EXPLORE THE RELATIONSHIPS AMONG TECHNOLOGY INNOVATION, INTELLECTUAL CAPITAL, AND SHAREHOLDER VALUE-ADDED

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ABSTRACT

This paper examines the relationship among technology innovation (TI), intellectual capital (IC), and shareholder value-added (SVA) in high-tech firms in Taiwan. Based on the sample of high-tech firms listed on the Taiwan Stock Exchange (TSE) during the period 1997 to 2001, we use the multi-regression and Vector Auto-regression methods to conduct this research. The conclusions are: (1) There is a significant association between technological innovation and intellectual capital. (2) The intellectual property variable can increase explanatory power on the relationship between the IC and SVA. (3) There is a time lagged effect for the impact of intellectual capital on the shareholder value-added. (4) Intellectual capital is an important source of corporate value. From the view of resource-based theory, we verify that intellectual capital is the core resource of a high-tech company.

INTRODUCTION

The World Economic Forum (WEF) reported that in 2004, Taiwan ranked number four in global growth competitiveness, the best among Asian economies (Huang and Liu, 2005). Such an achievement was contributed to the excellent performance on science, technology, and innovation. Between 1986 and 2000, Taiwan IT industry had a market-to-book value greater than one in each of the years, with the 1989 figure surpassing seven times. Such a market-to-book value figure has drawn wide attention from scholar investigations [4] [7] [20] [17] [13] [6].

This excess of the market value over the book value is exactly the same as the idea of excess profit, as proposed by the resource-based perspective advocates, to build up core resources for competitive advantage. Galbraith [8] was the first to propose the idea of intellectual capital (IC) to explain the difference between market value and book value.

Narvekar and Jain [15] indicated that IC may encourage innovation and in turn enhance corporate performance. Ross et al [17] stressed that the research of IC is not simply evaluating or presenting the underlying corporate value. Rather, the new wave of IC implementation tries to integrate all the evaluation measures into a single index and to study how and to what extent the change of IC will affect the underlying value creation impact on corporate value. Among the various IA issues, propriety rights for technological innovation (TI) are the most important. Past research studies on propriety rights [1] [3] [10] showed that patents have economic value and are significant on firms' market value. Griliches [9] proposed that propriety rights (PR) have a deferral effect on corporate value, especially as unexpected PR would relate to the elevation of corporate values.

Under the resource-based perspective, we employ a multiple regression and Vector Auto-Regression (VAR) to study IT firms in Taiwan during 1997 - 2001 for (1) the relationship among TI, IC, and stockholder value-added (SVA); and (2) the time lag-effect between corporate IC and SVA.

LITERATURE REVIEW

Various researchers have tried to classify IC without fully agreeing with others. Ross et al. [17] separated IC into thinkable human capital and unthinkable structural capital. Stewart [20] classified IC into human capital, structural capital, and customer capital. Sveiby [21] deemed that IC consists of human capital, internal capital, and external capital. Edvission and Malone [7] suggested that IC is comprised of human capital and structural capital, and further divided the latter into customer capital, innovation capital, and process capital. Brooking [4] categorized IC into four assets: market, intellectual property, human-centered, and infrastructure. Hurwitz et al [12] divided IC into four capitals: human, organization, customer, and intellectual. Litschka et al. [14] generalize d intellectual asset into human assets, organization assets, and other codified assets.

Boekestein [2] found two approaches for IC valuation. The first one examines all factors and indicators which influence IC, and another calculates the IC value of a particular company using a number of assumptions. Roundly, the individual indicator measure is somewhat like the so-called internal measure and uses all factors and indicators approach, while the integrated measure method is somewhat like the external measure and calculates the IC value of a company approach.

Ross et al. [17] argued that if we concentrate on individual measures, then we can provide individual IC information to top management; while holistic measurements, on the other hand, provide executives with a wider view of the corporate IC. The holistic measure, however, is not a substitution for individual factors, but supplements it. Thus, we follow the perspectives of Stewart [20], Ross et al. [17] and Shaikh [18] to separate the measurement of intellectual capital into individualistic evaluation and holistic evaluation.

Other scholars also have proposed some kind of integrated measurement. Shiu [19] applied the Value-added Intellectual Coefficient (VAIC) method to measure the value creation efficiency of a company from the view of efficiency. Litschka et al. [14] used the Delphi process to get the important success factors that influence human assets and organizational assets.

Porter [16] defined innovation as a new way of doing things that is commercialized, with the newness being either technological- or market-related. A technological innovation is the invention of new technology and the development and the introduction into the marketplace of products, processes, or services based on this new technology [15].

Narvekar and Jain [15] presented a framework to understand the TI process. They suggested that innovation is a process of creating something new in the organization. Therefore, organizations should pay more attention to improve the stock of IC by developing routines that encourage innovation. The patent is one kind of TI output, Chang et al. [5] indicated that patents can legally prevent competitors and potential entrants from manufacturing and selling a firm’s patented products. Consequently, while we invest in an IP project or trade and transfer IPs, we not only make future cash flows to enhance the enterprise value into discretionary consideration, but also conduct strategic decision making.

RESEARCH METHOD AND RESULTS

Hypotheses

Technological industries are heavily knowledge-dependent, and knowledge-based assets are increasingly important, especially for high-tech companies. IP provides an enterprise with a wide array of growth opportunities and competitive edges [5]. Among various IC factors, IP is one of the most important. Grilliches [9] indicated that among all IPs, propriety rights have a positive impact on corporate value. Thus, we expect that the input of propriety rights will increase corporate value. We hereby propose the first hypothesis to test this preposition.

Hypothesis 1. In the IT industry, IP variables have significant impact on intellectual capital.

And we use the the following multiple regression models for hypotheses testing:

Multiple regression without intellectual capital:

$$Tobin\ 'sQ = \alpha + \beta_1 CA + \beta_2 OE + \beta_3 RG + \beta_4 EE + \beta_5 HCROI \quad (1)$$

Adding intellectual property variables into the multiple regression formula (1)

$$Tobin\ 'sQ = \alpha + \beta_1 CA + \beta_2 OE + \beta_3 RG + \beta_4 EE + \beta_5 HCROI + \beta_6 NIRE + \beta_7 P \quad (2)$$

Here, CA is the age of the firm in years; OE is the ratio of administrative expenses on earnings; RG is the earnings growth rate; EE is per employee earnings; HCROI is the human capital return on investment; NIRE is the ratio of earnings over R&D expenses; P is the number of propriety rights.

Ross et al. [17] argued that research on IC should consider the total IC the company has and the connection between IC and firm value. Thus, holding the financial capital steady, the higher the IC is, the greater the firm value. Taking SVA as the proxy variable, we propose the following hypothesis.

Hypothesis 2. In the IT industry, IC and SVA are related to the variation explanation.

We use the following VAR model to do a statistical analysis (we also use the SVA as a proxy for corporate value and Tobin's Q as proxy for IC):

$$\begin{cases} Tobin\ 'sQ_i = \alpha + \sum_{i=1}^{3} \beta_i SVA_{t-i} + \sum_{i=1}^{3} \beta_i Tobin\ 'sQ + u_{1i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (3) \\ \bullet \\ SVA_i = \alpha' + \sum_{i=1}^{3} \theta_i Tobin\ 'sQ_{t-i} + \sum_{i=1}^{3} \theta_i SVA_{t-i} + u_{2i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (4) \end{cases}$$

Sample and Data

This research chooses IT firms listed in the Taiwan Stock Exchange (TSE) on and before 1997 based on data from the Taiwan Economic Journal Data Bank (TEJ Databank) and deducts companies with financial difficulties, first public offerings, and information deletions. We end up with 54 samples. For objectivity, we use data from public source such as TEJ Databank, and the patent information is from TWPAT databank run by the Asia Pacific Intellectual Property Association in Taiwan. This research follows the IC classification of Hurwitz et al. [12].

Results

From the independent variances relation matrix study, for the independent variables to have a significant level, the relationship coefficient should be between -0.3165 and 0.42953. The result indicates there is

no co-linearity between variables. Before the multiple regression analysis, we test co-linearity using the Variance Inflation Factor (VIF). The resulting VIF value is between (1.02798717, 1.37022186), further confirming that these independent variables do not show any co-linearity.

Propriety Rights Have Explanatory Power on Intellectual Capital

When we have the three variables of organization capital, customer capital, and human capital, the regression equation has explanatory power of 0.1050 (α0.0022) on IC. Adding IP variables into the regression model, the total explanatory power increases to 0.2181 (α0.0017). From the second VAR equation, we can see the independent variable's impact on the IC that for every one unit increase in the t-1 period, the IC value at period t increases by 0.002797 (α0.0402).

Considering the economic situation in Taiwan and using the stock indices as indicators, we see some economic growth years (1997 and 2000) and recession years (1998, 1999, and 2001). Table 4 presents the empirical results that the regression model 1, composed of OC, CC, and HC, is significant during both the growth and the recession periods at 0.0001 and 0.083 with explanatory powers of 0.367 and 0.0924, respectively. Adding IP variables into this model is still significant during the growth period, but does not have a significant impact during the recession periods. This implies that technological innovation has a stronger impact on the IC value during an economic growth period.

Analysis of the Vector Auto-Regression Model

From the VAR analysis, we have the Durbin-Waston values as 1.94725 and 2.206037, respectively. Thus, we conclude that the VAR model in this research is in conformity with the hypothesis of residue independence.

We see that after using the current SVA as a dependent variable, the total explanatory power is 84.28% (α0.0001), which shows that the past SVA has a very high explanatory power on the IC value. When the current IC is a dependent variable, the explanatory power is 73.31%, meaning that the past five years' SVA and IC can explain the current SVA. We hereby conclude that in the IT industry, the IC value and SVA are significantly related, which supports Hypothesis 2.

CONCLUSION

We have studied herein fifty-four publicly-listed TSE firms in the IT industry during 1997-2001 to investigate the relationship among TI, IC, and SVA. We have reached the following conclusions: (1) The number of propriety rights, which represent a firm's technological innovation ability, has a significantly positive impact on IC. The number of patents at t-1 has a significant impact on the IC value during an economic growth period, yet no significant effect during a recession period. (2) In the IT industry, when we add the IP variable to the VAR model, it can increase the explanatory power on the relationship between the IC and SVA. (3) In the IT industry, past IC values and SVAs have a significant impact on the current IC and SVA. The SVAs at t-2, t-3, and t-4 also increase the current IC value. (4) Such a significant impact on current SVA from past IC and SVA in the IT industry is due to the IC creating excessive profit, which in turn increases corporate value. This is a proof of the resource-based perspective: IC is the core resource of a firm.

To sum up, from the view of resource-based theory, this study has addressed that intellectual capital is the core resource of an enterprise. It enhances corporate value not only in the same period, but also in

the future. Therefore, executives must devote themselves to improving the technological innovation environment and capability, in order to enhance the intellectual capital value. Furthermore, the enterprise value will achieve significant progress.

REFERENCES

[1] Bloom, N. and Reenen, J.V. Patents, real options and firm performance. *The Economic Journal*, Mar., 2002, 112, C97-C116.

[2] Boekestein, B. The relation between intellectual capital and intangible assets of pharmaceutical companies. *Journal of Intellectual Capital*, 2006, 7 (2), 241-253.

[3] Bosworth, D. and Rogers, M. Market value, R&D and intellectual property: An empirical analysis of large Australian firms. *The Economic Record*, Dec 2001, 77 (239), 323-337.

[4] Brooking, A. *Intellectual capital*. Boston: International Thompson Business Press, 1996.

[5] Chang, J.R. Hung, M.W. and Tsai, F.T. Valuation of intellectual property: A real option approach. *Journal of Intellectual Capital*, 2005, 6 (3), 339-356.

[6] Chen, M.C., Cheng, S.J. and Hwang, Y.C. An empirical investigation of the relationship between intellectual capital and firm's market value and financial performance. *Journal of Intellectual Capital*, 2005, 6 (2), 159-176.

[7] Edvinsson, L. and Malone, M.S. *Intellectual capital*. New York: HarperCollins, 1997.

[8] Galbraith, J.K. The consequences of technology. *Journal of Accountancy*, June 1969, 124, 44.

[9] Griliches, Z. Market value, R&D and patents. *Economics Letters*, 1981, 7, 183-187.

[10] Hall, B.H. Jaffe, A. and Trajtenberg, M. Market value and patent citations, *Rand Journal of Economics*, 2005, 36 (1), 16-38.

[11] Huang, C.J. and Liu, C.J. Exploration for the relationship between innovation, IT and performance. *Journal of Intellectual Capital*, 2005, 6 (2), 237-252.

[12] Hurwitz, J., Lines, S., Montgomery B. and Schmidt, J. The linkage between management practices, intangible performance and stock returns. *Journal of Intellectual Capital*, 2002, 3 (1), 51-61.

[13] Lev, B. and Radhakrishnan, S. The measurement of firm-specific organization capital. *NBER Working Paper*, 2003, No. 9581, http//www.nber.org/papers/w9581.

[14] Litschka, M., Markom, A. and Schunder, S. Measuring and analyzing intellectual assets: An integrative approach. *Journal of Intellectual Capital*, 2006, 7 (2), 160-173.

[15] Narvekar R.S. and Jain, K. A new framework to understand the technological innovation process. *Journal of Intellectual Capital*, 2006, 7 (2), 174-186.

[16] Porter, M.E. *The competitive advantage of nations*. New York: Free Press, 1990.

[17] Ross, J., Edvinsson, R.L. and Dragonetti, N. *Intellectual capital: Navigating in the new business landscape*. New York University Press, 1998.

[18] Shaikh, J.M. Measuring and reporting of intellectual capital performance analysis. *Journal of American Academy of Business*, 2004, 4 (1/2), 439-448.

[19] Shiu, H.J. The application of the value added intellectual coefficient to measure corporate performance: Evidence from technological firms. *International Journal of Management*, 2006, 23 (2), 356-242.

[20] Stewart, T.A. Brain power: Who owns it … How they profit from it. *Fortune*, Mar. 1997, 17, 104-110.

[21] Sveiby, K. E. *The New Organizational Wealth: Managing and Measuring Knowledge-based Assets*. San Francisco: Berrett-Koehler, 1997.