The Research of the Relationship between Intellectual Capital in Technical Entrepreneurial Enterprises and Its Growth

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***Abstract*—Based on the financial data of 57 listed technical entrepreneurial companies in IT and electronics industry of China's capital market in 2011, and according to scholars' research point in knowledge capital structure in recent years, this paper adopts an improved knowledge value-added coefficient (VAIC) method to measure intellectual capital and then builds a composite indicator of business growth through a multiple linear regression analysis of the influence of intellectual capital on technical entrepreneurship in business. The study result indicates that the value-added capacity of potential intellectual capital is more effective physical or financial capital to bolster business growth in terms of technical entrepreneur.**

Keywords-intellectual capital; technical entrepreneur; business growth; VAIC.

I. INTRODUCTION

As China strives to elevate its competence in innovation, it has been active to promote diverse entrepreneurial activities. Over the past decade, China's entrepreneurial activity index has greatly increased from 12.3 to 18.8 throughout 2002 to 2011 ranking No. 15 in the 60 GEM participating members. According to the financial statistics regarding 153 GEM listed companies disclosed by Shenzhen Stock Exchange (at the end of 2011,) over 80% of the companies achieved dual growth in operating income and net profit1. Additionally, those companies that show higher level of intellectual capital in biomedicine, electronics and IT demonstrate a strong ability in development.

In recent years, many scholars have different views of knowledge capital structure, which consolidates the theoretical foundation of this paper's research of the influence of knowledge capital on business growth. The result of previous researches can be concluded as follows:

First, the two-dimensional structure concept of knowledge capital. Edvinsson L.2 conducted research on Swedish Scandinavian Diaz Company in terms of its intellectual capital, proposing the well-known intellectual capital two-dimensional coupling structure – human capital and structural capital.

Second, the third-dimensional structure concept of knowledge capital. Many scholars have different opinions in this field. Stewart3 presented the "H-S-C" third-dimensional structure of knowledge capital, suggesting that knowledge capital is embodied in the corporate structural capital, human capital, and customer capital. The main difference between this point of view and the two-dimensional structure concept is that it separates customer capital from structural capital and makes customer capital an independent element of intellectual capital. Sveiby4 proposes the "E-I-E" third-dimensional structure of knowledge capital and breaks it down to three parts: staff competence, the internal structure, and the external structure. Bontis and Seemna5 think that knowledge capital comprises human capital, relational capital and structural capital. Although scholars have reached a general agreement on the three-dimensional structure of knowledge capital (intellectual capital), there are still certain difference between the expression and measuring indicators of the structure model.

Third, the four-dimensional structure concept of knowledge capital. Brooking6 thinks that knowledge capital is a combination of four different parts – human capital, market capital, infrastructure capital, and intellectual property capital. Zhaohui Zhu and Jin Chen7 believe that intellectual capital is made of human capital, customer capital, structural capital and innovation capital. Their major contribution is that they separate innovation capital from structural capital and define and measure innovation capital from the aspect of innovation culture, innovation mechanism and innovation result.

In order to carry out study more precisely and accurately, this paper breaks technical entrepreneurial enterprises and intellectual capital down to the research on the measurement of entrepreneurial human capital, entrepreneurial structural capital, entrepreneurial customer capital, and entrepreneurial innovation capital.

II. THE MEASURE OF THE GROWTH OF INTELLECTUAL CAPITAL AND ENTREPRENEURIAL ENTERPRISE

Intellectual capital is known for its intangibility, high value added, uncertainty in the value, dependence, capital income and high risk in investing, which drove many scholars to analyze the relationship between intellectual capital and business growth. Based on the measurement of the consequences intellectual capital has on the growth of technology-oriented entrepreneurial enterprises, this paper examines the relationship between the two subjects.

The Knowledge Value-Added Coefficient method (VAIC) proposed by Ante Public8 focuses on the measurement of intellectual capital, calculating the growth of intellectual capital efficiency by using VAIC method. The main idea of VAIC is that human or intellectual potential has a significant impact on business growth. The extent to which a company masters its physical and intellectual capital reflects the full value of that enterprise.

VAIC method is formed on the base of the Skandia model9 and the theory of value added (VA) and the concept of efficiency. It aims at evaluating the value of the enterprise based on its value-added efficiency of both of the capital employed and intellectual capital.

First of all, assume that the VA rate of capital employed is CEE, the VA rate of intellectual potential is IPE, and the VA rate of enterprise knowledge is VAIC=CEE+IPE.

Next, as suggested by Skandia model, intellectual capital comprises human and structural capital. The VA rate of human capital is HCE and that of structural capital is SCE. The VA rate of the potential of enterprise knowledge is IPE=HCE+SCE, while the VA rate of enterprise intellectual capital is VAIC=CEE+HCE+SCE.

Furthermore, taking customer capital and entrepreneurial innovation capital into consideration is also an indispensable factor to promote the technical entrepreneurship for an enterprise. If the VA rate of customer capital CCE and that of innovation capital is ICE, then the VA rate of improved enterprise knowledge can be shown as (see Equation 1):

$$VAIC = CEE + HCE + SCE + CCE + ICE \tag{1}$$

The paper selects the technical entrepreneurial companies that are listed in the Shenzhen Stock Exchange GEM and excludes some of those companies with insufficient variable data as required, which narrows down to 57 listed technical entrepreneurial companies that make up the entire study samples. The 57 sample companies include 36 listed companies from IT industry and 21 from electronics industry. Relevant data can be found in the 2010 annual financial reports published on the Shenzhen Stock Exchange website (www.sse.org.cn)

According to the improved VA rate of enterprise knowledge, intellectual potential is composed of capital employed, intellectual potential, human capital, structural capital, customer capital and innovative capital. The selection of study variables in terms of the relationship between intellectual capital and the growth of technical entrepreneurial enterprises are shown in Table 1.

TABLE 1 EXPRESSION OF EACH VARIABLE

variable type	variable name	variable formula
explanatory variables	VA rate of capital employed	CEE=VA/CE
	VA rate of intellectual potential	IPE=HCE+SCE+CCE+ICE
	VA rate of human capital	HCE=VA/HC
	VA rate of structural capital	SCE=VA/SC
	VA rate of customer capital	CCE=VA/CC
	VA rate of innovation capital	ICE=VA/IC
result variable	enterprises growth	G
control variable	enterprises scale	SIZE: number of employees

The growth of technical entrepreneurial enterprises is a dynamic process. In order to objectively and effectively reflect the growth and the development potential of the technical entrepreneurial enterprises, 12 preliminary indicators are selected from the 2010 financial reports of the sample enterprises considering their solvency, profitability, operational capabilities and development capacity, constructing the system of indicators to measure the growth of technical entrepreneurial enterprises.

By using factor analysis and statistical software SPSS 16.0 and determining the applicability of the factor through Bartlett's test of sphericity and KMO test, four principal component factors are extracted (F1 stands for solvency factor; F2 for the development of capacity factor; F3 for operating capacity factor; F4 for profitability factor,) and the factor score coefficient matrix is shown in Table 2.

TABLE 2 COMPONENT SCORE COEFFICIENT MATRIX

X_i	Component			
	$C1_i$	**$C2_i$**	**$C3_i$**	**$C4_i$**
X_1 :current ratio	.229	.000	-.050	-.003
X_2 :quick ratio	.229	-.003	-.047	.002
X_3 :dedt ratio	.226	.026	-.007	.000
X_4 :net profit margin	.104	-.141	.131	.463
X_5 : return on equity	-.081	-.081	-.068	.663
X_6 :earnings per share	.091	.227	-.073	.221
X_7 : total assets turnover	-.154	.066	.052	.173
X_8 : inventory turnover	-.004	-.056	.522	.071
X_9 : receivables turnover	-.028	.113	.583	-.139
X_{10} : asset growth rate	.226	.223	.076	-.139
X_{11} : income growth rate	.019	.418	.047	-.204
X_{12} : net profit growth rate	.031	.391	.030	-.117

Note: The rate of the four main components of the cumulative contribution is 80.072%

The expression of calculating four principal factors through the standard value of the original variables and factor score coefficients is10:

$$F_j = \sum Cj_i \times X_i \,(j = 1 \sim 4; i = 1 \sim 12) \tag{2}$$

The factor score of the four principal factors are calculated through default regression method. The variance contribution of each principal is accounted for the proportion of all the factors of the total variance contribution rate as the right to redo the weighted aggregated to calculate the composite score F of the growth of technical entrepreneurial enterprises (see Equation 3).

$$F = (34.010 * F_1 + 21.387 * F_2 + 12.941 * F_3 + 11.734 * F_4)/80.072 \quad (3)$$

According to the calculation of Equation 3, the top 10 enterprises in the composite score of the 57 sample companies in terms of business growth are shown in Table 3.

III. EMPIRACAL ANALYSIS

To an enterprise, intellectual capital is the core competence and strategic resource in business growth and has a direct impact on its growth according to the endogenous growth theory. Unlike normal entrepreneurial enterprises, technical entrepreneurial enterprises that yield intensive high-tech supply need to continuously make technological innovation and transfer technology into production so that enterprises can provide better products and service, which proves that intellectual capital is highly influential in helping enterprises grow.

Based on the results of existing theories and practice, it can be hypothesized that intellectual capital plays an important role in promoting the growth of technical entrepreneurial enterprises, as shown in Figure 1.

The hypothesis is as follows:

H1: Intellectual capital has a positive effect to promote technical entrepreneurial enterprises to grow. Without considering other relevant factors, having a higher knowledge potential can greatly boost the growth of technical entrepreneurial enterprises.

TABLE 3 THE TOP 10 COMPANIES IN THE COMPOSITE SCORE OF THE GROWTH OF TECHNICAL ENTREPRENEURIAL ENTERPRISES

factor	**F1**	**F2**	**F3**	**F4**	**F**	ranking
Stock code	solvency	development	operating	profitability	composite score	
300052	14.32187401	-11.45607526	165.2215089	16.34219883	32.12067591	1
300075	46.33287981	2.478313766	2.983768598	0.090692222	20.83702257	2
300074	39.67607279	3.077377007	-2.503612941	-0.462466558	17.20168423	3
300085	34.39159365	0.759719169	12.00579924	1.77207632	17.01052559	4
300047	26.53075237	-0.533698234	21.22528418	2.93838521	14.98716279	5
300078	22.17195341	2.794567993	7.130802268	-0.609397927	11.22695322	6
300136	23.92569612	2.616707645	2.606068483	-0.612822548	11.19256075	7
300042	22.72622164	0.084430693	0.677079525	0.053008466	9.792544268	8
300170	3.131928555	-4.166689563	53.03968113	6.698110103	9.771031545	9
300101	19.65428362	2.200974458	0.980073421	-0.172756808	9.068968284	10

Note: The stock code in the table is the stock code of listed companies of China's Shenzhen Stock Exchange GEM

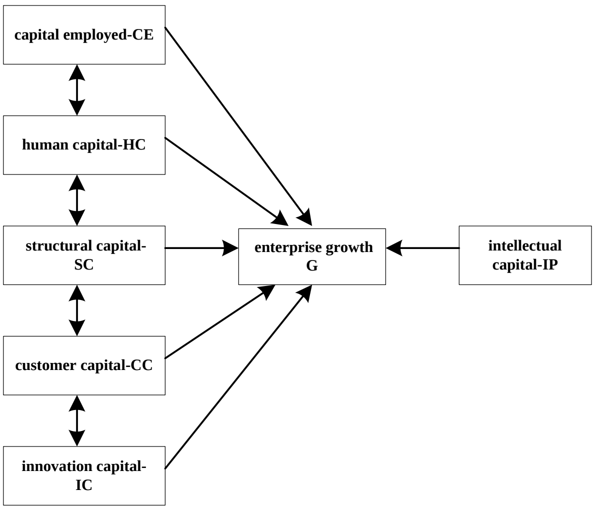

Figure 1 The hypothesized framework of the influence intellectual capital has over the growth of technical entrepreneurial enterprises

H2a: Capital employed plays a positive role in promoting technical entrepreneurial enterprises to grow. Without considering other relevant factors, greater capital employed can better promote the growth of technical entrepreneurial enterprises.

H2b: Human capital has a positive effect to help technical entrepreneurial enterprises grow. Without considering other relevant factors, having a higher potential in human capital can greatly boost the growth of technical entrepreneurial enterprise.

H2c: Structural capital plays a positive role in promoting the growth of technical entrepreneurial enterprises. Without considering other relevant factors, possessing more structural capital can yield business growth to a greater extent.

H2d: Customer capital plays a positive role in promoting technical entrepreneurial enterprises to grow. Without considering other relevant factors, having a higher potential in customer capital can greatly growth of technical entrepreneurial enterprises.

H2e: Human capital has a positive effect to help technical entrepreneurial enterprises grow. Without considering other relevant factors, having more structural capital can yield business growth to a greater extent.

The model to test the theoretical assumptions can be constructed by using the business growth composite indicator F through VAIC method and factor analysis11 (see Equation 4 and 5).

$$\text{Model1} \quad F = \beta_0 + \beta_1 CEE + \beta_2 IPE + \beta_3 SIZE + \varepsilon \qquad (4)$$

$$\text{Model 2} \; F = \beta_0 + \beta_1 CEE + \beta_2 HCE + \beta_3 SCE$$

$$+ \beta_4 CCE + \beta_5 ICE + \beta_6 SICE + \varepsilon \qquad (5)$$

In the above model, ß is the residual term. Model 1 is to examine the relationship between business growth and intellectual and capital employed. Model 2 is to examine the relationship between enterprises' growth and different parts that compose intellectual capital including human capital, structural capital, customer capital, and innovative capital.

In order to test the applicability of the above assumptions, the paper builds models and conducts empirical examination and analysis of the 57 sample data using statistical software. First of all, descriptive statistical analysis is done towards the growth of technical entrepreneurial enterprises, intellectual capital and its different components, and other variables, which is aimed at studying the intellectual capital of technical entrepreneurial enterprises in China and their growth characteristics. Then, the paper carries out correlation, regression analysis, and other statistical analysis methods to verify both the validity of the above model and the assumptions that have been made.

Descriptive statistical results are shown in Table 4. The minimum value of Knowledge Capital Appreciation rate (IPE) is greater than zero, indicating that all investment in intellectual capital made by technical entrepreneurial enterprises can drive business growth, though the driving forces vary to different extent. For example, to those enterprises, the average of CCE is 6.72326, suggesting that every yuan invested in customer capital can bring an average value added of 6.72326; the average of CEE is 0.14872, suggesting that every yuan invested into capital employed can produce an average value added of 0.14872. Compared with customer capital, capital employed slightly promotes business growth and is even less productive than human capital, structural capital and innovative capital.

TABLE 4 DESCRIPTIVE STATISTICS

Descriptive Statistics	N	Min.	Max.	Mean	Std. Deviation
CEE	57.0000	0.0158	0.6585	0.1478	0.1466
IPE	57.0000	1.9420	65.9195	15.9572	11.1394
HCE	57.0000	0.2476	10.4395	2.4689	1.9936
SCE	57.0000	0.6296	8.7626	2.3330	1.4557
CCE	57.0000	0.1829	40.7108	6.7233	7.3699
ICE	57.0000	0.5381	11.4471	4.4320	2.5844
composite score(F)	57.0000	3.9260	8.1860	6.1948	1.0359
Valid N (list wise)	57.0000				

Table 4 shows that compared with other projects of the structure of intellectual capital, the investment enterprises make in customer capital have greater effect in promoting business growth. The maximum value of integrated growth index F is 8.1860, the minimum is 3.9260, and an average of 6.1948. These statistics indicate that the sample enterprises in 2010 have an overall good growth, with a marginal difference of inter-enterprise growth.

In order to explore the relationship among three factors – physical capital, various elements of intellectual capital, and the growth of technical entrepreneurial enterprises, Pearson correlation analysis is adopted to examine the interaction between the three factors and the result is shown in Table 5.

As shown in Table 5, CEE, HCE, SCE, CCE, ICE and control variable SIZE all have a positive but varying correlation with the growth of technical entrepreneurial enterprises. The correlation coefficient between physical capital and the growth of technical entrepreneurial enterprises is low, accounting for 0.195. The correlation coefficient between human capital – one of the components of intellectual capital – and the growth of technical entrepreneurial enterprises is 0.480, which reaches a low correlation level of 0.01. Similarly, other intellectual capital components including structural capital, customer capital and innovative capital have correlation coefficients with the growth of technical entrepreneurial enterprises by 0.553, 0.508, and 0.674 respectively, all ranging between 0.5 and 0.8, which reach a moderate correlation level12. Therefore, there is a significant positive correlation between the growth of intellectual and physical capital and the development of enterprises. However, in contrast, innovative capital is in the closest relevance to the development of enterprises, while physical capital is least relevant to business growth.

In order to further examine the influence and the direction of which intellectual capital has over the growth technical entrepreneurial enterprises, multiple regression analysis is conducted to test the two assumptions in the model (Eq. 4, 5.).

First, set the growth technical entrepreneurial enterprises as the dependent variable, knowledge of potential value-added rate (IPE) and material capital appreciation rate (CEE) as independent variables, and control variables as firm scale (SIZE), and then study the influence intellectual and capital employed have on business growth. The next step is to conduct regression analysis to Model 1(Equation 4) and verify with Durbin-Watson test whose purpose is indicate that the description of the equation residuals item does not exist a significant one-order self-related. Then through variance analysis and reliability analysis, the multivariate linear regression model displays as significant in overall. Regression equation can then be proved meaningful and thus the relationship between the explanatory variables and the explanatory variables obtained by the models are credible. Model 1 regression equation is:

$$Model1\ \ F = 3.044E-16 + 0.097CEE + 0.636IPE + 0.001SIZE \tag{6}$$

According to the statistical data, the regression coefficient between intellectual potential value-added IPE and corporate growth F is 0.636 (significant test Sig. value is 0.086), indicating that a certain positive correlation exists between these two indicators, but not statistically significant, hypothesis H1 is therefore prove validated. Explaining that variables CEE show a significant positive correlation to the growth technical entrepreneurial enterprises in the 5% level suggests that capital employed can add value to business growth, which verifies the assumption of H2a. To control SIZE – the variable number of employees – has a positive effect to promote the growth of technical entrepreneurial enterprises.

TABLE 5 CORRELATION ANALYSIS

statistical variables		CEE	HCE	SCE	CCE	ICE	F1	number of employees
CEE	Pearson Correlation	1	.182	.215	.072	.196	.195	-.109
	Sig. (2-tailed)		.176	.109	.594	.143	.146	.419
	N	57	57	57	57	57	57	57
HCE	Pearson Correlation	.182	1	.783**	.379**	.639**	.480**	-.175
	Sig. (2-tailed)	.176		.000	.004	.000	.000	.193
	N	57	57	57	57	57	57	57
SCE	Pearson Correlation	.215	.783**	1	.338*	.765**	.553**	.045
	Sig. (2-tailed)	.109	.000		.010	.000	.000	.739
	N	57	57	57	57	57	57	57
CCE	Pearson Correlation	.072	.379**	.338*	1	.570**	.508**	.223
	Sig. (2-tailed)	.594	.004	.010		.000	.000	.095
	N	57	57	57	57	57	57	57
ICE	Pearson Correlation	.196	.639**	.765**	.570**	1	.674**	.065
	Sig. (2-tailed)	.143	.000	.000	.000		.000	.632
	N	57	57	57	57	57	57	57
F	Pearson Correlation	.195	.480**	.553**	.508**	.674**	1	.077
	Sig. (2-tailed)	.146	.000	.000	.000	.000		.568
	N	57	57	57	57	57	57	57
SIZE	Pearson Correlation	-.109	-.175	.045	.223	.065	.077	1
	Sig. (2-tailed)	.419	.193	.739	.095	.632	.568	
	N	57	57	57	57	57	57	57

It can be seen that both intellectual and physical potential value-added can be conducive to drive enterprise growth, but intellectual potential value-added has a greater effect on business growth in this regard.

Additionally, different intellectual capital components including human capital, structural capital, customer capital, and innovative capital are analyzed to study their effect on the growth of technical entrepreneurial enterprises. Referring to the same method as adopted before, regression analysis is taken to Model 2 (Eq.5), which suggests that the relationship between the explanatory variables and the explanatory variables obtained is credible. The Model 2 regression equation is:

$$\text{Model 2} \quad F = 4.755E-16 + 0.066CEE + 0.019HCE + 0.114SC + 0.201CCE + 0.447ICE + 0.009SIZE \quad (7)$$

According to the statistical data analysis, the significance test value between the CEE rate of capital employed value-added and the business growth F is 0.003, which indicates there is a manifest correlation between them. The regression coefficient between the CEE rate of capital employed value-added and business growth F is 0.066, which further proves the positive correlation between the two indicators. The analysis verifies the hypothesis H2a was established that greater capital employed can drive technical entrepreneurial enterprises to a greater extent without considering other relevant factors.

The positive correlation between human capital VA rate, structural capital VA rate, customer capital VA rate, and business growth F verifies the establishment of hypothesis H2b, H2c and H2d proposed by the paper that human capital, structural capital and customer capital play a positive role in driving the growth of technical entrepreneurial enterprises. The relationship is shown in Figure 2.

There exists significant correlation between innovative capital value-added rate (ICE), enterprise scale (SIZE) and the enterprise growth F. Besides, ICE and SIZE have positive correlation to business growth F in the level 5%, verifying the establishment of H2e that innovative capital can promote the growth of technical entrepreneurial enterprises.

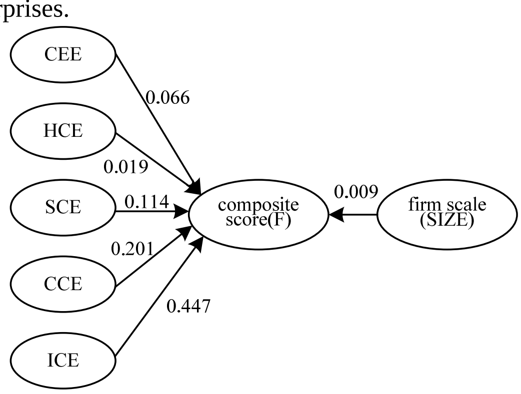

Figure 2 The structure of knowledge capital and its relationship with the growth of technical entrepreneurial enterprises

IV. CONCLUSIONS

The results of Bontis13 research suggest that the motivation intellectual capital has over business growth does not exist independently. The empirical analysis of the paper shows that the various elements of intellectual capital are interrelated and interacting. Human capital appreciation rate (HCE), structural capital appreciation rate (SCE), customer capital appreciation rate (CCE) and innovative capital appreciation rate (ICE) are significant correlated on the 1% statistical level, with a nonlinear positive correlation among the constituent elements. Additionally, the analysis results indicate that CEE, IPE, HCE, SCE, CCE and ICE are positively correlated to F, meaning physical and intellectual capital have a positive impact on promoting enterprises to grow. From a larger context, intellectual capital has a greater impact on business growth than capital employed and innovative capital has a greater impact on business growth than human capital, structural capital and customer capital.

The analysis result shows that intellectual capital can effectively drive the growth of technical entrepreneurial enterprises. Effective management of intellectual capital, therefore, forms the core competence of the enterprises to achieve continuous competitive advantage. At present, China is still in its preliminary stage as to understand and manage intellectual capital. While most of the companies have come to realize the significance of intellectual capital, to strengthen the management of intellectual capital has become the primary issue of process management and process control under the context of rising knowledge economy14.

V. RECOMMENDATIONS

The paper provides recommendation as follows:

1) To encourage more government policy to support and protect the investment in intellectual capital

The structure of intellectual capital determines the diversity of intellectual capital investment and government’s supporting policy plays an important role in building an environment that encourages technological innovation, respects knowledge, and protects the right of intellectual property. Government can make policies and regulations in terms of taxation, international exchanges, intellectual property protection, the introduction of technology professionals, science and technology information service platform, business support, etc. in order to develop diverse forms of public expenditure and management that bolsters and protects intellectual capital.

2) Well-rounded market mechanism in intellectual capital management that creates a value chain for that

The access of protection of intellectual capital involves multiple capital providers and users. Mature market mechanism in terms of capital market, venture capital and technology intermediary service should be established to make intellectual capital available to more capital users. An intellectual capital value chain that adapts to national and regional economy should be constructed to provide a better environment for enterprises to develop intellectual capital management.

3) To establish awareness of corporate intellectual capital management and implement effective strategic planning.

Intellectual capital has a greater influence than capital employed in driving business growth. For those enterprises that lack resources and basic facilities, they would usually invest their limited resources into capital employed because of their incompetence and their lack of strategic vision in intellectual capital investment. However, for those standardized enterprises and outstanding entrepreneurs, they should give more attention to the operation and management of intellectual capital and incorporate it as part of the strategic planning including talents, investment and technological innovation, in order to strengthen the enterprises' intellectual capital and their dynamic management of technological innovation.

VI. ACKNOWLEDGMENTS

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