# The Efficiency Of Intellectual Capital Investments As A Potential Leading Indicator

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**ABSTRACT**

*This paper aims to test the VAIC model in order to explore and recognize the relationship between Intellectual Capital (IC) components and the financial performance of companies, with an ambition to establish whether IC investment efficiency indicators can serve as potential leading indicators of the future financial performance of companies. We test our hypotheses by using the VAIC model. The data set includes more than 12,000 Slovenian companies within a 14-year period (from 1995 to 2008). OLS regression and panel regression method are used as tools. Most of the research hypotheses have been confirmed, but the results are of limited practical use. In contrast to the primary test, our test conducted on the ranked data indicates a high degree of correspondence between the improvement in rank of a company's IC investment efficiency and the improvement in rank of its financial performance in the peer group. As IC value is a result of above-average financial performance, the IC investment efficiency can potentially serve as leading indicators of future financial performance. By comparing the results of similar studies, we indicate possible systematic biases as potential sources of differences in the results, and suggest the areas that need further investigation.*

**Keywords:** VAIC model; Leading Indicators; Intellectual Capital; Human Capital; Structural Capital; Financial Performance; Residual Valuation Models; Slovenia

## INTRODUCTION

We can define Intellectual Capital (IC) as a predominantly social phenomenon (Sveiby, 2007). We also know that the evaluation of social phenomena within business finance can be a great challenge to researchers. There has been a persistent gap between the academic credibility and the practical usefulness of research findings that were introduced in the IC realm in recent decades. A lack of relevance for practitioners could be one important reason that extensive academic research in this area in Slovenia cannot be found.

However, it is not only the value of IC that matters. The predominant issue in evaluating IC is not the value of IC per se. The key questions are how to grasp the sustainability of the value creation process, and whether IC investment efficiency indicators can serve as leading indicators for the future financial performance of companies. In the previous fifteen years, over thirty different IC measurement and valuation methods have been introduced (Sveiby, 2007). One of the key reasons for this rather eclectic situation is the persistent dominance of the neoclassical paradigm in corporate finance, and an obsolete accounting system. The existing mainstream corporate finance principles are still based both on an industrial business model and the assumption of a perfect capital market. Input data for these models are drawn from traditional transaction-based accounting systems (Hand, 2003). All IC valuation models introduced in the previous two decades are relatively simple variations of traditional neoclassical valuation models. IC is a social phenomenon and the majority of valuation models are not designed for modeling social relations. This apparent disparity is one of the most challenging research areas. Forecasting and planning in

 

more predictable traditional industrial companies are much easier than in companies with a high presence of IC. According to some researchers, financial analysts' ability (and accuracy) to forecast the company's financial performance sharply declines with an increasing presence of IC (Montier, 2005). IC-intensive companies seem to be "black boxes" to financial analysts. Furthermore, according to existing empirical evidence, they systematically undervalue companies they do not reasonably understand (Lev, 2004).

Successfully designed leading indicators of the future financial performance of companies should lower the uncertainty of financial planning. To explore IC components' relationship with financial performance, we conduct two empirical tests. In the first test, we analyze the relationship among IC components and financial performance of companies using VAIC model (Value Added Intellectual Coefficient), introduced by Pulić (1998). In the second test, we explore the alignment of the VAIC model with assumptions underlying residual valuation models. We test our hypotheses on more than 12,000 Slovenian companies for the period from 1995 to 2008. For testing purposes, we use the VAIC model, because as it fulfills the majority of research requested features. Although we are aware that the VAIC model has its own limitations, the application of VAIC and its components as IC indicators is suitable for statistical analysis. The results of our first test are as mixed, as are results of several similar studies performed in other countries on different data set (See Appendix 1). Technically speaking, most of our hypotheses underlying the first test are confirmed. However, the explanatory power of the tested models is low, and the regression coefficients are of limited practical use. In contrast to the first test, the results of the test conducted on the ranked data segmented into sector-based peer groups are more promising. They indicate a high degree of correspondence between improvement in the rank of a company's IC investment efficiency within a sector-based peer group and improvement in the rank of its financial performance. This relationship suggests that there is a strong positive correspondence between a company's above-average IC investment efficiency and its above-average financial performance. This conclusion is in line with a basic assumption of residual evaluation models that claim that the value of IC is a result of above-average financial performance. In such a context, IC investment efficiency could potentially serve as leading indicators of the future financial performance of companies within a specially designed heuristic model based on VAIC model assumptions. Statistically and economically reasonable results of the second test indicate that the first step in further research should be to conceptually redefine the VAIC model and place it on a firm theoretical background with an ambition to improve its explanatory power and preserve its advantages. Only a more reliable VAIC model can serve as a starting point in the process of designing a heuristic model that will contain IC investment efficiency as a leading indicator of the future financial performance of companies.

## LITERATURE REVIEW

Over the previous two decades, the concept of IC has received almost complete support among researchers. Although there are a variety of IC definitions, most researchers agree that IC is a key source of a company's comparative business advantage. In recent years, there have been numerous attempts to introduce a standardized definition of IC (Edvinsson and Malone, 1997). Edvinsson and Malone (1997) define IC as knowledge that can be converted into value. Stewart (1997) extended the definition of IC as knowledge, information, intellectual property and experience that can be put to use to create wealth. Lev (2005) asserts that many regard IC as a factor of production in addition to physical and financial capital, while Petty and Guthrie (2000) say that it has an increasing impact on financial achievements of companies and their market valuations. Despite many attempts to re-define IC, most definitions divide IC into three components: human capital, structural capital and relationship capital, although authors use a variety of different names (Bontis, 1999, 2000; Edvinsson and Malone, 1997; Stewart, 1997; Sveiby, 1990; 2007). However, for the purposes of our study, we need a working definition of IC. We follow the definition introduced by Organization for Economic and Cooperation in 1999 and further developed by Petty and Guthrie (2000). This definition is similar to the IC definition offered by the Skandia Navigator method (Edvinsson and Malone, 1997), dividing IC into two components: human capital and structural capital. Besides the theoretical background, it offers some practical dimensions and also serves as a starting point in the development of the VAIC model introduced by Pulić (1998). In its practical dimension, it offers background to identify potential IC indicators in companies' financial statements that can serve as a proxy for IC measurement using the VAIC model.

Even though there is no consensus on the IC definition, the majority of IC scholars agree that the inability of accounting to capture and record IC is probably the most important reason the market values of companies differ significantly from their book value (Andrikopoulos, 2005; Chaminade and Roberts, 2003; Fincham and Roslender,

2003; Lev, 2001; Lev and Zarowin, 1999; Lev and Radhakishnan, 2002; Sveiby, 1990; Tseng and Goo, 2005; Zerenler and Gozlu, 2008). The widening gap between market and book value in many companies encouraged a new area of research: the development of IC measurement and evaluation methods. Similar to defining IC, there is no universally accepted IC measurement and evaluation method. Sveiby (2007) categorizes the methods into four groups: market capitalization methods (Andriessen, 2004; Bontis, 2001; Caddy, 2000; Guthrie, 2001; Sveiby 2007), direct IC measurement methods (Bontis, 2001; Caddy, 2000; Sveiby 2001), scorecard approaches (Edvinsson and Malone, 1997; Kaplan and Norton, 1992; Sveiby, 2007) and economic value added approaches (Stewart, 1997). The VAIC method cannot fit into any group, so Chan (2009) proclaimed it as a fifth approach to IC measurement.

We selected the VAIC model as a one that best suits to the purposes of our research. An increasing number of studies and the results of those studies suggest that the VAIC model approach is suitable for measuring IC and its components. The overview of the 28 most important VAIC model-based studies performed in the previous two decades is presented in Appendix 1. We have recognized some common characteristics of those studies. The most common motive that prompted researchers to explore the IC phenomenon was the evident difference between the market and book value of cited companies. More than half of the reviewed studies are targeted for the simultaneous detection of links between VAIC model variables, the market value of companies and among VAIC variables and financial performance (Bornemann, 1999; Chen, 2005; Firer and Williams, 2003; Mavridis 2005; Pulić, 1998; Van der Zahn, 2004). Few reviewed studies are exclusively directed at discovering the link between financial performance and VAIC model variables (Deol, 2009; Mavridis, 2004; Mohiuddin, 2006; Riahi and Belkaoui, 2003; Williams, 2004), or directed to discovering the connection between VAIC model variables and the market value of companies (Appuhami, 2007; Goh, 2005; Kujansivu and Lonnquist , 2007; Pulić, 1999; Tseng and Goo, 2005).

In the following paragraph, we emphasize some most referenced studies that are characterized as important milestones in VAIC-based research area so far. The initial studies were conducted by Pulić (1998) and Bornemann (1999). Both studies indicate a high degree of correspondence between VAIC indicators and the market value of companies on the London and Vienna Stock Exchanges. The very persuasive results of primary studies sparked a new era of research in IC measurement. The next milestone in VAIC-based studies is the research conducted by Williams (2001). Williams introduced the regression technique as the primary research tool, with VAIC as an independent variable and size and financial leverage as the most important control variables. This research is widely quoted by authors in subsequent VAIC-based studies. A similar study was conducted by Firer and Williams (2003) analyzing the data collected for 75 publicly traded companies listed on the Johannesburg Stock Exchange in South Africa. This study is widely referenced because of the research method used and due to the results, which revealed that South African investors are less reliant on IC as a performance and value driver in comparison to physical capital. This is probably the first VAIC-based study with results that substantially differ from the seminal studies conducted by Pulić (1998). The next methodological break-through was occurred in 2005, when Kujansivu and Lonnqvist (2007) introduced their research conducted on a data sample of Finnish companies. This is the first VAIC-based research performed on a very extensive data sample segmented according to industry. The next step in VAIC model development is introduced in the Taiwan-based research performed by Chen (2005). This study includes a large sample of Taiwanese listed companies from 1992 to 2002. The results reveal that each of the VAIC components showed a higher degree of association with companies' financial performance than VAIC as an aggregate measure.

After reviewing the most important milestones in the VAIC model development, we now summarize some of the most important common characteristics of VAIC-based studies represented in Appendix 1. The results of reviewed studies vary from solid confirmations of the hypotheses to complete rejections of them. More than half of studies support the hypotheses, about a quarter of them reject them and only a small proportion of the studies show partial hypothesis confirmation. The large number of studies confirming the hypotheses is probably one of the most important reasons the VAIC model is so popular in the IC research community.

Another common feature of the reviewed studies is that they are predominantly limited to specific countries. No international comparisons of research results have been performed. An exception is Pulić's study (1998). The time series of the data were relatively short, in most cases covering from one to three years. Another exception is a survey conducted by Chen (2005), who performed his study on a ten-year data period (1992–2002). Studies are predominantly cross-section oriented, which contradicts IC being a longer term dynamic concept.

Sample sizes vary widely. They range from a few dozen companies surveyed (Mavridis and Kyrmizoglou, 2005; Muhammad and Ismail, 2009; Pulić, 2000; Puntillo, 2009), to over 50,000 monitored companies (International Business Efficiency Consulting, 2003). We can also pinpoint that only two studies analyze developed countries with a long tradition of capital markets (the U.S. and England) (Bornemann, 1999; Williams, 2004). All other surveys are conducted in peripheral European countries or in countries belonging to the group of growing markets. It is notable that the VAIC model is used much less frequently by IC researchers from developed markets. Most researchers believe that the VAIC model validation process requires further studies on different data sets (Chan, 2009; Maditinos, 2010). The majority of researchers also claim that the model has evident shortcomings and needs to be upgraded (Chen, 2005; Nazari and Herremans, 2007). Nevertheless, most of the studies use the VAIC model without debating its possible weaknesses and without proposals of how to upgrade the model and the research methodology. Despite its recognized shortcomings, many authors believe that model has many decisive advantages that make it applicable (Chan, 2009; Chen, 2005; Firer and Williams, 2003; Goh, 2005; Mavridis 2004, 2010). Authors claim that model uses indicators that are quantifiable and objective without the requirement of subjective assessment. VAIC indicators are informative to all stakeholders, comparable between companies and financially oriented. These characteristics make them useful along with traditional financial measures. The VAIC model can be applied to a publicly available financial data, and it uses relatively simple procedures in the computation. The model also treats human capital as the most important part of IC, which is consistent with all major IC definitions (Chan, 2009).

The VAIC approach adopted in our study follows the methodological framework of all studies denoted as the most important ones in our literature review.

## THE CONCEPTUAL FRAMEWORK

The conceptual framework of the present study is an upgraded approach of the methodological framework of previewed studies. It first aims to investigate the relationship between IC and the financial performance of companies. The majority of IC researchers claim that IC is the most important value driver in companies (Stewart, 1997) and that a company cannot establish sustainable competitive advantage without proper knowledge management (Nonaka and Takeuchi, 1995). However, the empirical results of studies exploring the connection between IC and the financial results of companies are inconclusive. With an ambition to extend the empirical studies in IC to Slovenian companies, we define our research question as follows: Does the IC investment efficiency in companies affect their financial performance, measured by profitability, productivity and return on capital?

The first step in our research is to determine whether IC investment efficiency indicators indicate the transformation of IC investments into a financial performance, and can thus serve as a starting point in developing a heuristic model that will improve financial planning accuracy. Bearing in mind our research question and the findings of previous studies dealing with IC, we define our hypothesis as follows:

**H1:** IC investment efficiency in companies affects their assets profitability, productivity, return on equity and operating profit growth.

For hypothesis-testing purposes, we use the VAIC methodology (Pulić, 1998). We reviewed more than thirty known IC measurement and valuation models (Bontis, 2000) and, despite its shortcomings, we recognize that the VAIC methodology has important advantages that prevail on our decision. First, it does not require subjective evaluation decisions, surveys or writing questionnaires. All information for the application of this methodology is available in the companies' accounts and public databases. We believe that the VAIC method provides the most quantified and objective approach, and allows the use of quantitative methods on large data samples (Chan, 2009). Besides these advantages, the VAIC methodology concept perfectly fits our hypothesis: it explores companies' IC investment transformation ability based on the support of companies' financial and tangible assets. VAIC is, therefore, defined as a company's aggregate efficiency indicator, which indicates how a company utilizes available resources in the value creation process.

 

## RESEARCH METHODOLOGY

### Variable definition

The VAIC methodology provides four potential IC performance measurement constructs, which serve as independent variables in our study. Regarding their potential impact on the dependent variable, a company's size and financial leverage are included in the model as control variables. Both control variables are among the most commonly used control variables in VAIC-based studies (Firer and Williams, 2003).

**Independent variables.** Because we use the VAIC model to conduct our research, we can define four IC performance measurement constructs as independent variables. However, at the beginning, we first introduce the VAIC model in its advanced format (Pulić, 2004):

$$VAIC = HCE + SCE + CEE$$

where:

- VAIC = value added intellectual coefficient as an overall indicator of capital employed efficiency,
- HCE = indicator of human capital efficiency,
- SCE = indicator of structural capital efficiency,
- CEE = indicator of asset value efficiency.

The most important category in the model is company's value added (VA). It is defined as a difference between sales outputs (OUT) and inputs (IN):

$$VA = OUT\text{-}IN$$

While OUT represents sales, IN includes all expenses except labor costs, Given that VA represents the new wealth created within analyzed period, there are three important relations of VA included in the model. The first relation is called "human capital efficiency" (HCE), which shows how much VA is created by the human capital (HC) measured by yearly labor costs. This relationship indicates the ability of HC to create value in a company.

$$HCE = VA/HC$$

The second VA relation regards the contribution of structural capital (SC) in the value creation process. Pulić's original methodology (2004) defines SC as a difference between VA and HC:

$$SC = VA - HC$$

As HC and SC are inversely proportional, SCE measures the share of SC in the creation of VA:

$$SCE = SC/VA$$

The last VA relation includes physical and financial assets. SCE serves as an indicator for the VA created by one unit of physical and financial capital (CE) of a company:

$$CEE = VA/CE$$

For a more detailed explanation of model derivation and variables see Pulić's original paper (2004).

**Dependent variables.** Regarding our hypothesis, the present study includes four dependent variables that serve as companies' financial performance indicators. They are all calculated as accounting ratios:

- ROA = measures profitability of its total assets:

ROA = Operating Profit/Total Assets

- STA = is a coefficient between sales (SALES) and company's total assets

STA = Sales/Total Assets

- ROE = is an indicator of how efficient the management uses the capital that the owners of the company have invested:

ROE = Net Profit/Shareholder's Equity

- GROP = annual operating profits growth rate serves as an indicator that reflects the company's ability to enhance intrinsic value by growth:

$$GROP = (\text{Operating profit}_{(t)} / \text{Operating profit}_{(t-1)} - 1)*100\%$$

All dependent and independent indicators within our study are calculated according to the original methodology of the author of the model (Pulić, 2004).

**Control variables.** We use two control variables to control the results of the present study. The size of the firm (SIZE) and the level of financial leverage (FLEV) may have an impact on the dependent variables, the effects of which should be removed in OLS regression and panel regression analysis. Their inclusion is consistent with prior studies (Chan, 2009; Chen, 2005; Firer and Williams, 2003; Shiu, 2006).

- SIZE = serves as an indicator of company's size and is computed as a natural log of the book value of equity,
- FLEV = serves as an indicator of company's financial leverage and is computed as a ratio of interest bearing financial debt to book value of equity.

FLEV = Financial Debt/Shareholder's Equity

**Hypotheses.** Considering the VAIC model's assumptions, our basic scientific hypothesis is further developed in the four sets of hypotheses, which we test by using OLS regression and panel regression methods.

The first set of hypotheses:

*H1A:* Companies with higher VAIC have a higher ROA.
*H1b:* Companies with higher VAIC have a higher STA.
*H1c:* Companies with higher VAIC have a higher ROE.
*H1d:* Companies with higher VAIC have a higher GROP.

The second set of hypotheses:

*H2a:* HCE is positively associated with ROA.
*H2b:* HCE is positively related to the STA.
*H2c:* HCE is positively related to ROE.
*H2d:* HCE is positively related to GROP.

The third set of hypotheses:

*H3a:* SCE is positively associated with ROA.
*H3b:* SCE is positively associated with the STA.
*H3c:* SCE is positively related to ROE.
*H3d:* SCE is positively related to GROP.

 

The fourth set of hypotheses:

*H4a:* CEE is positively related to ROA.
*H4b:* CEE is positively related to the STA.
*H4c:* CEE is positively related to ROE.
*H4d:* CEE is positively related to GROP.

## RESEARCH METHOD AND REGRESSION MODELS

The VAIC model is first evaluated with a correlation analysis that serves as a control method. It enables us to compare the results of our study directly with the results of similar studies. In addition, we estimate our models using OLS regression and panel regression methods. We use both research techniques because in the case of the panel data format, the OLS regression method is of limited use. Coefficient estimates derived from applying OLS regression to panel data may be subject to omitted variable bias. Such a problem arises with an existence of unknown variables that cannot be controlled for those affecting the dependent variable. Being aware of method's shortcomings, we include it in our research for comparison purposes, because it serves as the most important research technique in majority of the VAIC-based studies (Bornemann, 1999; Chan 2009; Chen, 2005; Firer and Williams, 2003; Kujansivu, 2007; Mavridis 2004; Shiu, 2006; Williams 2001). The inclusion of the OLS regression technique also allows us to control for the differences in results caused by the application of different research methods. To diminish possible inconsistencies in results, we apply the *vce cluster robust* version of the OLS method. This version of OLS regression method estimates the standard errors in such a way that results are valid even if the standard errors are heteroscedastic. Within the estimation of OLS regression models, we control regression coefficients for multi-collinearity through the assessment of the VIF factor.

By using the panel regression method as our prime research tool, we are able to offset the methodological problems of OLS regression method. With a panel regression, we control for omitted variables by observing changes in the dependent variable over time. The group of companies in our sample has characteristics of short and long unbalanced panel data, because it consists of a large number of companies over a relatively long period of time, with the exception that not all companies are present each year. Using Housman's test, all the models are tested in terms of verifying which of the two available methods (random-effects method (RE) and fixed-effects method (FE)) gives the more reliable results. The FE method is suitable to control for omitted variables that differ between companies but are constant over time, while the RE method better serves when some omitted variables may be constant over time, but vary between companies.

Following the sets of hypotheses, we develop nine models to examine the association between independent variables and the four financial measures of corporate performance after controlling for the firms' size (SIZE) and the firms' financial leverage (FLEV). We present the models in panel regression format:

Models to test H1a, H1b in H1c:

$$ROA_{it} = B_i + \beta_1 VAIC_{it} + \beta_2 SIZE_{it} + \beta_3 FLEV_{it} + \varepsilon_{it} \quad (1)$$

$$STA_{it} = B_i + \beta_1 VAIC_{it} + \beta_2 SIZE_{it} + \beta_3 FLEV_{it} + \varepsilon_{it} \quad (2)$$

$$ROE_{it} = B_i + \beta_1 VAIC_{it} + \beta_2 SIZE_{it} + \beta_3 FLEV_{it} + \varepsilon_{it} \quad (3)$$

$$GROP_{it} = B_i + \beta_1 VAIC_{it} + \beta_2 SIZE_{it} + \beta_3 FLEV_{it} + \varepsilon_{it} \quad (4)$$

Models to test H2a, H3a in H4a:

$$ROA_{it} = B_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 FLEV_{it} + \varepsilon_{it} \quad (5)$$

Models to test H2b, H3b in H4b:

$$STA_{it} = B_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 FLEV_{it} + \varepsilon_{it} \quad (6)$$

Models to test H2c, H3c in H4c:

$$ROE_{it} = B_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 FLEV_{it} + \varepsilon_{it} \quad (7)$$

Models to test H2d, H3d in H4d:

$$GROP_{it} = B_i + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 SIZE_{it} + \beta_5 FLEV_{it} + \varepsilon_{it} \quad (8)$$

**SAMPLE, DATA SELECTION**

Hypothesis testing is based on annually reported and publicly available financial data of Slovenian companies for the 1995–2008 period, covering 79,407 companies. The data are collected and published by The Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). In Slovenia, the 1995–2008 period was marked by some special phenomena that should be carefully considered in the analysis. In the second half of the 1990s, there was a flood of new micro-companies, which were set up with minimal capital. These companies were often marked by a very limited range of operations, inadequate business models and relatively short life spans. Since such companies are not the population that we wish to observe in the study, reducing the information noise that such companies would have entered into the analysis is unavoidable. Therefore, we set four groups of logical criteria that should be satisfied by the company in order to become the subject of our research. Using the exclusion criteria, we eliminate most of unsuitable companies. Our target population represents the population of Slovenian companies that have already passed the initial development phase and have already established basic business processes and organization. Furthermore, they all have sustainable financing structure. These are companies that have already demonstrated survival ability on competitive markets. Companies that have not met the criteria are excluded from the study. The size of the company is not applied as a screening criterion, although a large proportion of exclusions are executed among small and micro-enterprises. In other words, for the companies that are included in the survey, we implicitly presume that they demonstrate at least a minimal presence of both elements of IC (HC and SC).

As already mentioned, we apply four groups of criteria that companies should meet in order to be included in the studied population:

1. We eliminate all companies for which the data necessary to calculate the independent variables are missing. We exclude companies missing data on human capital (HC), structural capital (SC), value added (VA), total assets (ASSETS), equity (EQ) and revenue from sales (SALES). According to this criterion, 10,692 companies are excluded. In some cases, a company is excluded from the sample for not meeting more than one criterion.
2. Companies whose HC, SC, VA, ASSETS, EQ, SALES are negative are excluded from the sample. According to this criterion, 28,852 companies are excluded. We eliminate all companies whose presence in the sample is less than six years, including to the year 2008. According to this criterion, 49,358 companies are eliminated.
3. We also eliminate companies with variables that show values outside some logical range. We assume that extreme values of indicators are not related to the effectiveness of IC investment. According to this criterion, 13,845 companies are excluded.

After applying all selection criteria, 12,450 companies or 150,565 surveyed units remain in the sample (15.8% and 25.25% of the initial population, respectively). On average, companies are included in the sample for 12.63 years with a minimum of six years and a maximum of 14 years. The largest number of exclusions from the sample (74%) is due to failing the presence criterion and 26% are due to not meeting other criteria.

 

## RESULTS

We first estimate the models through correlation analysis, OLS regression and panel regression tests.

### Descriptive statistics and correlation analysis

The correlation coefficients estimates are presented in Table 2 together with the results of their *t-test.* They are estimated using the STATA software package.

**Table 1: Descriptive statistics**

| Variable | Observations | AS | SD | MIN | MAX | MEDIANA |
|---|---|---|---|---|---|---|
| TIME | 150,565 | 12.63 | 2.30 | 6 | 14 | 14 |
| VA | 150,565 | 772,493,24 | 5,327,933 | 9 | 435,226,624 | 87,343 |
| HC | 150,565 | 484,593 | 2,906,977 | 5 | 160,243,600 | 55,474 |
| SC | 150,565 | 287,899 | 2,890,595 | -25,136,631 | 274,983,024 | 23,528. |
| OP | 150,565 | 106,922 | 2,607,375 | -639,393,408 | 223,254,192 | 9,092 |
| D | 150,565 | 180,976 | 2,858,514 | 0 | 662,409,472 | 11,992 |
| CE | 150,565 | 2,032,213 | 22,057,340 | 86 | 1,321,148,512 | 75,579 |
| EQ | 150,565 | 1,899,670 | 21,072,952 | 65,5 | 1,319,652,928 | 68,750 |
| DEBT | 150,565 | 773,372.74 | 7,250,563 | 0 | 434,225,776 | 18,710 |
| SALES | 150,565 | 3,157,959 | 26,164,089 | 360 | 2,605,370,624 | 330,205 |
| CE | 150,565 | 2,032,213 | 22,057,340 | 86 | 1,321,148,512 | 75,579 |
| HCE | 150,565 | 1.87 | 15.96 | 0 | 4,336 | 1.41 |
| CE | 150,565 | 0.23 | 4.19 | -1,000 | 1 | 0.29 |
| ICE | 150,565 | 2.10 | 16.53 | -1,000 | 4,337 | 1.70 |
| VAIC | 150,565 | 3.54 | 16.66 | -1,000 | 4,339 | 3.06 |
| ROA | 150,565 | 0.05 | 0.09 | -0.91 | 0,9 | 0.03 |
| STA | 150,565 | 1.90 | 1.59 | 0 | 79.76 | 1.55 |
| ROE | 150,565 | 0.13 | 0.21 | -1 | 1 | 0.08 |
| LEV | 150,565 | 0.92 | 3.53 | -32 | 380 | 0.23 |

**Table 2: Correlation coefficients estimates and their statistical significance**

| | ROA | STA | ROE | GROP | VAIC | HCE | SCE | CEE | SIZE | FLEV |
|---|---|---|---|---|---|---|---|---|---|---|
| **STA** | 0.1128 | 1 | | | | | | | | |
| | 0.0000*** | | | | | | | | | |
| **ROE** | 0.8234 | 0.1518 | 1 | | | | | | | |
| | 0.0005*** | 0.000*** | | | | | | | | |
| **GROP** | -0.0089 | -0.0051 | -0.0072 | 1 | | | | | | |
| | 0.0005*** | 0.0503 | 0.0053** | | | | | | | |
| **VAIC** | 0.0431 | 0.0268 | 0.0556 | -0.0002 | 1 | | | | | |
| | 0.0000*** | 0.0000*** | 0.0000*** | 0.9531 | | | | | | |
| **HCE** | 0.0271 | -0.0098 | 0.0273 | -0.0002 | 0.9585 | 1 | | | | |
| | 0.0000*** | 0.0001*** | 0.0000*** | 0.9387 | 0.0000*** | | | | | |
| **SCE** | 0.0548 | 0.0016 | 0.05 | 0.0001 | 0.2583 | 0.0065 | 1 | | | |
| | 0.0000*** | 0.5269 | 0.0000*** | 0.965 | 0.0000*** | 0.0121* | | | | |
| **CEE** | 0.0247 | 0.2699 | 0.1272 | -0.0004 | 0.1278 | -0.006 | 0.0035 | 1 | | |
| | 0.0000*** | 0.0000*** | 0.0000*** | 0.8875 | 0.0000*** | 0.0191* | 0.1785 | | | |
| **SIZE** | 0.0675 | -0.2678 | 0.0026 | -0.0083 | -0.022 | 0.0105 | 0.0108 | -0.2636 | 1 | |
| | 0.0000*** | 0.0000*** | 0.3104 | 0.0013** | 0.0000*** | 0.0000*** | 0.0000*** | 0.0000*** | | |
| **FLEV** | -0.0792 | -0.079 | -0.0034 | 0.0012 | 0.0299 | 0.0097 | 0.0024 | 0.1511 | -0.0304 | 1 |
| | 0.0000*** | 0.0000*** | 0.1906 | 0.6457 | 0.0000*** | 0.0002*** | 0.3471 | 0.0000*** | 0.0000*** | 0.0000*** |

*Significance: *** if p < 0.001, ** if p < 0.01, * if p < 0.05*

**Table 3: Results of models tests using OLS regression method**

*MODEL H1a (ROA)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.000 | 0.000 | 1.81 | 0.070 |
| SIZE | 0.003 | 0.001 | 12.15 | 0.000*** |
| FLEVERAGE | -0.002 | 0.000 | -5.26 | 0.000*** |
| INTERCEPT | 0.013 | 0.003 | 3.90 | 0.000*** |
| R-square | 0.013 | | | |
| F-value | 60.290 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.00 | | | |

*MODEL H1c (ROE)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.001 | 0.000 | 1.78 | 0.075 |
| SIZE | 0.000 | 0.002 | -0.80 | 0.438 |
| FLEVERAGE | 0.000 | 0.000 | -1.16 | 0.245 |
| INTERCEPT | 0.122 | 0.006 | 17.99 | 0.000*** |
| R-square | 0.003 | | | |
| F-value | 1.44 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.00 | | | |

*MODEL H1b (STA)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.002 | 0.001 | 1.59 | 0.111 |
| SIZE | -0.237 | 0.006 | -40.70 | 0.000*** |
| FLEVERAGE | -0.040 | 0.006 | -6.34 | 0.000*** |
| INTERCEPT | 4.657 | 0.073 | 63.74 | 0.000*** |
| R-square | 0.078 | | | |
| F-value | 561.590 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.00 | | | |

*MODEL H1d (GROP)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | -0.015 | 0.022 | -0.66 | 0.512 |
| SIZE | -2.627 | 1.466 | -1.79 | 0.073 |
| FLEVERAGE | 0.155 | 0.086 | 1.80 | 0.072 |
| INTERCEPT | 27.39 | 15.52 | 1.76 | 0.078 |
| R-square | 0.000 | | | |
| F-value | 1.200 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.00 | | | |

*MODEL H2a, (ROA) H3a, H4a*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.000 | 0.000 | 1.73 | 0.083 |
| SCE | 0.001 | 0.000 | 2.50 | 0.012* |
| CEE | 0.002 | 0.000 | 3.56 | 0.001** |
| SIZE | 0.004 | 0.001 | 11.62 | 0.053 |
| FLEVERAGE | -0.002 | 0.000 | -5.25 | 0.000*** |
| INTERCEPT | 0.002 | 0.005 | 0.41 | 0.681 |
| R-square | 0.017 | | | |
| F-value | 38.260 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.04 | | | |

*MODEL H2b, (STA) H3b, H4b*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | -0.001 | 0.000 | -1.66 | 0.097 |
| SCE | 0.001 | 0.001 | 1.36 | 0.175 |
| CEE | 0.167 | 0.046 | 3.62 | 0.000*** |
| SIZE | -0.184 | 0.143 | -12.92 | 0.000*** |
| FLEVERAGE | -0.541 | 0.094 | -5.76 | 0.000*** |
| INTERCEPT | 3.833 | 0.225 | 17.04 | 0.000*** |
| R-square | 0.129 | | | |
| F-value | 383.220 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.04 | | | |

*MODEL H2c, (ROE) H3c, H4c*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.000 | 0.000 | 1.69 | 0.091 |
| SCE | 0.002 | 0.001 | 2.45 | 0.012* |
| CEE | 0.135 | 0.004 | 3.65 | 0.000*** |
| SIZE | 0.004 | 0.001 | 3.66 | 0.000*** |
| FLEVERAGE | -0.001 | 0.000 | -3.10 | 0.000*** |
| INTERCEPT | 0.058 | 0.019 | 3.13 | 0.000*** |
| R-square | 0.021 | | | |
| F-value | 4.820 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.04 | | | |

*MODEL H2d, (GROP) H3d, H4d*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | -0.005 | 0.011 | -0.46 | 0.649 |
| SCE | 0.030 | 0.062 | 0.47 | 0.731 |
| CEE | -0.767 | 0.659 | -1.16 | 0.636 |
| SIZE | -2.869 | 1.596 | -1.80 | 0.075 |
| FLEVERAGE | 0.223 | 0.136 | 1.64 | 0.245 |
| INTERCEPT | 31.164 | 17.56 | 1.78 | 0.076 |
| R-square | 0.000 | | | |
| F-value | 0.880 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.04 | | | |

*Significance:* *** *if* $p < 0.001$ ** *if* $p < 0.01$ * *if* $p < 0.05$

The correlation matrix shows that correlations between dependent and independent variables are weak and that a fairly large proportion of correlation coefficients are statistically insignificant. That is particularly true for GROP dependent variables: all GROP correlation coefficients are statistically insignificant, except the correlation coefficient between GROP and SIZE variables. Correlation coefficients between FLEV and ROE, SIZE and ROE and SCE and STA are also statistically insignificant. In our hypotheses, we assume a positive correlation between dependent and independent variables. A positive sign of the majority of correlation coefficients has been proven as an appropriate assumption.

## OLS Regression Method

Table 3 represents the results of OLS regression estimation for all models and all included variables. Using the OLS regression method, the estimation of *H1c, H1d, H2d, H3d* and *H4d* models indicates that these models are not statistically significant; therefore, we cannot confirm corresponding hypotheses. All other models have very high statistical significance. Despite this, almost all individual HCE and SCE β coefficients are not statistically significant. The results of the models' estimations are presented in Table 3. For all estimated models, the VIF factor is within the 1.01 and 1.04 range, which indicates that the multi-collinearity (among explanatory variables) is very low and does not affect the results of our analysis. A VIF factor over 10 indicates strong multi-collinearity, while a VIF factor equal to 1 indicates no multi-collinearity among the explanatory variables (Cameron and Trivedi, 2009).

As we mentioned in previous sections of this paper, the time series of the data of the majority of similar studies are relatively short. In most cases, studies cover a period from one to three years in different phases of the global economic cycle. As this could be a potential source of bias in comparing results of those studies, we conduct additional demonstrative research. For selected years that indicate different phases of the last global economic cycle (2001–2008), we perform a cross-sectional analysis on our data set using the OLS regression method. In all three years, the data set consists of the same companies as the original data set. For demonstration purposes, we test a model with ROE (*H2c, H3c, H4c*) as a dependent variable. In Table 4, we represent test results in different time periods. All results shown in Table 4 are very highly statistically significant.

**Table 4: Results of cross-sectional analysis in different years using OLS regression method**

*MODEL H2c, H3c, H4c* *($ROE_{2004}$)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.017 | 0.004 | 3.51 | 0.000*** |
| SCE | 0.167 | 0.025 | 6.73 | 0.000*** |
| CEE | 0.108 | 0.015 | 4.25 | 0.000*** |
| SIZE | 0.001 | 0.000 | 9.40 | 0.000*** |
| FLEV | -0.003 | 0.000 | 4.25 | 0.000*** |
| INTERCEPT | -0.066 | 0.014 | 3.13 | 0.000*** |
| R-square | 0.31 | | | |
| F-value | 136.38 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.04 | | | |

*MODEL H2c, H3c, H4c* *($ROE_{2007}$)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.001 | 0.036 | 6.39 | 0.000*** |
| SCE | 0.239 | 0.031 | 7.86 | 0.000*** |
| CEE | 0.067 | 0.011 | 5.90 | 0.000*** |
| SIZE | 0.020 | 0.001 | 2.85 | 0.000*** |
| FLEV | 0.003 | 0.000 | 6.52 | 0.000*** |
| INTERCEPT | -0.025 | 0.015 | -2.85 | 0.000*** |
| R-square | 0.200 | | | |
| F-value | 35.75 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.03 | | | |

*MODEL H2c, H3c, H4c* *($ROE_{2008}$)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.014 | 0.002 | 7.86 | 0.000*** |
| SCE | 0.116 | 0.016 | 7.08 | 0.000*** |
| CEE | 0.027 | 0.009 | 2.99 | 0.003** |
| SIZE | 0.002 | 0.000 | 2.56 | 0.000*** |
| FLEV | -0.001 | 0.000 | -3.51 | 0.000*** |
| INTERCEPT | 0.018 | 0.001 | 5.72 | 0.000*** |
| R-square | 0.1350 | | | |
| F-value | 22.21 | | | |
| N (obs) | 150,565 | | | |
| Mean VIF | 1.02 | | | |

*Significance: *** if p < 0.001 ** if p < 0.01 * if p < 0.05*

As we can see from Table 4, a cross-sectional analysis shows significant fluctuations in the size of the coefficients of determination and in the size of SCE regression coefficients. If the model in 2004 explained 31% of the variability of the dependent variable, the explanatory power of the model in 2007 diminishes to only 20% and to only 14% in the recession year of 2008. The results of the presented additional demonstrative research will be analyzed in-depth in the concluding section of this paper.

**Panel regression method with fixed-effects**

Before applying panel data regression models estimation, we provide a test exploring which panel regression method is more effective. Hausman's test indicates that the fixed-effects method appears to be more meaningful and effective for all testing models. The estimates of models designed to test H1d, H2d, H3d and H4d hypotheses show the models not to be statistically significant. Given that the majority of regression coefficients within those models are also statistically insignificant, we cannot confirm the hypotheses that assume that the dependent variable GROP is positively related to HCE, CEE and SCE.

Although the correlation analysis did not provide conclusive results, the estimations with the panel regression method offer somewhat different results. All coefficients of determination estimated on the model level (excluding GROP models) are very highly statistically significant. Despite the very high statistical significance, the explanatory power of the models is low. The lowest explanatory power is demonstrated by models that include the VAIC as an explanatory variable. Slightly better explanatory power is indicated by other models. The highest explanatory power is represented by the H2b, H4b H3B models, which estimate the relationship between the HCE, SCE, CEE explanatory variables and the STA as an independent variable. The coefficient of determination shows that the variability of independent variables explains 9.2% of the variability of the dependent variable STA. All other coefficients of determination are even lower. Their explanatory power varies between 0.2% and 8%. If we compare the explanatory power of our models (both OLS regression and panel regression estimations) with the explanatory power of models in similar studies, we can conclude that it is far below average. In a similar study on a sample of 80 Taiwanese high-tech companies' financial statements for the 2003 fiscal year, carried by Shiu (2006), the explanatory power of models ranges between 40.20% and 79.46%. The study estimates the correlation between CEE, and HCE as independent variables and ROA and market value of equity as dependent variables. In Chan's study (2009), the estimated explanatory power of similar models executed on a sample of 33 Hong Kong companies from the HSI stock exchange index stood at 14.9%. Firer and Williams (2003) conducted research on a population of 75 high-tech companies from South Africa, and found that the explanatory power of models that explored the effect of IC investment efficiency on a financial performance of companies ranged between 4.8% and 43.5%. Within their research, the lowest explanatory power was found in the model in which return on assets (ROA) was explained by IC investment efficiency, and the highest in the model explaining the market value of companies.

**Interpretation of test results**

In spite of very high statistical significance, the low coefficients of determination characterize the goodness of fit of the VAIC model as being below our expectations. The estimated regression coefficients present a similar picture with the majority confirming the hypotheses regarding the signs of the coefficients between independent and dependent variables. The estimated dependencies are also very highly statistically significant. The majority of the reported regression coefficients between dependent and independent variables are positive. However, we indicate a large gap between the statistical and economic interpretation of research findings. Regarding the explanatory power of models and the estimated influence of explanatory variables, the results of the research have limited economic meaning since the majority of estimated regression coefficients are low. A tangible asset efficiency coefficient (CEE) shows the strongest influence on the dependent variables. The dominant influence of CEE is directly comparable to results of several similar VAIC-based studies (Chan 2009, Firer and Williams, 2003; Hurwitz, 2002; Shiu 2006). Such conclusions can be the cause of some debate regarding VAIC model assumptions and are in conflict with the expected results of our research. We presumed IC to have a dominant impact on financial performance of the companies. Tangible assets' prevalent effect on financial performance is comparable to the findings of studies that explore the relationship between IC and the market value of companies. Firer and Williams (2003) attribute the CEE dominance to the fact that investors in South Africa still prefer companies with a strong tangible assets background. Similarly, Shiu (2006) attributes the prevalence of the CEE variable to the traditional

 

performance-monitoring systems in Taiwan, while Chan (2009) attributes the dominant role of tangible assets to prevailing classical valuation models based on tangible assets, which are still preferred by investors.

**Table 5: Results of models tests using panel regression method**

*MODEL H1a (ROA)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.000 | 0.000 | 15.92 | 0.000*** |
| SIZE | 0.002 | 0.000 | 5.18 | 0.000*** |
| FLEV | -0.001 | 0.000 | -17.74 | 0.000*** |
| INTERCEPT | 0.028 | 0.004 | 6.58 | 0.000*** |
| R-square | 0.013 | | | |
| F-value | 200.40 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H1c (ROE)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.000 | 0.000 | 14.71 | 0.000*** |
| SIZE | -0.042 | 0.000 | -46.88 | 0.000*** |
| FLEV | -0.003 | 0.000 | -15.69 | 0.000*** |
| INTERCEPT | 0.613 | 0.010 | 59.40 | 0.000*** |
| R-square | 0.004 | | | |
| F-value | 863.700 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H1b (STA)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | 0.001 | 0.000 | 3.40 | 0.000*** |
| SIZE | -0.663 | 0.004 | -145.6 | 0.000*** |
| FLEV | -0.045 | 0.001 | -44.20 | 0.000*** |
| INTERCEPT | 9.586 | 0.052 | 181.77 | 0.000*** |
| R-square | 0.08 | | | |
| F-value | 7,398.88 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H1d (GROP)*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| VAIC | -0.005 | 0.092 | -0.05 | 0.957 |
| SIZE | 8.34 | 2.635 | 3.17 | 0.002 |
| FLEV | 0.421 | 0.591 | 0.72 | 0.473 |
| INTERCEPT | -99.454 | 30.506 | -3.26 | 0.001** |
| R-square | 0.002 | | | |
| F-value | 0.016 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H2a, (ROA) H3a, H4a*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.000 | 0.000 | 9.01 | 0.000*** |
| SCE | 0.001 | 0.000 | 16.79 | 0.000*** |
| CEE | 0.003 | 0.000 | 28.49 | 0.000*** |
| SIZE | 0.004 | 0.000 | 12.05 | 0.000*** |
| FLEV | -0.002 | 0.000 | -20.51 | 0.000*** |
| INTERCEPT | -0.008 | 0.004 | -1.73 | 0.083 |
| R-square | 0.016 | | | |
| F-value | 307.470 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H2b, (STA) H3b, H4b*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.000 | 0.000 | -2.28 | 0.022 |
| SCE | 0.002 | 0.000 | 4.01 | 0.000*** |
| CEE | 0.073 | 0.001 | 45.18 | 0.000*** |
| SIZE | 0.047 | 0.004 | -129.4 | 0.000*** |
| FLEV | -0.414 | 0.001 | -48.94 | 0.000*** |
| INTERCEPT | 8.842 | 0.055 | 161.05 | 0.000*** |
| R-square | 0.092 | | | |
| F-value | 4,916.62 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H2c, (ROE) H3c, H4c*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | 0.000 | 0.000 | 7.06 | 0.000*** |
| SCE | 0.002 | 0.000 | 15.12 | 0.000*** |
| CEE | 0.012 | 0.000 | 39.82 | 0.000*** |
| SIZE | -0.032 | 0.000 | -35.37 | 0.000*** |
| FLEV | -0.003 | 0.000 | -19.69 | 0.000*** |
| INTERCEPT | 0.489 | 0.000 | 45.47 | 0.000*** |
| R-square | 0.003 | | | |
| F-value | 856.34 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

*MODEL H2d, (GROP) H3d, H4d*

| Independent variable | Coefficients (β) | SE | t-value | p |
|---|---|---|---|---|
| HCE | -0.001 | 0.095 | -0.02 | 0.986 |
| SCE | -0.015 | 0.350 | 0.04 | 0.966 |
| CEE | -0.245 | 0.937 | -0.26 | 0.794 |
| SIZE | 8.154 | 2.733 | 2.98 | 0.003 |
| FLEV | 0.440 | 0.594 | 0.74 | 0.459 |
| INTERCEPT | -96.98 | 31.996 | -3.03 | 0.002** |
| R-square | 0.000 | | | |
| F-value | 0.067 | | | |
| N (obs) | 150,565 | | | |
| Hausman Prob>chi2 | 0.000 | | fixed-effects | |

**** if p < 0.001, ** if p < 0.01, * if p < 0.05*

Comparing our study with other similar studies, the significance tests of our models are above average. Other researchers experience mixed statistical tests. Most of them report sharp fluctuations in the explanatory power of the models and beta coefficient signs contrary to their expectations. In contrast, the explanatory power of our models and beta coefficients signs are fully in line with established hypotheses. The problem emerges with the practical application of the test results. We discuss possible reasons for the presented discrepancies in conclusion of this paper.

**VAIC model test on ranked data**

The basic premise of residual valuation models is that of an economic production function (Gu and Lev, 2001), whereby the earnings of a company are related to the assets that generate those earnings. Three groups of assets are recognized: physical, financial and intangible (IC). To isolate the earnings generated by IC, subtract the contribution of physical and financial assets from normalized earnings: the residual is the IC-driven earnings (Lev, 2005). The estimated returns on physical assets are calculated from sector- or industry-wide data. The final phase of the IC evaluation includes computation of the present value of the expected stream of IC-driven earnings. To resume: a part of financial performance of the company that exceeds the average financial performance of the peer group is a result of the intellectual potential of the company and creates IC value. The most well-known residual evaluation models are "Economic Value Added", known as the "EVA model" (Stewart, 1997), the "Calculated Intangible Value", known as the "CIV model" (Dzinkowski, 2000) and the "Comprehensive Value model", known as the "CV model" (Lev, 2001).

As we have already emphasized, the primary goal of our research is to find IC investment efficiency indicators that will show some impact on the financial performance of companies. If this assumption holds, these indicators can be further tested as potential leading indicators of companies' future financial performance. Our assumption is aligned with residual valuation models and states that if IC efficiency positively influences company's financial performance and if company's IC above-average efficiency (in comparison with peer group companies) corresponds with the company's above-average financial performance, then the above-average IC efficiency can serve as an indicator of the existence of company's IC. For IC efficiency to generate the value of the company's IC, it is inevitably sustainably above the peer group average. This can only be achieved if the intellectual potential of the company includes the company's ability to sustainably efficiently adapt in a changing business environment. This ability of the company is known as the company's adaptive efficiency (North, 1990). Adaptive efficiency is a concept implicitly built into residual evaluation models, and represents the ability of companies to sustainably transform their intellectual potential into (above-average) financial results and thus into the companies' (above-average) value. In other words, residual valuation models assume that companies with sustainable above-average investment efficiency have above-average financial performance, and thereby create above-average value of the company. This value surplus created by intellectual potential of the company is the value of the company's IC.

As an addition to our initial VAIC model test, we conduct a test that explores whether the VAIC model's basic assumptions are in line with the described assumptions of residual valuation models. Before conducting this test, we grouped companies from our original data set by sector criteria and then ranked them within sectors according to the value of each variable from the VAIC model. For example: if a firm in a particular sector in a given year exhibited the highest value of the HCE variable, the company was ranked as 1$^{st}$, the company with the second highest value of HCE variable was ranked as 2$^{nd}$, etc. The ranking was performed for each year, each sector and each variable separately. According to residual models, the creation of IC value depends on its above-average financial performance, which is (according to our assumption) a result of above-average IC investment efficiency. In order to test this assumption on companies, we develop the following hypothesis:

**H2:** Change in a company's IC investment efficiency rank induces a change in its financial performance rank within the sector.

If our hypothesis is valid, then explanatory variables (HCE rank, CEE rank and SCE rank) should show a certain level of influence on dependent variables (ROA rank, STA rank, ROE rank and GROP rank). To test this hypothesis, we used the same VAIC-based models as in our primary test. The only difference is that the original variables values are replaced with their rank values. To test the models, we use the same procedures and regression

 

models as in our primary test. First, we analyze the correlation matrix results and then extend our research with the OLS regression method and panel regression method. Using the panel regression method, Housman's test suggests that the fixed effects method is more efficient than the random effects method for all models estimations.

Correlation analysis reveals that correlations among ranked variables are substantially higher than correlations among variables in our primary research. The highest explanatory power is indicated in models in which the ROE rank serves as a dependent variable. For example: change in the VAIC rank explains 58% of the STA rank variability, 61% of the GROP rank variability, 67% of the ROA rank variability and 75% of the ROE rank variability.

The results of tests using OLS and panel regression methods indicate that all models (except model *H1d*, which is statistically insignificant) have proven to be of high statistical significance. The same applies to the regression coefficients. All models have explanatory power, which is significantly higher than in the primary test. The majority of coefficients of determination ($R^2$) exceed 48%. The lowest explanatory power is reported in models that include the independent variable VAIC rank, which is very similar to the base model testing results. The highest explanatory power is reported in models where the ROE rank variable serves as a dependent variable. If we compare the estimated regression coefficients values to those estimated in our primary research, we see that the HCE rank and SCE rank have a significantly greater impact on the dependent variable than the tangible asset efficiency rank (CEE rank), while the control variable rank FLEV and rank SIZE show a significantly smaller impact on the dependent variable. According to the test results, we can assume that there is a strong positive causal relationship between changes in the IC investment efficiency rank and changes in the financial performance rank of companies. This means that the relative improvement in the IC investment efficiency of the company within the sector induces a positive relative change in the financial performance of the company within the sector and thus increases the value of the company. In other words, there is a positive causal link between IC investment efficiency improvement and improvement in the financial performance and thus value of the company. If the company's IC investment efficiency is above the peer group's average, there is a high probability that its financial results are above average. Above-average financial results of the company contribute to above-average IC investment efficiency and create IC value.

The test results of the VAIC model performed on ranked data demonstrate that the VAIC model independent variables HCE, SCE and CEE can serve as a starting point of a research process within which we would like to develop a heuristic model designed to help as a leading indicator of the future financial performance of companies. However, before extending our research it is necessary to critically challenge the basic VAIC model assumptions and its theoretical background with the goal of elevating its explanatory power. Complete results of the test conducted on ranked data are available upon request.

## CONCLUSION

In an attempt to define potential ways of improving the VAIC model's explanatory power, we should primarily discuss possible reasons why such large differences in results between VAIC-based studies, which are methodologically and substantively very similar, emerge. There are probably several answers to this question.

The most fundamental reason for differences in results could be that the vast majorities of studies using the VAIC model are regionally limited and include companies only from specific countries and sectors. In some studies, samples are even narrower, reduced to a group of companies listed on local stock exchanges. Reviewing similar studies, we do not observe results being controlled for differences in economic systems, tax systems, economic structure, accounting systems, culture, etc. Most studies are performed on relatively small samples that are mostly selected by the criteria, such as size, sector, inclusion in a stock exchange index, etc. Samples composed only of listed companies are probably not a representative sample of the national economy; generalizing the results of such narrowly focused research to the companies throughout an entire national economy is questionable. This is especially true for countries where the structure of listed companies is significantly different from the national economic structure. Similarly, it is not appropriate to generalize the results across companies from different sectors. In most cases, the value creation process is heavily influenced by sector-specifics. Differences in studies' results may also occur due to differences in sample-selecting methods. In some cases, a potentially biased sample selection process may result in a sample that does not adequately reflect the characteristics of the sector as a whole. One

especially important dilemma remains whether locally relevant research results can be uncritically transferred to the sectors of other countries for comparison purposes as peer-group results. The comparison and interpretation of the results of methodologically consistent but locally oriented studies needs a great deal of attention and prudence.

The second important drawback refers to research methodology. Most studies exploring the link between IC investment efficiency and financial performance are based on a cross-sectional analysis methodology. IC investment efficiency, by definition, cannot be a one-year or two-year concept. As with all other investments, IC investments do not affect the financial performance of the company merely in the same single fiscal year that they are executed. This is the crucial point of mismatch between IC researchers who use the VAIC model for exploring IC value creation, and the business appraisers' community using classical valuation models. Figuratively speaking, the IC VAIC community is mostly short-term and cross-sectionally oriented, while the business appraisers' community is long-term and longitudinally oriented. A characteristic of the IC transformation process is theoretically explained in Nonaka's study (1995) of the knowledge transformation processes. These processes are an undoubtedly a long-term phenomenon, within which knowledge in organizations is constantly accumulated and is constantly transforming through time. A knowledge-based process of value creation is consequently a process of efficient investments in key tangible and intangible value drivers that will be reflected in the financial performance of the company through a longer period of time. If the performance of the company is below average, it means that the company's intellectual potential has not managed to transform the company's accumulated knowledge into an (above-average) business performance. According to the doctrine of residual valuation models in companies that exhibit below-average financial performance, the value of IC does not exist. If the company demonstrates average financial performance, the value of IC in this firm should be equal to zero, and if the financial result is above average, company creates so-called "hidden value" or "invisible capital". A company's IC Value becomes "visible" through transactions on a stock exchange or through mergers-and-acquisitions transactions. According to equity valuation methods (Copeland 1996, Pratt 2008, Reilly 1994), the intrinsic value of a firm's equity represents a net present value of future benefits (cash flows) to the owner of capital generated by the company. There are three key elements of future benefits: the value of benefits, their risks and their distribution in time. Time is therefore an important component of the intrinsic value of a company's equity. Valuation practice (Pratt, 2008) indicates that investors consider the company's value using the expected cash flow projections for several years in advance. Under the going concern assumption, they also add a residual value, which assesses the current value of the potential cash flows after the period of exact cash flow projections. The time period for residual calculations is rarely limited. Thus, within a business valuation process, investors are usually assessing company's cash flow for an unlimited period of time (perpetuity). All estimated benefits are discounted by the required rate of return, which in principle demonstrates the investor's investment risk. The intrinsic value of a company (and thus indirectly the value of IC) is therefore the concept of the discounted benefit's aggregation that the company generates almost indefinitely. It is important to emphasize that usually more than 50% of the calculated intrinsic value of company results from the residual (Pratt, 2008). In other words, more than 50% of the company is derived from something that will be generated in a period eight and more years in the future. In contrast, the conclusions from the cross-sectional VAIC studies are usually based on relatively short-period data sets (one to three years, on average). However, we have a "contradictio in adiecto" situation. Most VAIC-based studies try to assess, indicate or evaluate intellectual capital as a short-term period phenomenon even though the value of IC or indication of IC presence in a company can only be evaluated (and indicated) from the longer-term (above average) financial benefits produced by the company. In our study, we bridge the gap between typical VAIC methodology implementation and basic valuation principles by extending the research period to fourteen years (1995–2008).

Another important factor that influences the estimated explanatory power of models is the phase of the business cycle captured by the research. Studies conducted in different phases of the economic cycle are hardly comparable. An assumption that economic cycles have an impact on the IC value opens an exceptionally interesting and wide field of study that includes the study of economic cycles, capital markets movements, behavioral finance, etc. Expanding our research area at this time is beyond the scope of our research, but it opens up new challenging research questions about new potential aspects of IC. The business cycle is especially important when dealing with studies based on short-period data sets. Possible links between the equity market values and book values were elaborated in Soler's research (2007), which study presents the impact of an economic cycle on the market value of IC. Soler hypothesizes that IC value is partially linked to the cyclical movement of the economy, and that if we study IC within the time periods that do not cover the full economic cycle (periods of upswing and downturn), the

 

results of such research could be biased. To illustrate the potential business cycle's impact on IC investment efficiency, we compare the results of cross-sectional regression analysis for different representative years during 2001–2008 business cycle, 2004 represents the period of early recovery in the global economy; 2007 represents the late boom phase, and 2008 represents a period of recession in the global economy. Our indicative cross-sectional analysis shows significant fluctuations in the size of the coefficients of determination and in the size of regression coefficients in various years. We think that it is necessary to be extremely careful when comparing the results of various tests carried out at different time periods on different populations, especially when dealing with cross-sectional analysis. Contrary to the majority of VAIC-based studies, the IC investment efficiency phenomenon needs to be examined through both longitudinal and cross-sectional analyses. The results of the short-term analyses may be controversial in terms of their temporal stability and potential comparability. If the analysis is based on a short-term data set, a company's value drivers could be exposed to unusual swings in external factors not controlled by the research models. Such variations may partly be neutralized by lengthening the period under examination, but they should not be excluded from the analysis. The value of IC is not just a "good times" phenomenon; on the contrary, companies with an above average level of IC should in the long run be able to turn negative external shocks into their advantage. It should be noted that the cyclical movements of the Slovenian economy are not entirely comparable with global economic trends in last twenty years due to the fact that Slovenia followed specific transitory path as a former socialist economy.

By analyzing possible reasons for the differences in the results of similar studies, we challenge the methodological approaches of other authors as described above. However, in our opinion it is not enough only to improve the explanatory power of the VAIC model by aligning research methodology. Future research should focus on the following directions:

- As the VAIC model has weak theoretical background, it should be placed in a different and more consistent theoretical framework. The New Growth Theory (Romer, 1990) seems to be the proper theoretical background, as it incorporates two important points. First, it views technological progress as a product of economic activity and second, it holds that unlike physical objects, knowledge and technology are characterized by increasing returns, and these increasing returns drive the process of growth. Such an assumption is in line with the VAIC model idea. As New Growth Theory helps us make sense of the ongoing shift from a resource-based economy to a knowledge-based economy, it appears that the VAIC model should be rethought taking this theory into consideration. Neoclassical theory serves as a core theoretical background of the VAIC model. The point here is not that this theory is wrong but that it is incomplete.
- We also challenge the "linearity" assumption of the model. Within the VAIC model, all IC components are linearly connected. However, the potential for ideas (IC) to change things is enormous and we definitely cannot describe this potential as linear. The future research should be aimed at changing the linearity assumption of the model with multiplicative types of connections among IC components.
- The derivation of structural capital (SC) appears as one of the weakest points of the VAIC model. It lacks a firm economic explanation. If we simplify the interpretation of the SCE indicator, we can say that it explains how much value added is generated by residual of value added after subtracting labor costs. Future research should answer the question of whether the artificial division of the intellectual potential of the company into two components (HC and SC) within the VAIC model is reasonable.
- Furthermore, we believe that IC is a long-term concept and should be analyzed with an appropriate statistical toolkit. As a most widely used method, the OLS regression method has serious shortcomings. Cross-sectional analysis should not be in the center of researchers' interest, because IC appears to be a longer-term concept. Cross-sectional analysis is very sensitive to external factors, such as business cycles, and reveals only a small part of information about the IC relation with the financial performance of companies. It is necessary to add a longitudinal perspective to studying IC. We tested VAIC by using the panel regression method, which diminishes OLS regression shortcomings, while simultaneously enabling us to analyze IC from both the cross-sectional and longitudinal perspective.

Without a solid basic VAIC model, all its further extensions are of limited use. Statistically and economically reasonable results of the rank-based VAIC model test encourage us to proceed with conceptual and empirical research. The basic logic behind the VAIC model appears to be compelling and suitable for research

purposes. However, the results of the tests conducted by the VAIC model are inconclusive. To proceed with additional empirical research, the VAIC model needs to be rethought from its theoretical perspective and aligned with new findings in the research of the knowledge economy. The VAIC model has its weaknesses, but its important advantages (especially when dealing with companies from countries without established capital markets) encourage us to rethink the model and improve its usefulness. Some results in our study suggest that this is worthwhile endeavor.

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## REFERENCES

1. Andriessen, D. (2001). Weightless wealth: four modifications to standard IC theory. *Journal of Intellectual Capital, 2*(3), 204 - 214.
2. Andrikopoulos, A. (2005). The real-options approach to intellectual capital analysis: a critique. *Knowledge & Process Management, 12*(No. 3), 14-25.
3. Andriessen, D. (2004). Reconciling the rigor-relevance dilemma in intellectual capital research. *The Learning Organization, 11*(4/5), 393 - 401.
4. Andriessen, D. (2006). On the metaphorical nature of intellectual capital: a textual analysis. *Journal of Intellectual Capital, 7*(1), 93 - 110.
5. Appuhami, B. A. R. (2007). The impact of intellectual capital on investors' capital gains on shares: an empirical investigation of Thai banking, finance and insurance sector. *International Management Review, 3*(2), 14-25.
6. Arenas, T., & Lavanderos, L. (2008). Intellectual capital: object or process? *Journal of Intellectual Capital, 9*(1), 77 - 85.
7. Bontis, N. (1999). Managing an Organizational Knowledge by Diagnosing Intellectual Capital: Framing and Advancing the State of the Field. *International Journal of Technology Management, 18*(5/6/7/8), 433-462.
8. Bontis, N. (2000). Assessing Knowledge Assets: a review of the models used to measure intellectual capital. *Journal*, 21

9. Bontis, N., & Nikitopoulos, D. (2001). Thought leadership on intellectual capital. *Journal of Intellectual Capital, 2*(3), 183 - 191.
10. Bornemann, M., Knapp, A., Schneider, U., Sixl, K.I. (1999). Holistic measurement of intellectual capital. Paper presented at the International Symposium: measuring and reporting Intellectual capital: experiences, Issues and Prospects. from www.oecd.org/dataoecd/16/20/1947871.pdf
11. Bose, S., & Oh, K.-B. (2003). An empirical evaluation of option pricing in intellectual capital. *Journal of Intellectual Capital, 4*(3), 382 - 395.
12. Bose, S., & Oh, K. B. (2004). Measuring strategic value-drivers for managing intellectual capital. *The Learning Organization, 11*(4/5), 347 - 356.
13. Bose, S., & Thomas, K. (2007). Valuation of intellectual capital in knowledge-based companies: The need for new methods in a changing economic paradigm. *Management Decision, 45*(9), 1484 - 1496.
14. Bukh, P. N. (2003). The relevance of intellectual capital disclosure: a paradox? *Accounting, Auditing & Accountability Journal, 16*(1), 49 - 56.
15. Caddy, I. (2000). Intellectual capital: recognizing both assets and liabilities. *Journal of Intellectual Capital, 1*(2), 129 - 146.
16. Cameron, A. C., Trivedi, P.K. (2009). *Microeconometrics Using STATA*. Colle Station, Texas: StataCorp LP.
17. Chaminade, C., Roberts, H. . (2003). What it means is what it does: a comparative analysis of implementing intellectual capital in Norway and Spain. *European Accounting Review, 12*(4), 733-751.
18. Chan, K. H. (2009). Impact of intellectual capital on organizational performance: An empirical study of companies in the Hang Seng Index (Part 2). *The Learning Organization, 16*(1), 22 - 39.
19. Chang, J.-R., Hung, M.-W., & Tsai, F.-T. (2005). Valuation of intellectual property: A real option approach. *Journal of Intellectual Capital, 6*(3), 339 - 356.
20. Chen, M.-C., Cheng, S.-J., & Hwang, Y. (2005). An empirical investigation of the relationship between intellectual capital and companies' market value and financial performance. *Journal of Intellectual Capital, 6*(2), 159 - 176.
21. Chen, S. (2003). Valuing intellectual capital using game theory. *Journal of Intellectual Capital, 4*(2), 191 - 201.
22. Chen, S. (2003). Valuing intellectual capital using game theory. *Journal of Intellectual Capital, 4*(2), 191 - 201.
23. Cheng, M.-Y., Lin, J.-Y., Hsiao, T.-Y., & Lin, T. W. (2008). Censoring model for evaluating intellectual capital value drivers. *Journal of Intellectual Capital, 9*(4), 639 - 654.
24. Deol, H. S. (2009). Strategic environment and intellectual capital of Indian banks. *Journal of Intellectual Capital, 10*(1), 109 - 120.
25. Copeland, T. E., Weston, J.F., Shastri, K. (1996-2004). *Financial Theory and Corporate Policy* (4 ed.): Addison Wesley.
26. Dzinkowski, R. (2000). The measurement and management of intellectual capital: an introduction. *Management Accounting Vol. 72*(No. 2), 32-36.
27. Edvinsson, L., Malone, M.S. (1997). Intellectual Capital: Realizing your Company's True Value by Finding Its Hidden Brainpower. *Harper Business, New York, NY.*
28. Edvinsson, L. (2000). Some perspectives on intangibles and intellectual capital 2000. *Journal of Intellectual Capital, 1*(1), 12 - 16.
29. Firer, S., & Williams, S. M. (2003). Intellectual capital and traditional measures of corporate performance. *Journal of Intellectual Capital, 4*(3), 348 - 360.
30. Fincham, R. a. R., R. (2003). Intellectual accounting as management fashion: a review and critique. *European Accounting Review, 12*(4), 781-795.
31. Ghosh, D., & Wu, A. (2007). Intellectual capital and capital markets: additional evidence. *Journal of Intellectual Capital, 8*(2), 216 - 235.
32. Goh, P. C. (2005). Intellectual capital performance of commercial banks in Malaysia. *Journal of Intellectual Capital, 6*(3), 385 - 396.
33. Gu, F., Lev, Baruch (2001). Intangible Assets: Measurement, Drivers, Usefulness. *Journal*, 32
34. Guthrie, J. (2001). The management, measurement and the reporting of intellectual capital. *Journal of Intellectual Capital, 2*(1), 27 - 41.

35. Hand, B. L. (Ed.). (2003). *Intangible Assets: Values, Measures, and Risks*. New York: Oxford University Press.
36. Hurwitz, J., Lines, S., Montgomery, B., & Schmidt, J. (2002). The linkage between management practices, intangibles performance and stock returns. *Journal of Intellectual Capital, 3*(1), 51 - 61.
37. International Business Efficiency Consulting. (2003). *Intellectual Capital; Efficiency on National and Company Level. Zagreb*. Zagreb: Croatian Chamber of Economy – Intellectual Capital Association.
38. Kaplan, N. P. D. (1996). *The Balanced Scorecard* (1 st ed.). Harvard: Harvard Business School Press.
39. Kristandl, G., & Bontis, N. (2007). The impact of voluntary disclosure on cost of equity capital estimates in a temporal setting. *Journal of Intellectual Capital, 8*(4), 577 - 594.
40. Kujansivu, P., & Lonnqvist, A. (2007). Investigating the value and efficiency of intellectual capital. *Journal of Intellectual Capital, 8*(2), 272 - 287.
41. Lev, B., Zarowin, P. . (1999). The Boundaries of financial reporting and how to extend them. *Journal of Accounting Research, 37, Autumn* (353-85).
42. Lev, B. (2001). *Intangibles: Management, Measurement, an Reporting* (1st ed.). N.W., Washington D.C.: The Brookings Institution.
43. Lev, B., Radhakrishnan, S. (2002). *The Valuation of Organizational Capital*. Paper presented at the 2001 Strategy Conference-Harvard University.
44. Lev, B. (2004). Sharpening the Intangibles Edge. *Harvard Business Review, June 2004*, 109-116.
45. Lev, B. (2005). Intangible Assets: Concepts and Measurements. *Encyclopedia of Social Measurement, 2*(1), 299-305
46. Maditinos, D., Chatzoudes, D., Tsairidis, C., Theriou, G. (2011). The impact of intellectual capital on firms' market value and financial performance. *Journal of Intellectual Capital, Vol. 12*(No. 1), pp. 132-151.
47. Marr, B. (2004). Measuring and benchmarking intellectual capital. *Benchmarking: An International Journal, 11*(6), 559 - 570.
48. Mavridis, D. G. (2004). The intellectual capital performance of the Japanese banking sector. *Journal of Intellectual Capital, 5*(1), 92 - 115.
49. Mavridis, D. G. (2005). Intellectual capital performance determinants and globalization status of Greek listed companies. *Journal of Intellectual Capital, 6*(1), 127 - 140.
50. Mavridis, D. G., & Kyrmizoglou, P. (2005). Intellectual capital performance drivers in the Greek banking sector. *Management Research News, 28*(5), 43 - 62.
51. Mohiuddin, M., Najibulah, S., Shahid, A.I. (2006). An explanatory study on intellectual capital performance of the commercial banks in Bangladesh. *The Cost and Management, 34*(6), 40-54.
52. Montier, J. (2005). Seven Sins of Fund Management [Electronic Version]. *Global Investment Strategy*, from www.drkwresearch.com
53. Mouritsen, J. (2006). Problematising intellectual capital research: ostensive versus performative IC. *Accounting, Auditing & Accountability Journal, 19*(6), 820 - 841.
54. Mouritsen, J., Bukh, P. N., & Marr, B. (2004). Reporting on intellectual capital: why, what and how? *Measuring Business Excellence, 8*(1), 46 - 54.
55. Mramor, D. (1990). Teorija finančne politike podjetja. Unpublished doktorska disertacija
56. Univerza v Ljubljani.
57. Mramor, D. (1991). *Finančna politika podjetja: teoretični prikaz*. Ljubljana: Gospodarski vestnik.
58. Muhammad, N. M. N., Ismail, M.K.A. (2009). Intellectual capital efficiency and companies' performance: study on Malaysian financial sectors. *International Journal of Economics and Finance, 1*(2), 206-212.
59. Nazari, J. A., & Herremans, I. M. (2007). Extended VAIC model: measuring intellectual capital components. *Journal of Intellectual Capital, 8*(4), 595 - 609.
60. Nonaka, I., Takeuchi. (1995). The Knowledge Creating Company: How Japanese Create the Dynamics of Innovation. *New York. Oxford University Press*.
61. North, D. C. (1990). Institutions, Institutional Change and Economic Performance. *Cambridge. Cambridge University. Press*.
62. Palacios, T. M. B., & Galvan, R. S. (2007). Intangible measurement guidelines: a comparative study in Europe. *Journal of Intellectual Capital, 8*(2), 192 - 204.
63. Petty, R., & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting and management. *Journal of Intellectual Capital, 1*(2), 155 - 176.

64. Petty, R., Ricceri, F., & Guthrie, J. (2008). Intellectual capital: a user's perspective. *Management Research News, 31*(6), 434 - 447.
65. Pratt, P. S. (2008). *Valuing a Business* (Vol. 5th Edition). New York: McGraw-Hill
66. Pulic, A. (1998). Measuring the Performance of Intellectual Potential in Knowledge Economy. Paper presented at the 2nd McMaster World Congress on Measuring and Managing Intellectual Capital.
67. Pulić, A. (2004). Intellectual capital – does it create or destroy value? *Measuring Business Excellence, 8*(1), 62 - 68.
68. Pulić, A., Bornemann, M. (1999). The physical and intellectual capital of Austrian banks. from www.vaic-on.net
69. Puntillo, P. (2009). Intellectual capital and business performance from Italian banking industry. *Electronic Journal of Corporate Finance, 4*(2), 97-115.
70. Reilly, F. R. (1994). Valuation of intangible assets for bankruptcy and reorganization purposes. *CPA Journal, Vol. 53*(4), 10.
71. Romer, P. M. (1990). Endogenus Technological Change. *Journal of Political Economy, Vol. 98*(No. 5, pt. 21), 71-102.
72. Roos, G., Bainbridge, A., & Jacobsen, K. (2001). Intellectual capital analysis as a strategic tool. *Strategy & Leadership, 29*(4), 21 - 26.
73. Roos, G., Bainbridge, A., & Jacobsen, K. (2001). Intellectual capital analysis as a strategic tool.
74. Riahi-Belkaoui, A. (2003). Intellectual capital and firm performance of US multinational companies: a study of the resource based and stakeholder views. *Journal of Intellectual Capital, 4*(2), 215-226.
75. Samiloglu, A. T. (2006). The performance analysis of the Turkish banks through VAIC and MV/BV ratio. *Journal of Administrative Sciences, 4*(1), 207-226.
76. Shannon P. Pratt, R. F. R., Robert P. Schweihs. (2000). *Valuing a Business: The Analysiss and Appraisal of Closely Held Companies* (4 th. ed. ed.). New York, NY: MCgraw-Hill Professional.
77. Shapiro, H. R. V. (2003). The Information Economy. In B. Lev (Ed.), *Intangible Assets: Values, Measures, and Risks* (pp. 48-62). Oxford: Oxford Management Readers.
78. Shiller, R. J. (2002). From Efficient Market Theory to Behavioral Finance. [Discussion paper]. Cowles Foundation Discussion Paper
79. Shiu, H. (2006). The application of the value added intellectual coefficient to measure corporate performance: evidence from technological companies. *International Journal of Management, 23*(2), 356-365.
80. Soler, L. E. V., & Celestino, D. J. C. d. O. (2007). Evaluating the scope of IC in companies' value. *Journal of Intellectual Capital, 8*(3), 470 - 493.
81. Stern, M. J., John S. Shiely, Irwin Roos. (2001). *The EVA Challenge: implementing value added change in an organization* (1 st ed.). New York, NY: John Wiley&Sons, Inc.
82. Stewart, S. (1990). The Quest for value.
83. Stewart, T. A. (1997). Intellectual Capital: The Wealth of New Organisations,. *Knowledge Management No. 65*.
84. Sveiby, K.-E. (2007). Methods for Measuring Intangible Assets.
85. Sveiby, K. E. (1990). *The Invisible Balance Sheet: Key indicators for accounting, control and valuation of know-how companies*: Affarsvarlden Forlag
86. Stahle, P., & Hong, J. (2002). Dynamic intellectual capital in global rapidly changing industries. *Journal*
87. Tan, H. P., Plowman, D., & Hancock, P. (2007). Intellectual capital and financial returns of companies. *Journal of Intellectual Capital, 8*(1), 76 - 95.
88. Tan, H. P., Plowman, D., & Hancock, P. (2008). The evolving research on intellectual capital. *Journal of Intellectual Capital*
89. Tomlinson, J. (1987). Review Article: To Plan or not to Plan. *Journal of Economic Studies, 14*(1), 60 - 65.
90. Tseng, C., Goo, Y.J. (2005). Intellectual capital and corporate value in an emerging economy: empirical studies of Taiwanese manufacturers. *R&D Management, 35*(2), 187-201.
91. Van der Zahn, M. J.-L. W., Tower, G. and Neilson, J. (2004). *Intellectual Capital and Efficiency of Value Added: Trends in the Singapore Capital Market 2000-2002*. Burleigh: Poseidon Books.
92. Williams, S. M. (2001). Is intellectual capital performance and disclosure practices related? *Journal of Intellectual Capital, 2*(3), 192 - 203.

93. Williams, S. M. (2004). Downsizing– intellectual capital performance anorexia or enhancement? *The Learning Organization, 11*(4/5), 368 - 379.
94. Zerenler, M., Gozlu, S. (2008). Impact on itellectual capital on exportation performance: research on the Turkish automotive supplier. *Journal of Transnational Management, 13*(4), 318-341.
95. Zhou, A. Z., & Fink, D. (2003). The intellectual capital web: A systematic linking of intellectual capital and knowledge management. *Journal of Intellectual Capital, 4*(1), 34 - 48.

 

**APPENDIX 1: Overview of important research, which directly or indirectly used the VAIC model**

| No. | Author | Period | Sample | Research conclusions |
|---|---|---|---|---|
| 1 | Maditinos, Chatzoudes, Tsairidis, Theriou | 2010 | 96 listed Greek companies from four different sectors. | Majority of hypotheses were not confirmed. There was a statistically significant relationship between HCE and business performance. |
| 2 | Muhammad, Ismail | 2009 | 18 companies from financial sector in Malaysia. Cross-sectional analysis for 2007. | A strong influence was detected in the banking sector, followed by the insurance industry and brokerage. IC showed a positive relationship with business performance. Market value of equity showed a stronger dependence on the financial and physical capital than on IC. |
| 3 | Puntillo | 2009 | 21 banks listed on the Milan Stock Exchange. | The study did not confirm the link between the variables involved. The only statistically significant correlation was found between CEE and business performance indicators. |
| 4 | Chan | 2009 | All companies from HSE index were included for the 2001–2005 period. | The study did not confirm the links between VAIC coefficients of efficiency and business performance indicators. It reported a dominant influence of physical capital to the market value of companies. |
| 5 | Deol | 2009 | Analysis of cases in the Indian banking sector. | The survey showed that banks in India developed all the components of IC (HC, SC and RC) after reform of banking system. |
| 6 | Gan, Saleh | 2008 | High tech companies listed in Bursa Malaysia. | VAIC model explained the profitability and productivity. Influence of IC on the market value has not been confirmed. |
| 7 | Appuhami | 2007 | Companies quoted on the Thailand stock exchange. | IC has a significant positive impact on the rate of return of shares included in the study. |
| 8 | Tan, Plowmann, Hancock | 2007 | 150 companies listed in Taiwan stock exchange. | IC and performance are positively related. IC showed correlation with future performance of companies. IC growth in the company was positively related to business performance. IC performance contribution varies by industry. |
| 9 | Kujansivu, Lonnqvist | 2007 | 20,000 companies from Finland divided into 11 sectors for the 2001–2003 period. | The study did not confirm the link between VAIC and CIV. |
| 10 | Kamath | 2007 | The sample of banks in India for the 2000–2004 period. | The analysis is based on VAIC model and shows significant differences between bank's performances in India. Regarding IC efficiency, banks indicate a positive trend. Foreign banks show better results than local. |
| 11 | Samiloglu | 2006 | Banks, quoted in Istanbul for the 1998-2001 period. | No significant relationship between the MV/BV coefficient and the VAIC model independent variables has been detected. |
| 12 | Shiou | 2006 | 80 companies listed in Taiwan. Data for 2003. | The study confirmsa high significant association between VAIC, financial performance and market value. Relationship between VAIC and productivity is proven to be negative. |
| 13 | Mohiuddin | 2006 | 17 banks in Bangladesh for 2002-2004 period. | The survey discovers that all companies systematically show higher HCE coefficients among all efficiency coefficients. |
| 14 | Tseng, Goo | 2005 | Listed Taiwanese manufacturing companies. | Positive correlation between the IC and the market value of companies has been confirmed. |

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| 15 | Chen | 2005 | Taiwan listed companies. 4,254 observations for the 1992–2002 period. | The survey shows that investors prefer companies with higher IC. Higher IC efficiency is associated with higher profitability and higher current and future revenues growth. IC was recognized as a strategic asset. Relationship between partial efficiency indicators and financial performance is more pronounced than between aggregate VAIC indicator and financial performance. |
| 16 | Goh | 2005 | The sample of banks in Malaysia. | Banks with average financial performance show lower IC coefficients. |
| 17 | Mavridis, Kyrmizoglou | 2005 | 102 listed Greek companies. | The survey shows that locally oriented companies have "technocratic focus" and are strongly influenced by the "blue collar" lobbies. Global business is characterized by a significantly higher impact of intellectual capital through "white collar" lobbies. |
| 18 | Mavridis, Kyrmizoglou | 2005 | 17 companies from the Greek banking sector for the 1996–1999 period. | There is a statistically significant correlation between VA and physical capital, and VA and IC. |
| 19 | Mavridis | 2004 | 141 Japanese banks for the 2000–2001 period. | Survey shows strong differences among Japanese banks groups and large differences in performance among Japanese and European banks. |
| 20 | Van der Zahn | 2004 | 300 companies quoted on the stock exchange in Singapore, banks for the 2000–2002 period. | Study demonstrates a positive association between asset efficiency indicators and value creation. |
| 21 | Williams | 2004 | Sample of 56 U.S. companies that have implemented "downsizing" programs. | The analysis states that companies show a drop in ICE coefficient over the three-year period after the implementation of a program, and rebound of this coefficient in a fourth year. |
| 22 | Firer, Williams | 2003 | Sample of 75 quoted companies from South Africa. | Links between HCE, SCE, CEE, and productivity, operating performance and market value of capital were not confirmed. It is hypothesized that in South Africa physical capital has a dominant influence on financial performance. |
| 23 | International Business Efficiency Consulting | 2003 | EU countries. | Small countries in the EU have the most efficient economies. In large EU countries, a small efficiency change is reflected in significant change in VA. |
| 24 | Riahi, Belkaoui | 2003 | Sample of U.S. multinational companies. | Study confirms link among ROA, VA and IC. The survey confirms the assumptions of "stakeholders" and "resource-based" doctrines. |
| 25 | International Business Efficiency Consulting | 2002 | 56,987 companies from Croatia. | The survey showed that only four regions in Croatia show above average VAIC. In 16 regions, VAIC is lower than the average. |
| 26 | Pulić | 2000 | Random sample of 30 companies quoted on the Financial Times Stock Exchange and Vienna Stock Exchange for the 1992–1998 period. | Discloses a strong link between VAIC and the market value of companies. |
| 27 | Bornemann | 1999 | The sample of companies listed in London. | Study confirmed link between VAIP and financial performance of companies. |
| 28 | Pulić | 1998 | Study includes banks and companies from different countries. Examines different short time periods. | The case study confirms the strong correlation between VA and VAIP. |

 