The Journal of Applied Management and Entrepreneurship, 2004, Vol. 9, No. 2

Measuring the Effect of Investment in Intellectual Capital

John T. Sennetti, Nova Southeastern University
Chang-Soo Kim, Chung-Ang University
Robert J. Sellani, Nova Southeastern University

Executive Summary

IBM purchased Price Waterhouse Coopers Consulting (PWCC) in 2002 for $2.6 billion (net), of which only about $600 million were "hard" assets. The rest, about $2 billion, is an asset called "intellectual capital" (IC). If IBM had instead invested $2 billion in training to compete with PWCC, this 2 billion would not have been counted as a plus to investments but instead as a negative against profits, one measure of management's success. Broadly speaking then, how can we measure the unrecorded investment in training, research and development, and other such management contributions to IC?

For this measurement, we compared the highly-rated, well-managed South Korean "best technology and IT firms' to similar non-rated firms using four accepted measures of IC: the market-to-book ratio (MTB), Tobin's Q, a cash flow return on investment (CFROI), and the calculated intangible value (CIV). We find each of these four measures distinguishes the well-managed firms, but the latter two which emphasize profits over assets provide more consistent measures over time. Successful IC management is correlated with those companies making larger incomes proportional to their relatively lower assets, even when the IC costs counted against income.

Introduction

In the 1990s, U.S. firms spent over 1.0 trillion in "intellectual capital" (IC, specialized knowledge and general expertise), to increase their abilities to compete in the global economy with apparently no direct accountability. Given that which is easier to measure is then easier to manage, this paper seeks to measure the successful management of IC. For example, the measures of management "investments" in training are difficult because such are not recorded as investments (financial assets) but as costs. As costs they actually reduce profits, a measure of management success. In this sense the management of IC is treated contrarily as a negative rather than a positive management contribution.

This paper seeks to find a reliable measure of contributed IC that defines successful management. We examine four financial measures based upon recognized book and market values. These measures are then applied to recognized, well-managed IT firms in Korea to discover the effectiveness of each measure in capturing the recognized "competitive advantage" of IC, made in part by R&D and other unrecognized "investments" in training and know-how.

The Measurement Problem

Successful management (accumulation, development, and deployment) of IC can make the difference between a highly successful and an average performing company. Successful management changes assets and other financial resources to know-how and special abilities; it creates internal and external value (Chanaron and Jolly, 1999). Measuring this value obtained from the creative arts may be as difficult as its creation. Tepper (2002) suggests reviewing current practices for some insight.

Unfortunately assets can only be 'probable future economic benefits obtained or controlled by a particular entity as a result of past transactions or events' with other entities (FASB, 1985). IC, e.g., IC obtained from management training, does not satisfy this definition since it is not purchased from "outside" parties. Therefore you can not find "training cost to increase IC" listed as an investment asset in any financial statement.

Because IC represents specialized knowledge and abilities, it can be classified into five categories: 1) the unrecognized technology (i.e., research and development, R&D) and engineering-related IC obtained from recognized assets such as patents, trademarks and copyrights that provide the unrecognized technical know-how; 2) unrecognized data processing-related IC which gives the organization internal strength, such as specialized business processes, automated databases, and the external strength derived from these systems; 3) marketing and customer-related IC which give the company power in the market place obtained from recognized and unrecognized assets such as brand names, logos, customer loyalty, and customer lists; 4) unrecognized human resource-related IC which is derived from its employees' knowledge, competencies, work-related know-how, networking capability, corporate culture, and employment agreement; and 5) other know-how obtained from artistic-related or location-related IC. Among these five different groupings, we consider directly just the first, the R&D-related IC.

IC From R&D Costs

Essentially, all R&D costs, those leading up to the design of a new product or process, or a significant improvement to an existing product or process up through and including development of a prototype and pilot production, are expensed against profits (Nikolai and Bazley, 2003). Only costs related to post-pilot production and support, those that create the product, enter into the product and are part of inventory, hence create assets, are listed as "investments." Even though R&D training may provide future economic benefits, the employees are not "other entities" that created "training investments." Therefore if a company generates its own R&D and related training costs, these costs are not recorded as investments. But what if it buys such capability in the form of another company?

IBM buys Price Waterhouse Coopers Consulting

The recent purchase of Price Waterhouse Coopers Consulting (PWCC) by IBM for approximately $3.5 billion dollars in recognized assets serves as an example in the table below:

(dollars in millions)	AMORTIZATION LIFE (IN YEARS)		PWCC
Current assets		$	1,197
Fixed/non-current assets			199
Intangible assets:			
Goodwill	N/A		2,461
Completed technology	3		—
Strategic alliances	5		103
Non-contractual customer relationships	4 to 7		131
Customer contracts/backlog	3 to 5		82
Other identifiable intangible assets	3 to 5		95
Total assets acquired			4,268
Current liabilities			(560)
Non-current liabilities			(234)
Total liabilities assumed			(794)
Net assets acquired			3,474
In-process research and development			—
Total purchase price (source: IBM 12/31/2002 10-K)		$	3,474

In this case, IBM "bought" intellectual capital for about two billion dollars ($3,474-1,197-199=$2,078) and recognized it as an asset. IBM would otherwise have to expense this two billion against its profits if it had to hire and train its own people. Also, it would take many years of hiring, training, and investment in R&D to duplicate the now-available PWCC capabilities. Therefore even though the total expenses would be about the same over time, IBM by its purchase has these capabilities now and therefore can generate more revenue streams (future economic benefits). It has a recognized IC asset.

Through "management of IC-by-purchase," i.e., by purchasing PWCC, IBM gets these benefits of instant revenue capabilities along with advantages of delaying (amortizing) the costs associated with producing this revenue. On the other hand, through the "management of IC-by-training" IBM will continue to invest in (but not recognize) the continuous training of its new PWC employees and add (unrecognized) value to this PWC purchased investment.

New Tools to Measure Management's Contributions to Intellectual Capital

One possible solution to measuring the contributions of management to intellectual capital is to use several methods and compare the results over the same period of time and across the firms within industry. The cost, market, and income approaches are those most commonly used attempt to measure internally created intellectual capital (Upton, 2001).

The replacement-cost approach measures what it would cost today to acquire the same or similar assets. This approach is highly reliable in dealing with tangible personal property and real estate but is not used since it is difficult to apply to training or R&D costs. The market approach, measured with the market-to-book (MTB) or Tobin's Q ratios, asks what the assets are selling for in the market. The income approach, found in the cash flow return on investment (CFROI) or calculated intangible value (CIV) measures, asks what investors are willing to pay as a given income stream in the future.

Market-to-book ratio (MTB)

The most widely-known indicator of the intellectual capital is the market-to-book value. The contention is that the value of a firm's intellectual capital will be represented by the difference between the book value and the market value of the firm. If a firm's stock market value is 300 million, and its book value is 200 million, then the residual 100 million represents the value of the intellectual capital of the firm. Hence if there is any IC, the market-to-book value ratio is greater than one. The greater the contribution of IC the greater the market-to-book value ratio, $MTB_{it,}$

$$MTB_{it} = MVE_{it} / BVE_{it} = \{(NCS_{it} \times PCS_{it}) \times (NPS_{it} \times PPS_{it})\} / TA_{it} \text{ -------------- } (1)$$

where

MTB_{it}	=	Market-to-book ratio of firm i at the end of fiscal year t
MVE_{it}	=	Market value of equity of firm i at the end of fiscal year t
BVE_{it}	=	Book value of equity of firm i at the end of fiscal year t
NCS_{it}	=	Number of common stock of firm i at the end of fiscal year t
PCS_{it}	=	Price of common stock of firm i at the end of fiscal year t
NPS_{it}	=	Number of preferred stock of firm i at the end of fiscal year t
PPS_{it}	=	Price of preferred stock of firm i at the end of fiscal year t
TA_{it}	=	Total assets of firm i at the end of fiscal year t

These values can be found from the company's financial statements and are easily calculated in spreadsheets. Higher MTB values come from lower recorded assets (TA), lower perhaps from the "unrecognized investments," and from higher market (stock) prices. Prior studies also show that firms spending more on R&D and IT than their competitors (and hence not recording these unrecognized assets) have a higher market-to-book value ratio (Knight, 1999; Landsman and Shapiro, 1995).

One caution in using this ratio is that it suffers from questionable internal validity. Stock prices also can be influenced by industry deregulation, supply conditions, and the various other types of information that determine investor perceptions of the income generating potential of the firm. Therefore, MTB is best suited to making comparisons of the value of intellectual capital of firms within the same industry, serving the same markets and operating similar facilities. We will use the South Korean IT industry.

Tobin's Q ratio (Tobin Q)

Tobin's Q ratio was initially developed by a Nobel laureate in economics, James Tobin as a method for predicting investment behavior. It uses the value of the replacement costs of a firm's assets to predict the investment decisions of the firm. The Q is the ratio of the market value of companies' equity (share price times the number of shares) to the replacement cost of their assets minus the market value of liabilities. (The last number, the denominator, is net worth.) If the market value of a firm's assets is higher than its replacement cost of its all assets, then a company has an on-going advantage, is getting "monopoly rents (i.e., intangibles)," or higher than normal returns on their investment (Tobin, 1978, Lindenberg and Ross, 1981; Ross, 1993). If Q is greater than one, the asset is worth more than the cost of replacing it; thus it is likely that the company has value that is otherwise unrecognized. Technology and human capital-related-IC and firms with more R&D and IT costs are typically associated with high "Q" ratio (Perfect and Wiles, 1994; Ross, 1993). The equation calculating Tobin's Q ratio is:

$$\text{Tobin } Q_{it} = (MVE_{it} + MVL_{it}) / RCTA_{it} = (MVE_{it} + MVL_{it}) / TA_{it} \quad \text{------------- (2)}$$

where

MVE_{it}	=	Market value of firm i at the end of fiscal year t
MVL_{it}	=	Market value of firm i at the end of fiscal year t
$RCTA_{it}$	=	Replacement cost of total assets of firm i at the end of fiscal year t
TA_{it}	=	Total assets of firm i at the end of fiscal year t

As with the MTB, Tobin's 'Q' ratio is subjected to the same problems of internal validity and should be used when making comparisons of the value among firms within the same industry and across the same periods.

Cash Flow Return on Investment

A third measure, the Cash Flow Return on Investment (CFROI), calculates the value of total investment from the optimal market value of the firm. It is the difference between the optimal market value (best target share price times the number of shares) of the firm and the amount of total ("official") investment, calculated as

$$CFROI_{it} = MVE_{it} - INVT_{it} = MVE_{it} - (PPE_{it} + AAD_{it} - IR_{it}) \text{ ------------------- } (3)$$

where

$CFROI_{it}$ =	The measure of intellectual capital of firm i at the end of fiscal year t
MVE_{it} =	Market value of firm i at the end of fiscal year t
$INVT_{it}$ =	Total investment amount of firm i until the end of fiscal year t
PPE_{it} =	Property, plant and equipment of firm i at the end of fiscal year t
AAD_{it} =	Amount of accumulated depreciation of firm i at the end of year t
IR_{it} =	Investment return (IR) of firm i at the end of fiscal year t, where IR_{it} is calculated by ordinary income times (1-corporate tax rate of year t)

Thus this ratio, somewhat subject to the same market price issues of the MTB and Tobin's Q, overcomes this question by adding IR, which is just simply net income, reported profits. Large market value companies making large incomes with little recorded plant and equipment assets remaining after depreciation suggest that what is not recorded (IC) may impact more than what is recorded as assets.

Calculated intangible value (CIV)

A fourth measure, the calculated intangible value (CIV), measures the company's excess over the industry's average return on operating assets (ROA) as a basis for determining its value,

$$CIV_{it} = \{AOA_{it} \times (AVGROA_{it} - INDROA_{t}) \times (1 - TR_{it})\} / CC_{it} \text{ ---------------- } (4)$$

where

CIV_{it}	=	Calculated intangible value of firm i at the end of fiscal year t
AOA_{it}	=	Average operating assets of firm i at the end of fiscal year t
$AVGROA_{it}$	=	Average ROA of firm i at the end of fiscal year t
$INDROA_{it}$	=	Industry average ROA at the end of fiscal year t
TR_{it}	=	Corporate tax rate of firm i at the end of year t
CC_{it}	=	Capital cost of firm i at the end of fiscal year t

Unlike the three other measures of intellectual capital the CIV does not depend upon market value and hence its exogenous variables. Like the others, the CIV increases with decreases in "official" assets, since it depends upon the average ratio of earnings to assets, ROA. Yet, since it is based on an average, it may be subject to extremes. Also, higher interest rates, hence costs of capital, decrease the CIV, and give an unfair advantage to the degree of leverage, and decrease reliability. The CIV could be overvalued or subjected to extreme variation.

Sample Selection and Statistical Model

In order to determine the effectiveness of these four measures, we applied them to the rated "Wol Gan Chosun Best 50 Technology Firms and Best 30 IT Firms" of South Korea. Firms that win these awards are recognized for their achievements in technology and IT talent in Korea and are based upon the recommendations of their peers. In the year of 2000, "Wol Gan Chosun" played host to announce best 50 technology firms and best 30 IT firms based on the recommendations of 12 non-profit technology evaluation organizations and 5 stock trading companies. The awards honor the fastest-growing, efficiently operating R&D technology or IT companies in terms of their revenue growth, operation efficiency, and profitability over the past year. Therefore, we would expect the performance of these 80 firms under these four measures (MTB, Tobin Q, CFROI, and CIV) to be higher than similar but non-award-winning firms in the years previous to 2000, for example, over the period of years 1991-1998. This time period also puts the measures through controlled tests of rising and falling markets. (After the year 1998 the extreme market variation observed in the US and Korean markets could distort the market-based measurements.)

The similar but non-award-winning firms were chosen as closely as possible by stock price (i.e., the market value of equity) available from the Korean Stock Exchange (KIS-FAS) database for listed firms. Beginning in 1998 and working back to 1991 we find that of the award-winning 80 firms, only 34 technology firms and 15 IT firms are listed in the Korean Stock Exchange in 1998, and not all of these 49 companies are available over the sample period from 1991 to 1998. In 1991 of the original 34 Technology and 15 IT companies, only 22 and 12 remain to be matched with similar companies for those years. Table 1 gives the statistics of final chosen sample of award-winning firms (the testing group) and those of the comparative matching group by year, and Table 2 calculates each of the four ratios for these two groups.

Table 1 Sample Firms by Year

Year	Testing Group		Matching Group		Total
	Technology Firms	IT Firms	Technology Firms	IT Firms	
91	22	12	22	12	68
92	22	12	22	12	68
93	22	12	22	12	68
94	23	13	23	13	72
95	24	13	24	13	74
96	31	15	31	15	92
97	34	15	34	15	98
98	34	15	34	15	98
Total	212	107	212	107	638
	319		319		

Table 2 Descriptive Statistics

Measures	N	Means	Std. Dev.	Coefficient of Variation
MTB	319	1.40	1.145	0.045
Tobin Q	319	1.159	0.465	0.022
CFROI	319	2,173,258	6,117,422	0.157
CIV	319	184,540	857,075	0.260

1) MTB and Tobin's Q are ratios. CFROI and CIV are million in Korean Won.
2) N represents number of sample firms

Table 3 Pearson's Correlation Coefficient

Measures	MTB	Tobin Q	CFROI	CIV
MTB	-	0.917 (0.000)	0.156 (0.005)	0.003 (0.959)
Tobin Q	0.917 (0.000)	-	0.144 (0.010)	0.004 (0.942)
CFROI	0.156 (0.005)	0.144 (0.010)	-	-0.019 (0.735)
CIV	0.003 (0.959)	0.004 (0.942)	-0.019 (0.735)	–

1) Numbers in ( ) represent the significance level.
2) The sample size is 319 observations.

Table 4 t-Test Results

Measures	Group	N	Means	t-value	p-value
MTB	Testing	319	1.400	2.913	0.004
	Matching	319	1.171		
Tobin Q	Testing	319	1.159	3.064	0.002
	Matching	319	1.065		
CFROI	Testing	319	2,173,258	5.205	0.000
	Matching	319	380,899		
CIV	Testing	319	184,539	5.203	0.000
	Matching	319	49,073		

Results

Table 2 shows the wide disparity of the four measures. For example, as expected the CIV has the highest relative variation (0.26) and therefore its mean may not be as reliable as that of the other three measures. As mentioned earlier, CIV could be affected by outliers and hence may be harder to measure.

The Table 3 Pearson correlations show that two of the measures, MTB and Tobin Q are so related that they may duplicate each other since their correlation (0.917) is statistically significant (.000). The MTB and Tobin Q are also related to the CFROI, but not strongly so since the correlations are small, 0.156 and 0.144, respectively. The CIV ratio seems not to be related to any of the other three measures because the CIV has statistical p-values for each correlation coefficient greater than 0.05.

Table 4 shows the statistical advantage that each of these four measures demonstrate over the eight years. Every one of their comparisons demonstrate the significant statistical difference (t > 2.0) that the award-winning firms have over their matched counterparts in measures of intellectual capital, with the highest "t" values associated with the income approach measures (CFROI and CIV).

The next four figures present a descriptive study, limited to the time period of 1991 to 1998, of how each of these four measures identified value for the award-winning companies. First, in Figure 1, the market to book (MTB) shows just a slight advantage over time where as in Figure 2, the Tobin Q advantage disappears over time for the award-winning companies. As expected from Pearson correlation coefficients, the Tobin Q does not show much more than the MTB, and as shown in Figure 3, both are affected by the market direction.

Figure 1: Trend of MTB by Year

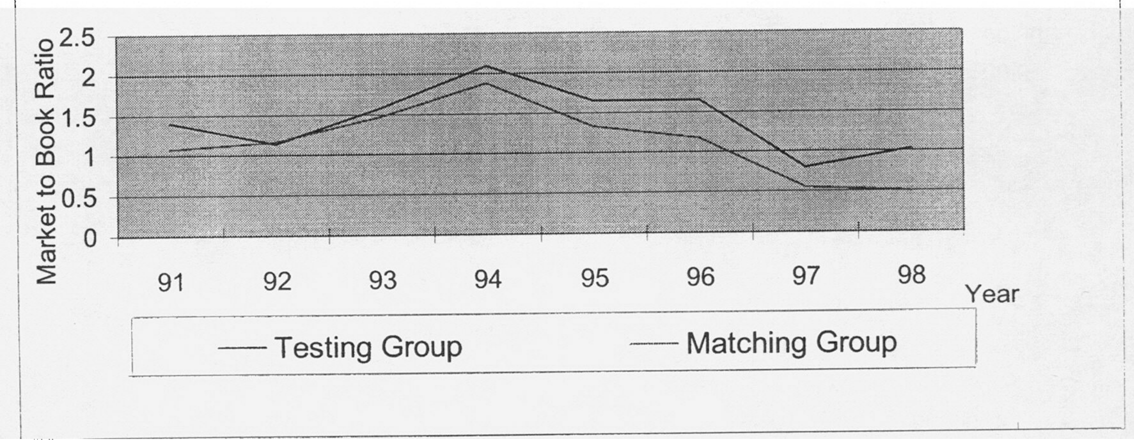


Figure 2: Trend of Tobin Q by Year

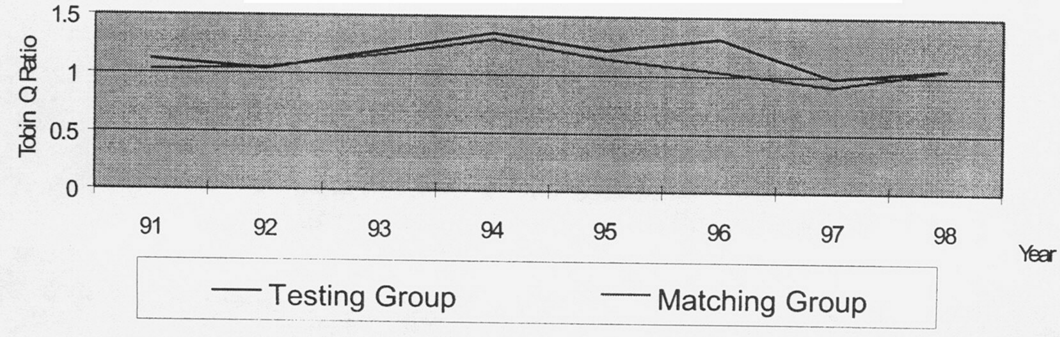


Figure 3: Korea Stock Price Index (KOSPI) by Year

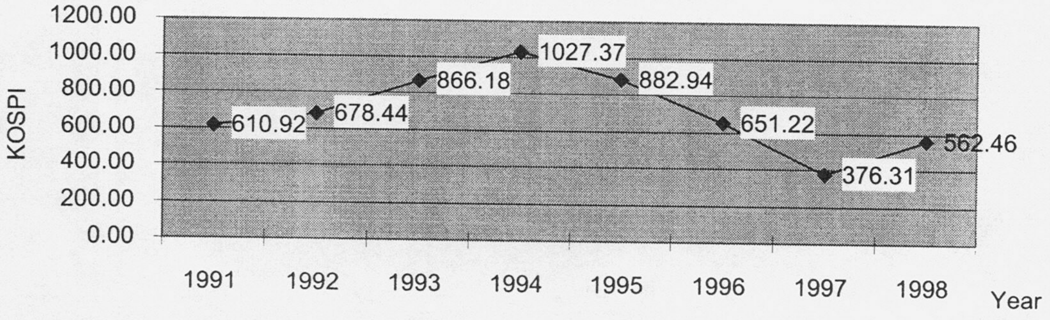


Figure 4: Trend of CFROI by Year

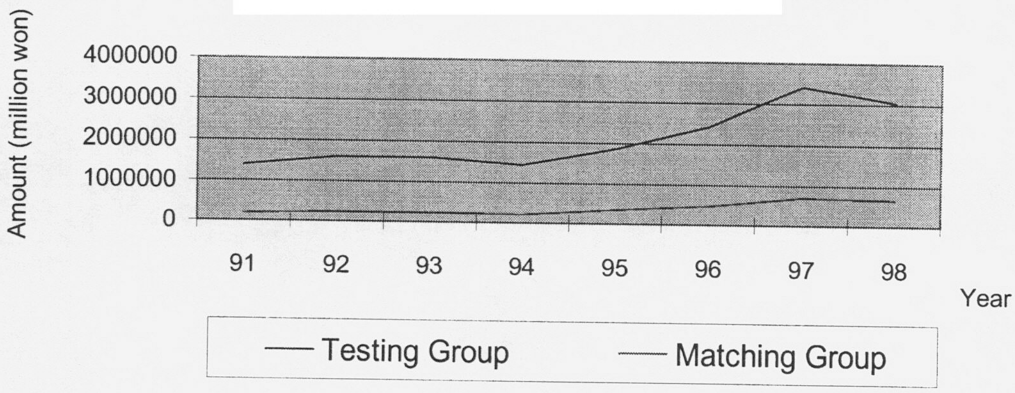


Figure 5: Trend of CIV by Year

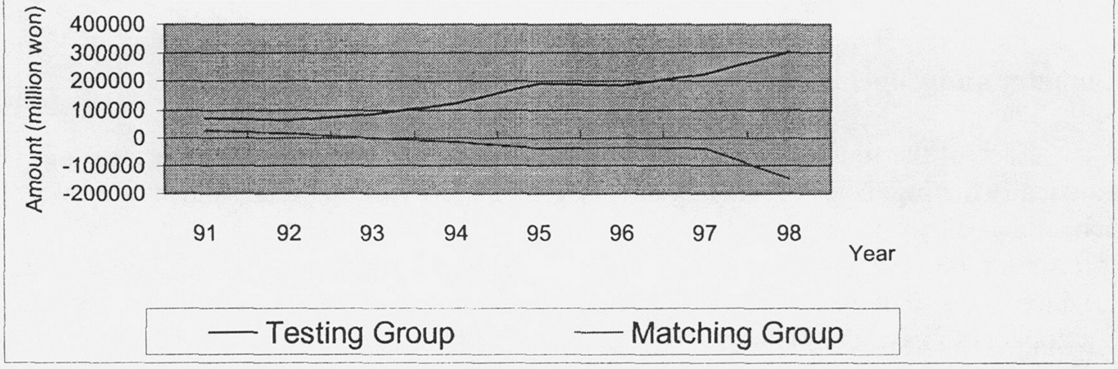
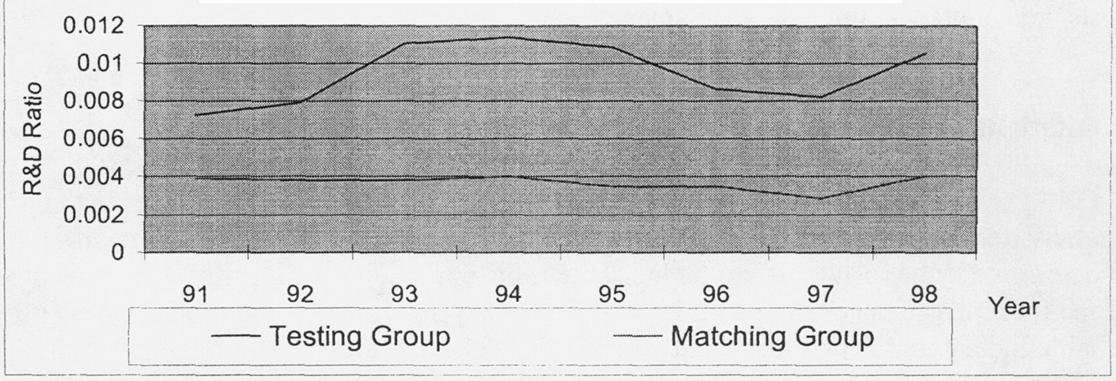


Figure 6: Trend of R&D to Total Assets Ratio



But Figure 3 shows different results for the income approach, found in the last two measures, CFROI and CIV. From mid 1994 through mid 1997, the Korean market trend was negative, yet Figures 4 and 5 show both CFROI and CIV measures for the award-winning companies were increasingly positive, surprisingly so since at least CFROI is somewhat market-based. For the matching companies during the same time period, the CFROI was only slightly positive (Figure 4), and the CIV was actually negative (Figure 5).

Therefore the award-winning firms' management advantage is better seen in either income approaches, the cash flow measure, CFROI, or in the low-to-industry asset-based CIV measure. Of these two, even though CFROI may be less variable than the CIV, the CIV may be more IC-related. The CFROI generally increases over time in Figure 4, but declines in 1998 when the market rises and when a measure of IC, R&D, increases. In Figure 5 the CIV also increases but accelerates in 1998 with the increase in R&D relative to ROA (see Figure 6), thus showing a greater strength of internal validity. R&D increases with the CIV, as would be expected. The higher the R&D (IC), the higher the measure of IC, CIV. Unfortunately, although this is true for the award-winning companies, the matched companies do not have a rising CIV as IC (R&D) increases.

Summary and Conclusion

Each of the four methods (MTB, Tobin's Q, CFROI and CIV) of measuring IC statistically distinguishes the management of the award-winning companies. Therefore each could be used to measure the management of IC. Of these four, the latter two, representing the income approach, also appear to be less dependent on other stock market variables and to that extent, the more reliable. Of these two, the statistically less stable CIV appears to have the most internal validity with IC. At least during the period studied, the CIV is statistically-related to IC, distinguishes well-managed companies, is independent of the stock market and non-related variables that appear that to influence the market, and for the period 1991-1998 follows R&D (IC) [at least for the award-winning companies]. Successful IC management then is correlated with those companies making larger incomes proportional to their relatively lower assets, even when the IC costs are counted against these incomes.

Limitations and Future Research

The results may be limited to the control period studied (1991-1998) or to the publicly traded Korean market. All Korean firms were publicly traded and it is difficult to determine if the results would be the same if the companies were privately held. Three of the four measures consider some form of market value in the calculation and may not reliable indicators for privately held companies. Also, it is difficult to say whether the results would be the same if these companies were measured over a different time period or if they were U.S.-based companies, therefore further research should be undertaken using U.S. firms. Finally, the conduct of the CIV for non-award companies during times when these companies were increasing their R&D relative to their return on assets (Figure 6) is puzzling, suggesting that there may be a threshold for increases in R&D, a minimum amount, before movement in IC registers in the computation of the CIV.

Importance

Harrison and Sullivan (2000) consider our two branches of IC management strategies, value creation (IC management-by-training) and value extraction (IC management-by purchase). They add time as another dimension of IC strategy, expressed here as the time necessary to make the IBM PWC purchase equivalent to that of comparable training. It is also possible that IC management-by-purchase strategy is more appealing to companies that are in high tech industries as time may not allow for an IC management-by-training strategy. Finally, these measures of successfully managed IC add to the view of employees as revenue generators rather than cost burdens (Carroll and Tansey, 2000).

References

Chanaron, J. & Jolly, D. (1999). Technological management: expanding the perspective of management of technology, *Management Decision,* 37 (8): 613.

Carroll, R. F. & Tansey, R. R. (2000). Profiting from Intellectual Capital: learning from leading companies, *Journal of Intellectual Capital,* 1 (4): 296-311.

Financial Accounting Standards Board Statement of Concepts No. 6. (1985). Elements of Financial Statements of Business Enterprises, par. 25.

Harrison, S. & Sullivan, P. H. (2000). Profiting from Intellectual Capital: learning from leading companies, *Journal of Intellectual Capital,* 1 (1): 33-46.

Knight, D. J. (1999). Performance Measures for Increasing Intellectual Capital, *Strategy & Leadership* (March-April): 22-27.

Landsman, W. & Shapiro, A. (1995). Tobin's Q and the Relation Between Accounting ROI and Economic Return, *Journal of Accounting, Auditing & Finance* (Winter): 103-20.

Lev, B. (2001). *Intangibles: Management, Measurement, and Reporting,* by Baruch Lev for the Brookings project, (Washington: Brookings Institution, awaiting publication). December 2000 draft available online at http://www.stern.nyu.edu/~blev/.

Lindenberg, E. B. & Ross, S. A. (1981). Tobin's Q Ratio and Industrial Organization, *Journal of Business* (January): 1-32.

Nikolai, L. A. & Bazley, J. D. (2003). *Intermediate Accounting, 9th edition,* Thomson/South-Western, Mason, Ohio, 460-466.

OECD. (1996). Measuring What People Know: Human Capital Accounting for the Knowledge Economy, (by Miller, Riel), OECD. Paris.

Perfect, S. & Wiles, K. (1994). Alternative Constructions of Tobin's Q: An Empirical Comparison, *Journal of Empirical Finance* (July): 313-42.

Ross, S. A (1993). Accounting and Economics, *Accounting Review* (April): 375-380.

Tepper, S. J. (2002). Creative assets and the changing economy, *Journal of Arts Management, Law and Society,* Washington: 32 (2): 159.

Tobin, J. (1978). Monetary Policies and the Economy: The Transmission Mechanism, *Southern Economic Journal* (April): 421-431.

Upton, Jr., W. S. (2001). FASB, *Special Report: Business and Financial Reporting, Challenges from the New Economy.* *http://www.fasb.org/articles&reports/new_economy.shtml*

About the Authors

Dr. John T. Sennetti is a professor of accounting, auditing and information systems at Nova Southeastern University's (NSU) H. Wayne Huizenga School of Business and Entrepreneurship. He has been with NSU since July of 1996. Having served as a professor both in statistics at Texas Tech and in accounting at Florida International University, he now teaches doctoral and master's courses in accounting. Dr. Sennetti has degrees from Virginia Tech (PhD), the University of Florida (MSTAT), Bucknell University (MA), and the University of Scranton (BA). He is certified as an accountant in the State of Texas and is published in numerous nationally recognized academic journals

Dr. Chang-Soo Kim is a professor of accounting at Chung Ang University's School of Business. He has been with Chung Ang University since March of 1994. Dr. Kim has degrees from Florida International University (Ph.D. and Master of Accounting), Chung Ang University (BA). He has published in numerous nationally recognized academic journals such as Managerial Finance, Information Systems Review, Korean Accounting Review, Korean Management Review and Accounting Journal. His major research has been in the areas of IT performance, accounting for digital contents, knowledge management and information system audit.

Dr. Robert J. Sellani is currently an Assistant Professor at the H. Wayne Huizenga School of Business and Entrepreneurship of Nova Southeastern University. Prior to joining NSU, Dr. Sellani has 20 years experience in three divisions of Fortune 200 Corporations and was a consultant with Ernst and Young. He specializes in Cost Management and Business Systems having been responsible for implementing four major systems, in addition to holding senior financial and operational positions. Dr. Sellani received his BBA and MBA from the University of Miami and DBA from Nova Southeastern University and was the first practicing accountant in South Florida to be certified in production and inventory management (CPIM).