Panel regression method based on Stata analysis of impact of technology innovation and human capital on enterprise value

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Abstract. This paper is to test applicability of panel regression method on economics, and study the impact of technology innovation and human capital on enterprise value. Firstly, we built a model to describe the relationship of above factors. Then, panel regression method based on Stata was applied for analyzing the influence of technology innovation and human capital on enterprise value, taking the data in listed information technology companies from 2018-2021 as samples. Finally, we found that the combination of panel regression method and economics is meaningful and both of technological innovation and human capital can improve firm value significantly.

Keywords: Panel regression method, technological innovation; human capital; enterprise value; information technology industry

1 Introduction

Nowadays, there is an urgent need for highly sophisticated technology and high-end talent in China. The information technology sector, which concentrates high-end technology, high-quality human capital and drives qualified economic growth, is in the spotlight. Theoretically, this paper refines theories related to technological progress, human capital and firm value. Practically, the combination of panel regression method and economics can be used for the research method of this paper, taking the panel data of information technology industry listed in A-shares market from 2018-2021 as samples. the panel regression method is used to establish the model and observe its relationship of enterprise value, technological innovation and human capital.

2   Relevant theoretical foundations

2.1   Enterprise value

Since the 1980s, studies on firm value are emerging, and found that firm value could be increased by investing in high technology [1]. Since then, scholars have been focusing on enhancing the value path of the business. Meanwhile, most studies have shown that technological innovation can have an impact on the value of a business measured by R&D investment, intangible assets, number of patents, number of technical personnel [2][3]. Human capital as a driving factor of corporate value which is evaluated by payables to employees, education level of employees, average age of executives [4][5].

2.2   Panel Regression

The ordinary least square panel regression method was used to analyse the data which was panel in nature. The ability of the panel data estimation framework to control for heterogeneity and endogeneity informed its selection for this research. In this paper, we use Pooled Model as one type of panel regression for study which can be described as simple OLS model and focuses only on dependencies between the individuums.

Panel regression can be applied to mathematical statistical analysis in many fields. In economics, it is used to see the impact of global financial crisis towards the financial performance of Islamic banking industry in Bahrain [6]. Panel regression is applied panel regression to study and analyze the determinant factors of commercial banks' interest margin in Indonesia. In medical science [7]. Panel regression is used to examine the relationship between physical disability and depression among adults [8]. In environmental science, multivariate panel regression is applied to evaluate multiple predictors of environmental concern for 82 countries across seven years [9].

3   Model

Based on previous summary and analysis, and taking into account the characteristics of the information technology industry, Tobin's Q should be adopted as the explanatory variable to measure enterprise value. The innovation investment ratio is used to measure technological innovation. And this paper draws on the idea of employee's education level to describe human capital. Meanwhile, given the characteristics of industry, this paper selects corporate capital structure, corporate size and corporate capital intensity as control variables. The variables and their definition are shown in Table 1.

Table 1. Variables

Variables		Symbols	Definition
Dependent variable	Tobin's Q	q	(Market value of equity + market value of net debt)/Total assets
Independent variable	R&D Investment Ratio	RDratio	R&D expenses/ business revenue

	Employee under-graduate rate	EUratio	Number of employees with bache-lor's degree/total employees
Control variable	Enterprise size	size	Ln (Total assets)
	Capital Concentra-tion	cap	Fixed assets/total number of employ-ees
	Concentration of shareholding	Top-tenRate	Sum of the shareholding ratio of the top ten shareholders

Source: author's analysis

For analyzing the impact of technological innovation and human capital on firm value in the information technology industry, this paper establishes panel multiple regression models as follows:

$$qit = \alpha + \beta1 RDRatioit + \beta2 sizeit + \beta3 capit + \beta4 ToptenRateit + \varepsilon it + \mu it \tag{1}$$

$$qit = \alpha + \beta1 EUratioit + \beta2 sizeit + \beta3 capit + \beta4 ToptenRateit + \varepsilon it + \mu it \tag{2}$$

$$qit = \alpha + \beta1 EUratioRDRatit + \beta2 RDRatioit + \beta3 EUratioit + \beta4 capit + \beta5 sizeit + \beta6 toptenRateit + \varepsilon it + \mu it \tag{3}$$

Where, i denotes individual listed firm, t is time series, α denotes constant term, μ_{it} is the intercept term for individual effect heterogeneity, and ε_{it} represents the compound perturbation term.

4 Empirical analysis

4.1 Data

This paper selects the sample data as listed companies in the information technology industry from 2018 to 2021, and obtain total 820 sample data of 205 listed companies. All the data for this study are obtained from the CSMR database.

By using the STATA software, the experimental data are descripted which is shown in Table 2.

Table 2. Statistical description

	Mean.	S.D.	Min.	Max.
Tobin's Q	3.141	3.360	0.959	26.818
R&D Investment Ratio	10.747	10.251	0.130	57.490
Employee undergraduate rate	52.612	19.310	1.231	88.656
Enterprise size	22.103	0.768	19.199	26.440
Capital Concentration	3.184	1.937	0.261	14.660
Concentration of shareholding	52.391	14.292	21.410	91.720

Source: CSMR and author's analysis

4.2   Regression analysis

By using the STATA software, the experimental data are analyzed by panel regression analysis. The results are as follows

According to the Model Summary of the correlation analysis table, the compound relation number of models is respectively 0.441, 0.439, 0.464. The regression equation can be obtained as a significant table (Table 3) of regression coefficients.

$$qit = 35.274 + 0.219RDRatio - 0.725cap - 0.054ToptenRate - 1.328size \tag{4}$$

$$qit = 354.440 + 0.476RDRatio - 0.717cap - 0.107ToptenRate - 1.093size \tag{5}$$

$$qit = 42.530 + 0.461EUratioRDratio + 0.093RDratio + 0.270EUratio - 0.370cap - 0.040ToptenRate - 1.588size \tag{6}$$

Table 3. Coefficients

	Model 1	Model 2	Model 3
Constant	35.274**	34.440**	42.530**
EUratioRDratio			0.461*
RDratio	0.219*		0.093*
EUratio		0.476*	0.270*
cap	-0.725**	-0.717*	-0.370**
ToptenRatio	-0.054*	-0.107**	-0.040*
size	-1.328**	-1.093*	-1.588**

Source: CSMR and author's analysis

4.3   Economic analysis

By analyzing the panel regression results, we found that: (1) research investment ratio is positively and significantly correlated with the explanatory variables. This indicates that in the information technology industry, investment in technological innovation does have a significant impact on firm value and is more strongly correlated than human capital. (2) Employee undergraduate rate also shows a positive and significant correlation with the explanatory variables. This presents that information technology firms may have a high demand for employees' learning ability, but there is a time effect because the value of human capital is often not synchronized. (3) Technological innovation and human capital have an overall contribution to enterprise value.

5   Conclusion

Based on empirical analysis of the effect of innovation and human capital on firm value, this paper finally concludes that the information technology industry is a talent

technology industry based on research and development, many companies are similar in size but there are gaps in the state of development, so the choice of the right development model is crucial to the industry competition, technological innovation is an indispensable factor in the development of this industry, but over time, the value of a large number of innovative inputs will gradually diminish, as opposed to this, human capital is an impact on the enterprise Human capital is an enduring factor in the value of a business.

Panel regression method was used to analysis the impact of technological innovation, human capital on enterprise value. This statistical method is used to make reasonable statistics of panel data and the relationship of variables. This combination with economics is very meaningful and helpful. However, we should also notice that the hypothesis of the experiment is much simpler than that of the actual economy, so we cannot judge the influence of these factors on the enterprise value only by unilateral experiments, further study should be still necessary.

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