Intellectual Capital and Enterprise Performance: Empirical Study in Taiwan High-Tech Industry

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Abstract: Intellectual capital has been widely recognized as a critical resource for competitive advantage of firms. The purpose of this study was to research how intellectual capital will contribute towards the enterprise value of high-tech companies in Taiwan. By AMOS 17.0 maximum likelihood estimate program, empirical results show a direct and positive effect relationship between the intellectual capital and enterprise performance of 285 high-tech companies. Hence, the importance of intellectual capital cannot be overemphasized in a rapidly changing and competitive business environment.

Keywords: Intellectual Capital, Enterprise Performance, AMOS 17.0

I. Introduction

In meeting with the changes and challenges of a dynamic and complex global economy, the importance of knowledge-based resources is one of the main factors in keeping a sustainable competitive advantage of firms. The knowledge-intensive companies believe that it is crucial to maximize the utilization of resources, especially intellectual capital, and promote competitive advantages that are the basis of value generation [10] [5]. Compared with traditional viewpoints, intellectual capital reveals more information of a company's sustainable competitive ability and operation efficiency and effectiveness. An improvement of intellectual capital means an increase of the knowledge base of the company. Thus, they posit that they are better positioned than their competitors [2]. On the other hand, companies that lack intellectual capital, accounting recognition and its growing role in the value creation process, imply that financial statements have lost some of their value for shareholders and many other users.
Our study is motivated by the conceptual link which could exist between intellectual capital and its contribution to the enterprise performance of a company. Out of 285 samples of listed high-tech firms in Taiwan, the relationship of intellectual capital and value creation could be demonstrated in each construct by the benefit of the AMOS 17.0 maximum likelihood estimate program analysis software. Even though different constructs disclose different contributions to the value generation process, our study revealed the influence of information to enterprise performance.

II. Literature review& hypotheses development

Galbraith (1969) proposed the idea of intellectual capital, which is mainly used to account for the discrepancy between market value and book value. Stewart (1997) defines intellectual capital as the data of an enterprise, which can be utilized to create extra advantages. Any intellectual materials that can create wealth, such as knowledge, information, techniques, intellectual property rights, experience, organization learning and competence, team communication systems, customer relations, and brands, are able to create value for a firm. Generally speaking, scholars regard those cannon be revealed in the financial statements as intellectual capital. Moreover, intellectual capital was also defined as the total stock of all intangible assets and capabilities in a company, which can create value or competitive advantages [10] [20].
Many models and classifications are defined as intellectual resources in literature. Most of them could be termed as the Sveiby-Stewart-Edvinsson model [7]. The model consists of human capital, structural capital, and customer capital. According to Sveiby (1997), human capital involves capacity to act in a wide variety of situations to create both tangible and intangible assets. Stewart (1997) emphasized that the primary purpose of human capital is innovation of new products and services or the improvement of business processes.
Structural capital, as suggested by Sveiby, Edvinssons, and Mallone (1997) consists of internal structure which includes patents, concepts, models, computers, and administrative systems. Steward (1997) defined it as knowledge that does not go home at night. Customer capital, on the other hand, is defined as an external structure which includes relationships with customers and suppliers. It also encompasses brand names, trademarks, and the company's reputation or image.
Bontis (1998) exhibited a simple model that includes one of each of the three dimensions of the intellectual capital and directly affects enterprise performance but does not present how they relate to each other. Some authors have declared that causal relations exist between human capital, structural capital and customer capital with a measurable performance increase in intellectual capital in the logistics industry [23] [8] [22]. They found that the three mentioned dimensions of capital have a positive association with the yields of intellectual capital and did not differ from one region to

another.

Shih (2008) measured intellectual capital with four dimensions, as based on the characteristics of intellectual capital in the financial service industry. These four dimensions are human capital, innovation capital, process capital, and customer capital. He concluded that customer capital of the financial industry is dependent upon employees' training and product development of human capital.

Moreover, Jardo´n and Martos (2008) studied a sequential model where human capital was the base of the other dimensions of intellectual capital. During the value creation transaction, human capital is developed in internal relations, and facilitates external relations that generate relational capital. After linking the relation with clients, suppliers and other social agents, it will contribute to an effect on enterprise performance. Consequently, the following hypotheses are formulated:

H1. Human capital has a significant positive effect on enterprise performance.

H2. Customer capital has a significant positive effect on enterprise performance.

H3. Innovation capital has a significant positive effect on enterprise performance.

H4. Process capital has a significant positive effect on enterprise performance.

III. Methodology

Sample and data collection

The research data were obtained from the Taiwan Economic Journal database（TEJ）and Market Observation Post System of Taiwan Stock Exchange (MOPS) that contains financial information on 285 high-tech companies listed in the Taiwan Stock Exchange (TWSE) from 2009 to 2010. As the demonstration shows, these companies include the "integrated circuit industry (57, 20%)", "electronic component industry (60, 21%)", "computer and related industry (48, 17%)", "communication industry (34, 12%)", "optical and electricity industry (46, 16%)", and "other industry (40, 14%)".

Measurement variables

Fama and French (1992) developed the pricing model which explains the book-to-market ratio of individual stocks. Book value is an accounting term which means the portion of the company held by the shareholders; in other words, the company's total tangible assets less its total liabilities. Market value is the current market price. The market-to-book ratio has the ability to explain cross-sectional variation in stock returns, and companies which currently have high market-to-book ratios generally perform better in the future. In our study, we use the market-to-book ratio as the proxy variable to measure a company's performance as well as a company's value. Besides, according to the intellectual capital in the annual report of Skandia Company [10] [20], we selected the variables Employee Productivity (EP), Employee Value (EV), Staffing Ratio (SR), Sales Growth Rate (SGR), Product Acceptance Rate (PAR), Market Share Rate (MSR), Inventory Turnover (IT), Fixed Asset Turnover (FAT), Total Assets Turnover (TAT), Research and Development Intensity (RDI), and Research and Development Strength (RDS) as the intellectual capital measurements..

Factor analysis

Factor analysis is a technique that is used to reduce a large number of variables into fewer numbers of factors. The approach extracts maximum common variance from all variables together to form a new smaller set of derived variables with a minimum loss of information. Several types of factor analysis methods are available, but principle component analysis is used most commonly. Also, factors are formed that are relatively independent of one another; however, since it requires the data to be correlated, all assumptions that apply to correlations are relevant here.

Kaiser (1970) proposed a measure of sampling adequacy, now called the Kaiser-Meyer-Olkin (KMO) index. The KMO measurement of sampling adequacy is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. Large values for the KMO index indicate that a factor analysis of the variables is a reliable measure. A KMO index should be greater than 0.6 for a satisfactory factor analysis to proceed. Another indicator of the strength of the relationship among variables is Bartlett's test of sphericity [18]. Bartlett's test of sphericity is used to test that the null hypothesis of the variables in the population correlation matrix are uncorrelated. The observed significance level is .0000, which is small enough to reject the hypothesis. As can be seen in Table 1, the KMO index is greater than 0.6, which is satisfactory, and the observed significance level of Bartlett's test of sphericity is .00. It is thus concluded that the strength of the relationship among variables is strong, which indicates that it is possible to proceed with a factor analysis for the data.

Table 1. KMO and Bartlett's test

Kaiser-Meyer-Olkin	Measure of Sampling Adequacy	.66
Bartlett's Test of Sphericity	Approx. Chi-Square	1192.61
	df	55
	Sig.	.00

In terms of factor analysis (see Table 2), we selected variables with factor loading larger than 0.70, and dropped all components with eigenvalues under 1.0 [14]. From Table 3, we can see that the factor loading lies between 0.77 and 0.93, and the eigenvalues of four factors are 2.70, 2.01, 1.94, and 1.71, respectively, by the Varimax normalized rotation method. The cumulative total variance of these four factors is 75.92%. From the communalities of variables, we named these four factors as process capital, human capital, customer capital, and innovation capital.

Table 2. Factor analysis of principal components (Varimax normalized rotation method)

Construct	Variable	Factor loading	Eigenvalue	Cumulative total variance %
Process capital	Inventory Turnover	0.91	2.70	24.52
	Fixed Asset Turnover	0.87		
	Total Assets Turnover	0.86		
Human capital	Employee Productivity	0.80	2.01	42.76
	Employee Value	0.90		
	Staffing Ratio	0.83		
Customer capital	Sales Growth Rate	0.77	1.94	60.37
	Product Acceptance Rate	0.87		
	Market Share Rate	0.81		
Innovation capital	R& D Intensity	0.92	1.71	75.92
	R& D Strength	0.93		

Measure reliability and validity

Structural equation analysis (SEM) was conducted for the measurement of model analysis. A two-stage analysis approach, measurement model and structural model, was used for data analysis by the AMOS 17.0 maximum likelihood estimate program [1]. This analysis allows for modeling based on both latent (unobservable) variables and manifest (observable) variables, which is a property well suited for the hypothesized model, where most of the represented constructs are abstractions of unobservable phenomena. Furthermore, structural equation modeling considers errors in measurement, variables with multiple indicators, and multiple-group comparisons.

A confirmatory factor analysis (CFA) was used to further check the goodness of the measurement scale. CFA assumes that the factor structure is known a priori. The objective of CFA is to empirically verify or confirm a factor structure which is based on an underlying theory, and we assessed five reliability coefficients: cronbach's alpha reliability, construct reliability (CR) and average variance extracted (AVE), convergent validity, and discriminate validity [12] [1]. The AMOS 17.0 maximum likelihood estimate program was used to perform these analyses.

Goodness of fit tests determine if the model being tested should be accepted or rejected. For the wide disagreement on which fit indexes to report, Kline (1998) recommended at least four tests. In our research, we propose absolute fit measures, i.e. RMR, GFI and AGFI, baseline fit measures i.e. NFI, IFI, CFI and RFI, parsimony measures i.e.$\chi 2$/df, and information theory measures i.e. RMSEA as indexes of overall CFA model fit measurement (see Table 3). The results show that almost all goodness-of-fit measures are within acceptable levels.

Table 3. Overall CFA model fit measurement

Fit indicators	Parameter	Recommendation criteria	Research model values
Overall model fit	χ^2/df	<3	2.29
	RMR	<0.05	0.02
	GFI	>0.9	0.95
	AGFI	>0.8	0.91
	NFI	>0.9	0.93
	CFI	>0.9	0.96
	IFI	>0.9	0.96
	RFI	>0.9	0.90
	RMSEA	<0.05	0.07

After the overall model fit was accepted, each of the variables and constructs can be evaluated by examining every construct's cronbach's alpha reliability (0.7 or above, the higher the better), construct reliability of potential variables (0.7 or above, the higher the better), variance extracted (0.5 or above, the higher the better), and convergent validity (0.6 or above, the higher the better) to verify the reliability and validity of the model. From Table 4, we can see that the result of the cronbach's alpha reliability for all items was between 0.74 and 0.85, which is larger than the 0.7 recommended level. The construct reliability of potential variables was between 0.76 and 0.86, exceeding the recommended level of 0.7. All variance extracted measures substantially exceeded the recommended level of 0.5, and all convergent validity measures substantially exceeded the recommended level of 0.6. The results demonstrate that each construct has acceptable reliability and validity.

Table 4. Reliability and convergent validity measurement

Variable	Standardized factor loadings	Factor	Construct reliability	Variance extracted	Cronbach's alpha reliability
Employee Productivity	0.67	Human capital	0.82	0.60	0.75
Employee Value	0.92				
Staffing Ratio	0.71				
Inventory Turnover	0.90	Process capital	0.86	0.67	0.85
Fixed Asset Turnover	0.79				
Total Assets Turnover	0.76				
Sales Growth Rate	0.60	Customer capital	0.76	0.53	0.74
Product Acceptance Rate	0.86				
Market Share Rate	0.69				
R& D Intensity	1.00	Innovation capital	0.86	0.76	0.84
R& D Strength	0.72				

Discriminate validity of each factor correlations among all the constructs was examined through a procedure that involved testing $\chi 2$ difference values [1]. This was done for one pair of constructs at a time by constraining the estimated correlation parameter between them to 1.0, and then performing the $\chi 2$ difference test on the values obtained for the constrained and unconstrained models [1]. The resulting significant difference in $\chi 2$ indicates that the two constructs are not perfectly correlated and that discriminate validity is achieved [3]. From Table 5, we can see that most of the $\chi 2$ difference in this study is greater than $\chi 2$ 1,0.05 with the value of 3.84, which provides good evidence for the constructs' discriminate validity.

Table 5. Discriminate validity measurement

		Unconstrained model		Constrained model		△χ^2
Construct		χ^2	d.f.	χ^2	d.f.	△χ^2
Human capital	Process capital	15.63	8	303.00	9	287.37
	Customer capital	11.10	8	221.75	9	210.65
	Innovation capital	5.48	5	296.58	6	291.1
Process capital	Customer capital	5.25	8	217.55	9	212.3
	Innovation capital	46.48	5	423.73	6	377.25
Customer capital	Innovation capital	3.44	5	219.33	6	215.89

Structural model analysis was performed after satisfying the requirements of the measurement model to assess the robustness of the results and the stability of the models by the AMOS 17.0 maximum likelihood estimate program. For the structural model, the GFI is 0.94, AGFI is 0.90, $\chi 2$/df is 2.63, NFI is 0.91, CFI is 0.94, and RMR=0.019. The parameters of indicators all together suggest that the data fit the hypothesized model reasonably well (see Figure 1).

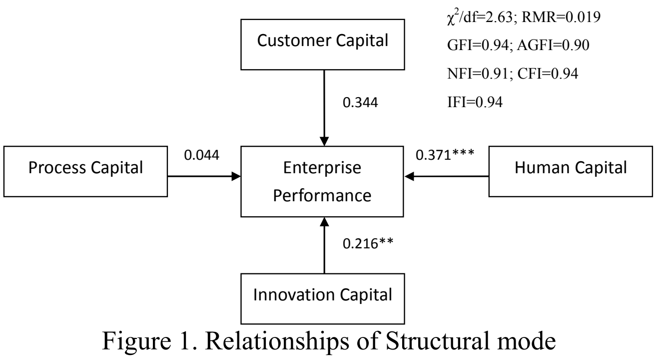

Figure 1. Relationships of Structural mode

In Table 6, we illustrate the parameter estimates in the structural model with the standardized coefficients for the research sample. Hypothesis 1 supposes that human capital has a significant positive effect on enterprise performance, the C.R. value for human capital to enterprise performance is 3.50 (to 1.96), and P is significant at the 0.01 level, therefore H1 was supported. Hypothesis 2 suggests customer capital has a significant positive effect on enterprise performance, the C.R. value for customer capital to enterprise performance is 1.17 (to 1.96) and P is not significant at the 0.05 level, hence H2 was unsupported. Hypothesis 3 supposes that innovation capital has a significant positive effect on enterprise performance, the C.R. value for innovation capital to enterprise performance is 2.62 (to 1.96), and P is significant at the 0.05 level, thus, H3 was supported. Finally, Hypothesis 4 predicted that process capital has a significant positive effect on enterprise performance, the C.R. value for process capital to enterprise performance is 0.34 (to 1.96) and P is not significant at the 0.05 level, so H4 was unsupported.

Table 6. Structural path parameter estimates

Hypothesis	Path	Estimate	S.E.	C.R.	P
H1	Human capital to enterprise performance	0.371	0.106	3.501	***
H2	Customer capital to enterprise performance	0.344	0.295	1.167	0.243
H3	Innovation capital to enterprise performance	0.216	0.082	2.622	0.009**
H4	Process capital to enterprise performance	0.044	0.130	0.340	0.734

IV. Discussion and Conclusion

Our study considered information on 285 high-tech companies listed in the Taiwan Stock Exchange (TWSE) from 2009 to 2010, including the "integrated circuit industry (57, 20%)", "electronic component industry (60, 21%)", "computer and related industry (48, 17%)", "communication industry (34, 12%)", "optical and electricity industry (46, 16%)", and "other industry (40, 14%)". By implementing a structural equation modeling approach, this study integrated four constructs including human capital, customer capital, innovation capital, and process capital. The major findings and implications are discussed as follows. Firstly, the results of the structural equation model indicate that human capital has a significant positive effect on enterprise performance. This finding shows that with more human capital acquired from a company, there is improved enterprise performance by building sustainable competitive advantages. This finding is consistent with research that considers humans as not merely resources which companies must treasure, but also as a set of values, attitudes, aptitudes and capacities that allow the generation of value for the company [6].

Secondly, in terms of innovation capital, the results of the structural equation model show that the relationship between innovation capital and enterprise performance is significant and the coefficient is positive. This is consistent with Bukh's et al. (2001) study, that innovation capital is a critical intellectual resource investment in rapidly growing business environments, contributes to the ability to create new knowledge with existing resources and is the result of an organization's culture.

Thirdly, our empirical study shows that either customer capital or process capital do not directly influence enterprise performance. The reason for this phenomenon could be that human capital is the source of intellectual capital. During the value creation transaction, human capital is developed in internal relations, and facilitates external relations for generating customer capital and process capital. After linking the relation with clients, suppliers and other social agents, it will contribute to an effect on enterprise performance [13]. Even though the customer capital or process capital do not directly influence enterprise performance, the indirect influence of enterprise performance could be generated by human capital. The result also supports previous empirical studies that human capital is the most important dimension of intellectual capital, even significantly influences the enterprise performance, and verifies that investments in customer capital reward the best from a company' s performance.

Despite certain limitations of this study, the research results show that among the critical elements of intellectual capital, human capital plays a vital role to determine the performance of enterprises. This result not only matches the previous studies from the literature review, but also confirms Drucker’s proposition (2008), “Knowledge workers are the essential ingredients of the modern economy, and people are an organization's most valuable resource”.

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