categories of companies is different. Researchers have produced fruitful research results on the relationship between the human capital of organizations and their innovation performance. There are still the following deficiencies:

First, theoretical and empirical studies on the heterogeneity effect of microenterprises are relatively scarce.

Secondly, a few scholars who consider the heterogeneity of enterprises are limited to a specific type of factor. There needs to be a systematic study framework on the impact of human capital on the innovation of heterogeneous organizations because of the significant variations in research techniques and samples which prevent the conclusions from being comparable.

There are disputes about the mechanism design of the human capital innovation effect of different types of enterprises in the existing literature and the policy recommendations usually need to consider the heterogeneity characteristics of enterprises. Therefore, this paper takes innovation theory as the starting point, brings enterprise heterogeneity factors into the study framework of the enterprise innovation effect of human capital and offers a theoretical explanation for the innovation effect of human capital.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESES

2.1. Literature Review

Nelson and Phelps first demonstrated the mechanism of human capital in innovation (Nelson & Phelps, 1966). According to Griliches (1979), innovation is a function of human capital, material capital and innovation efficiency (surplus). Technology was internalized and the relationship between human capital and technological advancement was made clear (Romer, 1986).

Romer (1986) thought that human capital as a variable should have a substantial role in determining the innovation performance of organisations. Hitt, Bierman, Shimizu, and Kochhar (2001) conducted a study using data from 59 countries and found that human capital plays a catalytic role in the process of technological innovation. Dakhli and De Clercq (2004) believe that improving a country's overall human capital level can play a positive role in promoting regional technological innovation capabilities. Vancauteren (2018) found through empirical research on food processing industry enterprises that patent output increases with the increase in R&D investment intensity and human capital has a positive impact on enterprise R&D activities. Li, Zhao, and Zhang (2019) measured the level of human capital by the average ratio of the number of college graduates to the number of enterprises over the years and found that human capital helps to improve the quantity and quality of technological innovation in enterprises.

Academic education is becoming a crucial component of human capital as higher education advances (Li, Sun, & Liu, 2020). Among human capital characteristics, the academic degree has the most substantial promotion effect on enterprise innovation performance.

From the enterprise heterogeneity effect perspective, policy and institutional advantages are typically more prominent in state-owned enterprises than in non-state-owned enterprises. According to Zhuang, Wang, and Zhang (2020), state-owned firms have more financing channels and less financial restraints than non-state-owned enterprises and more readily available resources and government financial support lead to state-owned enterprises being more capable of obtaining external capital elements than non-state-owned enterprises. It can create a better innovation and R&D environment for employees, attract excellent talents and enhance innovation abilities.

Therefore, state-owned enterprises have more vitalization ability than non-state enterprises. According to the perspective of organizational economics, the rigid hierarchical system in large enterprises causes them to lack flexibility due to slow decision-making and the extended information chain in terms of enterprise scale (Xing & Wang, 2018). Moreover, large enterprises are monopolists of existing technologies and "disruptive" innovation brings higher costs to large enterprises (Lu & Li, 2021). Therefore, the innovation incentives for large enterprises could be higher.

2.2. Research Hypotheses

According to the theory of enterprise resources, human capital within an enterprise is considered a distinctive resource that can provide competitive advantages and directly impact the company's innovation performance.

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Enterprise human capital is formed by investment in human resources, so the greater the value of enterprise human capital, the greater the benefits for enterprises and individuals. The variables related to corporate human capital set in this paper are all from the perspective of corporate human capital formation (Deng, Huang, Zhang, & Zhou, 2012). These variables are positively related to corporate innovation performance. Therefore, the following assumptions are proposed:

H_{1a}: There exists a direct relationship between the innovation performance of enterprises and their human capital stock.

H_{1b}: A direct relationship exists between the salary and welfare levels of employees and the innovation performance of enterprises.

H_{1c}: There is a positive relationship between employee training and the innovation performance of enterprises.

H_{2a}: State-owned enterprises are influenced by the stock of human capital in terms of their innovation performance compared to enterprises that are not state-owned.

H_{2b}: The innovation performance of state-owned enterprises is influenced by the salary and welfare level of employees in comparison to enterprises not controlled by the government.

H_{2c}: The impact on government-owned enterprises is more prominent in employee training costs related to their innovation performance compared to non-state-owned enterprises.

H_{3a}: Smaller enterprises are more significantly influenced by the human capital stock in terms of their innovation performance when compared to larger enterprises.

H_{3b}: The innovation performance of smaller enterprises is strongly affected by the salary and welfare level of employees in comparison to larger enterprises.

H_{3c}: The innovation performance of smaller enterprises is significantly influenced by employee training costs compared to larger enterprises.

3. MODEL SETTING AND VARIABLE SELECTION

3.1. Measurement Model Setting

Patent application data which is provided as a non-negative integer and deviates from the assumption of a normal distribution is used to evaluate companies' innovation performance. Consequently, logarithmic processing is carried out for the performance of innovation in enterprises. The panel least square method is used for regression analysis. The fixed effect panel regression model is chosen based on the outcomes of the Hausman test. The specified mode is described as follows:

$$Apply_{i,t} = \alpha_0 + \alpha_1 Stock_{i,t} + \alpha_2 Train_{i,t} + \alpha_3 Salary_{i,t} + \alpha_k \, Governs + v_i + v_t + \varepsilon_{i,t} \quad (1)$$

In the specified model, "Apply $_{i,t}$" represents the dependent variable denoting the quantity of patent applications of the i-th company in the t-th year. "Stock$_{i,t}$" represents the independent variable signifying the human capital stock of the i-th enterprise in the t-th year. Similarly, "Train $_{i,t}$" refers to the training cost per employee of the i-th enterprise in the t-th year. In contrast, "Salary$_{i,t}$" represents the employee compensation and welfare level of the i-th enterprise in the t-th year. The "controls" term includes a set of variables under control such as company scale, company age, ownership type, industry type and the level of investment intensity in research and development (R&D). The parameter to be determined is denoted by " α ". Additionally, "v_i" represents the effect at the individual level, "v_t" signifies the effect over time and "i" and "t" represent the company and year separately. Lastly, "$\varepsilon_{i,t}$" represents the random interference term.

3.2. Selection of Variables and Source of Data

This research uses data from the China Stock Market and Accounting Research Database focusing on listed companies in China's Growth Enterprise Market (GEM) between 2009 and 2020. The sample data underwent several processing steps.

Companies with incomplete or abnormal data as well as those classified as special treatment (ST) or Particular Transfer(PT) or that have been delisted are not considered financially listed companies. Additionally, this paper applies Winsorization to continuous variables. A complete list of variables and their descriptions are given in Table 1.

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Table 1. Choosing and explaining variables.

Variable classification	Measurement tool	Notation for variables	Choosing and explaining variables
Dependent variable	Performance of innovative	Apply	Application of patent.
Independent variables	Stock of human capital	Stock	The mean duration of higher education among employees in a company is as follows: The time for vocational education (College diploma) is three years, undergraduate education (Bachelor's degree) is four years, graduate education (Master's degree) is seven years and doctoral education is ten years.
	Employee salary and welfare level	Salary	The per capita funding for enterprise trade unions and employee education funds.
	Training cost per employee	Train	The cost of total employee compensation and benefits as a percentage of annual business revenue for the company.
	Enterprise scale	Scale	Total assets of the company.
	Ownership	Own	State-owned enterprises are represented as "1" while others are described as "0".
Control variable	Enterprise age	Age	Use "1" to indicate companies with an age more significant than the average and "0" to show companies with an older age than the average.
	Industry	Industry	The manufacturing sector is represented by 1 while the non-manufacturing sector is represented by 0.
	R & D investment intensity	RD	Research and development (R&D) expenditure as a percentage of total assets.

4. RESULTS

4.1. Analyzing Each Variable Using Descriptive Statistics

The results of the descriptive statistical analysis are shown in Table 2 and they focus on four major aspects: average value, standard deviation, greatest value and lowest value. They analyse how the dependent variable and the main explanatory variable, human capital perform in terms of innovation.

Table 2. The variable's descriptive statistics.

Variable	Sample size	Average value	Std. dev.	Min. value	Max. value
Apply	5,145	1.976	1.355	0	5.053
Stock	5,145	7.533	1.029	3.912	10.254
Train	5,145	5.731	2.368	0	8.455
Salary	5145	0.581	1.718	0.032	14.130
R&D	5,145	7.342	6.617	0	98.490
Age	5,145	2.726	0.352	1.619	3.377
Scale	5,145	22.280	0.828	19.810	23.650
Ownship	5,145	0.0624	0.254	0	1

The findings presented in Table 2 reveal a significant disparity in the innovation performance of the sampled enterprises when comparing the minimum and maximum values. Some companies have a strong dedication to innovation as seen by their impressive invention capabilities and numerous patent applications. On the other hand, some enterprises do not prioritize innovation and consequently lack any tangible output in terms of innovation. According to the data on the standard deviation and average value of innovation performance, the

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performance in innovation among the sampled companies is highly variable indicating that there is still a need for improvement in the companies' overall capacity for innovation. It becomes clear that there is a substantial gap between the organisations in terms of their human capital stock demonstrating a reasonably broad range of variation by comparing the highest and minimum values as well as the standard deviation and average value of the human capital stock. Most companies strongly emphasize enhancing their human capital stock while a few enterprises need to focus on improving their existing human capital resources. By comparing the minimum, maximum, standard deviation and average values of the average training cost of enterprise employees, the findings indicate a significant disparity in the training cost investment per employee among the sampled companies. There is a considerable gap wherein certain enterprises prioritize and emphasize employee training while a few enterprises need to prioritize or invest adequately in employee training. The salary and welfare level disparity across the sample firms is considerable and the degree of dispersion is rather high as evidenced by comparisons between the minimum value, maximum value, standard deviation and average value of employee wages and welfare levels.

4.2. Correlation Analysis

The correlation study shows an important relationship between innovation performance and all independent and control factors based on the correlation data shown in Table 3. This shows that there is a significant correlation between the selected variables. Among them, the correlation coefficient between the stock of human capital, R & D, age, scale, ownership and performance of innovation exhibits a significantly positive impact at the 1% level indicating that if enterprises have a higher level of human capital stock, it will increase the intensity of R&D investment and expand the scale of enterprises. The expansion of the firms plays a significant and advantageous role in promoting the enhancement of the performance of innovation in the enterprise. The per-training cost, the characteristics of the industry and innovation performance are positively correlated at a 5% water level indicating that increasing employee training will promote innovation performance and that the manufacturing industry is more inclined to innovation than the non-manufacturing industry. The correlation coefficient between employee wage and welfare level is significantly negative at 1% which is inconsistent with the hypothesis. The regression equation must be further verified and analyzed a more rigorous conclusion.

Table 3. Correlation analysis.

Variable	Apply	Salary	Train	Stock	RD	Age	Industry	Scale	Own
Apply	1								
Salary	-0.191***	1							
Train	0.035**	0.191***	1						
Stock	0.156***	0.265***	0.087***	1					
RD	0.071***	0.303***	-0.015	0.192***	1				
Age	0.036***	0.295***	0.159***	0.158***	-0.027*	1			
Industry	0.031**	0.034**	-0.086***	0.093***	0.153***	0.0130	1		
Scale	0.145***	0.243***	0.179***	0.608***	-0.081***	0.192***	0.029**	1	
Own	0.055***	0.106***	0.083***	0.036***	0.010	0.034**	0.049***	0.068***	1

Note: The symbols: * * *, * *, and * correspond to the significance levels (1%, 5%, and 10%, respectively).

The presence of collinearity among independent variables can impact the precision of regression results. The multiple collinearities of the model are tested by the variance inflation factor (VIF); the variance inflation factor for each variable is below 2.5 indicating the absence of a significant issue with multicollinearity among the variables.

4.3. Empirical Analysis

The Housman test is employed in this paper to evaluate the model while the hypothesis is tested using the panel ordinary least squares (OLS) regression. A fixed effect model is used to examine the relationships between variables. The test results are presented in Table 4. According to the coefficient obtained from the regression analysis at a significance level of 1%, there is a strong and positive relationship between the stock of human capital and innovation performance with a coefficient of 0.0860. The results indicate that as the level of human capital stock in enterprises increases, their innovation capabilities also improve. A higher level of human capital stock corresponds to enhance information processing abilities, a better understanding of industry development trends

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and the company's progress, a sharper ability to identify potential innovation opportunities and a greater capacity to implement practical innovation strategies. Consequently, it is advisable for enterprises to actively seek, recruit, and onboard high-level talents to enhance their innovation performance. As a result, H1a is confirmed. The regression coefficient of employees' wages and welfare level on innovation performance is negatively significant at the 1% level with a coefficient of -0.0727. This suggests that a higher wage level has a crowding-out effect on other factors influencing innovation. As GEM enterprises primarily consist of high-tech firms, they tend to offer relatively higher wages and welfare levels which may crowd out certain essential factors for innovation. Hence, H_{1b} is not supported. The coefficient obtained from regression analysis representing the relationship between training and performance is positively significant at the 10% level with a coefficient of 0.0136. The results indicate that human capital training enhances employees' knowledge and skills, increases enthusiasm, increases employee satisfaction and increases loyalty towards the enterprise. As a result, employees exhibit a heightened concentration on the company's production and operations facilitating the effective implementation of innovation strategies and ultimately improving innovation performance. Therefore, hypothesis H_{1c} is supported.

Human capital has an impact on enterprise innovation performance. The findings demonstrate that both the stock of human capital and employee training positively influence innovation performance. This suggests that enterprise performance in innovation improves as the level of human capital increases. Additionally, this beneficial relationship is further strengthened by raising staff members' educational levels and implementing a comprehensive staff training structure and system. However, the level of employee welfare and innovation performance will have a negative impact. Higher employee salaries and benefits are associated with lower innovation performance in enterprises due to the crowding-out effect that occurs when the level of wages and benefits hinders other elements necessary for innovation. An unreasonable wage system must motivate employees to engage in innovation activities effectively.

Table 4. Influence of human capital on innovation performance.

Model	**(1)**	**(2)**	**(3)**	**(4)**
Variable	**Apply**	**Apply**	**Apply**	**Apply**
RD	0.015***	0.014***	0.014***	0.014***
	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.520**	-0.527**	-0.438*	-0.438*
	(0.024)	(0.022)	(0.055)	(0.055)
Industry	-0.002	-0.002	-0.002	-0.002
	(0.473)	(0.432)	(0.260)	(0.273)
Size	0.211***	0.153***	0.152***	0.151***
	(0.000)	(0.000)	(0.000)	(0.000)
Own	-0.086	-0.077	-0.074	-0.076
	(0.390)	(0.445)	(0.455)	(0.447)
Stock		0.086***	0.102***	0.104***
		(0.003)	(0.000)	(0.000)
Salary			-0.073***	-0.073***
			(0.000)	(0.000)
Train				0.014*
				(0.084)
_cons	-4.498**	-3.899*	-4.255*	-4.313*
	(0.047)	(0.085)	(0.059)	(0.055)
N	5.1e+03	5.1e+03	5.1e+03	5.1e+03
r2	0.096	0.097	0.111	0.111

Note: p-values in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01.

Hence, the influence of human capital on enterprise innovation performance is contingent upon the magnitude of both positive and negative effects. If the positive impact of human capital on innovation performance is greater than the negative impact, the research reveals a positive relationship between human capital and the extent to which enterprises perform in terms of innovation. Suppose the positive impact is equal to or less than the adverse

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effect. In this case, it shows that human capital investment does not impact innovation performance and even squeezes out other innovation factors to form a negative correlation. Therefore, establishing a reasonable human resources management system such as a salary and welfare system, a talent recruitment system and an employee training system can attract high-quality human capital and effectively encourage employees to innovate.

4.4. Stability and Endogenous Test

Two methodologies are used to evaluate the validity of the research results. Firstly, it examines the methodologies used in the relevant existing literature to establish a foundation for comparison. Panel Poisson regression and panel negative binomial regression are used to consider the non-negative nature of innovation performance in the sampled firms in order to assess the robustness of the research findings. The results of these regression analyses presented in Table 5 largely align with the findings presented in Table 4. This consistency indicates the reliability and strength of the findings of this study.

The baseline regression findings validate and examine all hypotheses. Two potential factors could introduce endogeneity issues in the constructed model. First, it is still possible that certain variables are missing which could cause endogeneity issues although many model variables have been taken into account and controlled. Secondly, there is a possibility of bidirectional and reverse causality between the dependent and core explanatory variables resulting in endogeneity issues. The instrumental variables approach using two-stage least squares (IV-2SLS) was employed in this study to retest the hypotheses in order to alleviate the repercussions of endogeneity on the regression findings and obtain more accurate outcomes. In this context, instrumental variables were selected by considering the one-stage lag of the independent variables and the 2SLS technique was used to conduct the endogeneity test. The findings are displayed in Table 5.

Table 5. Findings of robustness test and endogenous test.

Model	**(1)**	**(2)**	**(3)**
Variable	**Apply**	**Apply**	**Apply**
Salary	-0.209***	-0.130**	-0.190***
	(-4.67)	(-2.50)	(-9.07)
Train	0.018*	0.017	0.011
	(1.77)	(0.90)	(0.37)
Stock	0.142***	0.214***	0.171**
	(3.08)	(2.74)	(2.54)
RD	0.009**	0.013**	0.017**
	(2.00)	(2.02)	(2.30)
Age2	-0.205	-0.190	0.174
	(-1.38)	(-0.41)	(1.13)
Industry	-0.002	0.002	-0.000
	(-0.99)	(0.36)	(-0.12)
Scale	0.161***	0.384***	0.252***
	(2.83)	(3.57)	(3.01)
Own	0.088	-0.082	0.324**
	(0.73)	(-0.44)	(2.47)
_cons	-4.252***	-3.879*	-6.099***
	(-3.87)	(0.0754)	(-3.69)
N	4971	4971	3748
adj. R^2	0.235	0.139	0.136

For each variable, the Kleibergen-Paaprk Lagrange multiplier (LM) statistic produces a p-value of 0.000 in the evaluation for overidentifying limitations providing strong reasons to reject the over identifying rules null hypothesis. Furthermore, the test results for weak instrumental variables indicate that the statistical values of F significantly exceed the critical importance of 10% suggesting the absence of weak instrumental variable problems and verifying the suitability of instrumental variable selection. The majority of the outcomes presented in Table 5

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show consistency with the findings in Table 2 implying that the empirical findings in this research remain strong and resilient to potential endogeneity biases.

4.5. Heterogeneity Regression Results

The benchmark regression results demonstrate that enhancing human capital stock and employee training expenses has a specific promotion effect on company innovation performance. Human capital has a specific influence on how well organisations perform in terms of innovation. Employee wage and welfare levels have a clear crowding-out impact on enterprise innovation performance. However, the relationship between human capital and the level of firm innovation performance will also be affected by solid ownership, fit size, etc. The sample enterprises were further grouped by regression according to the ownership nature of enterprises and the heterogeneity of enterprise size and Fisher´s permutation test was performed on the regression coefficients of different subsamples in order to examine the role of these factors in the relationship between human capital and innovation performance.

Existing studies show that the ownership nature of an enterprise has a significant impact on its innovation performance to determine whether there are significant differences between the regression coefficients of different subsamples. It can be further inferred that the relationship between human capital and firm innovation performance may differ in firms with different ownership properties. According to the ownership nature of the sample enterprises, they can be classified into two categories: state-owned enterprises (referred to as own 1) and non-state-owned enterprises (referred to as own 0). The results of the regression analysis are displayed in columns (1) and (2) and the permutation test is shown in Table 6. The significance of human capital stock differs between state-owned enterprises and non-state-owned enterprises with the former being significant at a 10% level and the latter at a 1% level and the difference coefficient between groups is essential at the level of 1% (P= -0.092) indicating that the human capital stock of state-owned enterprises has a noteworthy impact on the extent of enterprise innovation performance. Therefore, H_{2a} is established. State-owned enterprises usually have more policy and institutional advantages than non-state-owned enterprises (Zhuang et al., 2020). Fei have a more stable work nature and high-level talents may tend to work in large state-owned enterprises after graduation (Liu & Zhao, 2023). The salary and welfare levels of employees in state-owned and non-state-owned enterprises are significant at 1% and the difference coefficient between groups (P=0.089) fails the significance test. It shows that employee wage and welfare levels do not significantly influence enterprise innovation outcomes in enterprises under state ownership or those without state ownership. So H_{2b} does not hold. The reason may be that companies with state ownership and companies without state ownership attach great importance to employees' incentives and employees' fair wages and welfare levels play a specific incentive role. The staff training cost of state-owned enterprises is significant at 1% level. However, the employee training cost of non-state-owned enterprises still needs to pass the significance test. The different coefficient between groups was significant with a confidence level of 1% (P= -0.135) revealing a significant difference between the two sub-samples of companies with state ownership and companies without state ownership in the influence of employee training costs on the performance of innovation in enterprises. State-owned businesses have a more significant impact on company innovation and employee training costs. H2c has thus been proven. State-owned businesses promote long-term employment to gain more structured employee training in the future (Xie, 2007). The more consistently an enterprise employs people, the more frequently it offers on-the-job training (Li & Zhu, 2015).

According to the average of the total assets of the sample companies, the selected enterprises are separated into two categories: large companies and small companies. Small businesses (scale 0) have assets below the average, whereas large businesses have assets above the average. The human capital stock of large and small enterprises is significant at 5% and 1%, respectively and the inter-group difference coefficient is essential at 1% (P=-0.085). It is evident from the study that the influence of human capital stock on the performance of innovation is more pronounced in small-scale enterprises. Therefore, H_{3a} is established. Liu Xintong put limited resources to improve the human capital level in small enterprises which is equivalent to building the infrastructure system of enterprises well (Liu, 2020). The critical point for enterprises to obtain more innovative results is to make reasonable use of their limited resources and establish efficient talent training mechanisms, incentive mechanisms and security mechanism which are very beneficial to the innovative output of small enterprises. In the process of enterprise scale, many people will lead to the decline of organizational efficiency and untimely information transmission will affect innovation performance. The wage level of employees in small enterprises is significant at 1%. The wage

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level of employees in large enterprises has yet to pass the significance test and the inter-group difference coefficient is P=0.042 which has not passed the significance test. It shows that small enterprises have no significant impact on employees' wages, welfare levels or innovation performance, so H_{3b} is not established. The possible reason is that small enterprises are more flexible than large enterprises in salary adjustment and increase while large enterprises pay more attention to employee welfare than small enterprises (Yu & Zheng, 2009). Both wage and welfare systems have advantages and disadvantages. Small-scale enterprises do not significantly impact employees' wages, welfare level or innovation performance. The staff training fee of large enterprises failed to pass the significance test while the staff training fee of small enterprises was significant at 10%. The inter-group difference coefficient is essential at 1% (P=-0.022) indicating that small-scale enterprises' staff training considerably impacts innovation performance. Therefore, H_{3c} is established. Small enterprises aim to enhance their abilities and technology can be applied in practice to reduce the burden on their management costs and stimulate the innovative vitality of their talents. Large companies have an exceptional training system but only some of it is used in the real world. All the training courses can make enterprises fail to achieve the desired results even if they invest a lot in their workforce and material resources.

Table 6. Regression results of own and scale heterogeneity.

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variable	**Own0**	**Own1**	**Scale1**	**Scale0**	**Own(0-1)**	**Scale(0-1)**
Stock	0.096*** (3.24)	0.232* (1.90)	0.084** (2.23)	0.172*** (2.69)	-0.092***	-0.085***
Train	0.009 (1.09)	0.101*** (2.92)	0.014 (1.49)	0.037* (1.78)	-0.135***	-0.022***
Salary	-0.068*** (-7.34)	-0.157*** (-3.99)	-0.000 (-0.01)	-0.040*** (-3.15)	0.089	0.042
Control	Y (4.14)	Y (-1.08)	Y (0.54)	Y (5.30)	Y	Y
Year	Y	Y	Y	Y	Y	Y
_cons	-3.740* (-1.65)	115.267 (1.21)	-8.827*** (-2.85)	-0.056 (-0.01)		
N	4847.000	328.000	2733.000	2442.000		
r2	0.107	0.324	0.072	0.205		
P-value					0.000	0.000

Note: The symbols ***, **, and * denote significance levels of 1%, 5%, and 10% in the two-tailed test, respectively.

5. DISCUSSION

This study aims to examine the effectiveness of various ownership structures and company sizes in terms of their human capital's contribution to innovation performance. However, there are also other facets of heterogeneity such as the geographic location of the company, industry characteristics and the age of the enterprise.

This paper examines the cost of creating human capital in relation to the measurement of human capital in businesses.

6. CONCLUSION

Using microdata, this paper focuses on human capital and investigates the relationships between human capital, firm innovation performance and firm heterogeneity. Hypotheses test results are shown in Table 7.

Human capital impacts the performance of enterprises in terms of innovation and property ownership characteristics and firm scale affects the relationship between human capital and the performance of innovation. The significance of human capital as a key element of an enterprise's core competitiveness cannot be emphasised as the scientific and technological revolution and industrial transformation deepen and develop. The research findings have led to the following recommendations.

First, it is recommended for enterprises to enhance the accumulation of human capital, formulate reasonable recruitment and personnel allocation plans and foster a learning organization that cultivates a conducive self-

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learning environment throughout the entire enterprise facilitating the development of knowledge and skills in human capital.
Second, enterprises can combine the flexibility and innovation of small enterprises to maximize overall operation efficiency and enterprise value.
Thirdly, enterprises should formulate reasonable and fair salary and welfare systems to motivate employees to innovate.

Table 7. Hypotheses test result.

Hypothetical number	Hypothetical content	Inspection result
H_{1a}	There exists a direct relationship between the innovation performance of enterprises and their human capital stock.	True
H_{1b}	A direct relationship exists between the salary and welfare levels of employees and the innovation performance of enterprises.	False
H_{1c}	There is a positive relationship between employee training and the innovation performance of enterprises.	True
H_{2a}	State-owned enterprises are more influenced by the stock of human capital in terms of their innovation performance compared to enterprises that are not state-owned.	True
H_{2b}	The innovation performance of state-owned enterprises is more influenced by the salary and welfare level of employees in comparison to enterprises not controlled by the government.	False
H_{2c}	The impact on government-owned enterprises is more pronounced by employee training costs related to their innovation performance compared to non-state-owned enterprises.	True
H_{3a}	Smaller enterprises are significantly influenced by their human capital stock in terms of their innovation performance when compared to larger enterprises.	True
H_{3b}	The innovation performance of smaller enterprises is strongly affected by the salary and welfare level of employees in comparison to larger enterprises.	False
H_{3c}	The innovation performance of smaller enterprises is significantly influenced by employee training costs compared to larger enterprises.	True

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INSTITUTIONAL REVIEW BOARD STATEMENT
The Ethical Committee of the International College, Krirk University, Thailand has granted approval for this study on 30 June 2022 (Ref. No. 2022-0630).

TRANSPARENCY
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

COMPETING INTERESTS
The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

The ideas, concepts and design of the research, the concepts, instrument development and data analysis, M.L.; the data analysis and formatting of the article, Y.W. Both authors have read and agreed to the published version of the manuscript.

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