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# A study of causality between disintegrated intellectual capital and firm performance

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**Abstract:**

This paper aims to provide the new and unique way to analyze the factors which causes Intellectual Capital (IC) and its impacts on firm's performance. The data is obtained from 41 Chinese companies listen in Shanghai Stock Exchange Company from 2005 to 2011The empirical technique adopted to investigate this research is also unprecedented. This study uses Vector Auto-Regression (VAR) model on panel data structure to analyze the relationship between disaggregate intellectual resources and its impacts on the profitability at the firm level. The diverse estimation technique is used which covers both cross-sectional and time behavior of data. The variety of empirically tools; unit root, co-integration and granger causality tests are applied respectively to validate the hypothesis. The overall results confirm the hypothesis whereas, in the light of the results of the descriptive statistics, the low value of SCE shows that the Chinese high-tech companies are not investing enough as compared to the other components of intellectual capital as compare to HCE and CEE. The results from the short run causality test based on VECM signify bidirectional causality between ROE and HCE and unidirectional causality from HCE to SCE and CEE to SCE. The results of the data analysis provide useful implications for the theory of intellectual capital. The results indicate that the presence of intellectual capital causes a firm to attain better performance.

**Keywords:** Firm Performance, Intellectual Capital, Vector Autoregression

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## 1. Introduction

With the advent of 'knowledge economy' and the recognition of Intellectual Capital (IC) as the strategic factor for the value creation of the firm, the research in this specific area has been increased manifolds. However, the theory of IC is still developing and authors agree on further research to refine the theory of intellectual capital. Empirical studies are required to support the proposed theories so that the theories can be generalized.

The importance of intellectual capital has been recognized by many authors and it has been regarded as the strategic factor responsible for creating value for the organization (Sveiby, 1997, Stewart and Ruckdeschel, 1998, Martin-de-Castro et al., 2010, Kaufmann and Schneider, 2004). Although there can be issues in the measurement and financial evaluation of intellectual capital, but its strategic importance for the firm cannot be ignored (Bontis, 1998). In recent years, there has been enormous increase in the investments in intangibles by the firms (Edvinsson, 2000). Thus, the strategic importance of IC coupled with the increased investment calls for more research in the area. Consequently, IC has been one of the highly focused research topic in the recent business literature and a huge volume of literature has been produced as well, (Alcaniz et al., 2011). (Tan et al., 2008) argues that the research on the topic has undergone subsequent developmental stages of definitions, measurement models, empirical studies and strategic importance of IC. Their study covers in detail the evolution of the research in the area of IC. The introduction of specialized journals such as *The Journal of Intellectual Capital* and special issues in other journals have further enhanced the research on IC (Alcaniz et al., 2011).

Various researchers have empirically studied the relationship of intellectual capital with other variables but the most of the studies have focused on the relationship between intellectual capital and performance of the firm and intellectual capital and the market value of the firm. These studies have produced different and somehow contradictory results. However, these studies are limited to one way relationship from intellectual capital to performance or market value of the firm and the quantitative technique commonly used were regression models. There have been very few studies that focused on the causal relationships in order to know what causes intellectual capital in the firm and the relationship among the various components of intellectual capital is rarely studied in the literature. If intellectual capital is a strategic resource of the firm, as recognized by majority of the researchers, then it is important to study the causes of intellectual capital beside its consequences. In this way, we can improve our understanding of Intellectual Capital by studying its causal relationship. It helps to identify that how Intellectual capital is generated and how the firm can improve its intellectual capital. The notion of conducting empirical research to analyze the relationship among the various components of intellectual capital is in growing need. The key reason to do so is the components of IC work in collaboration to create value but not in isolation. Understanding the relationship among the components of intellectual capital can help firm to use them in a smoother way to create superior value. This study focuses on the causal relationship of disintegrated intellectual capital with the performance of the firm and the causal relationship among the components of intellectual capital.

In order to study the causal relationship between disintegrated intellectual capital and performance of the firm and the relationship among the components of IC, the Granger causality test is applied.

Value Added Intellectual Coefficient (VAIC) model, developed by Ante Pulic, is used to measure the intellectual capital of the firm while performance of the firm is measured through the traditional measure of Return on Equity (ROE). Data is collected from 41 companies listed on Shanghai Stock Exchange. All the companies belong to High-Tech industry, which is a non-traditional industry and the role of intellectual capital is expected to be high in the performance. The rest of the paper is structured as follows. The next section provides a brief literature review of the empirical studies that have been conducted and their findings. After that, methodology and data for this study is explained. The second last section shows the analysis of the data and finally the last section provides the conclusion of research and some recommendations for the future research.

## 2. Literature Review

Research in the area of intellectual capital emerged in the early 1990's with mostly practitioners and consultancy firms taking the initiative (Martin-de-Castro et al., 2010). The main reason behind this start was the huge discrepancies found by researchers between the book value and market value of the firm (Martin-de-Castro et al., 2010). Perhaps that is why that most of the seminal researchers (Sveiby, 1997, Stewart and Ruckdeschel, 1998, Roos and Roos, 1997, Edvinsson, 2000, Bontis, 1998) defined intellectual capital as the difference between the book value and the market value of the firm. (Dumay, 2012) has criticized this view arguing that the difference can be the cause of many other market factors and not just intellectual capital of the firm. However, as the theory developed, new definitions emerged. Although there is no generalized standard definition of IC (Martin-de-Castro et al., 2010, Kaufmann and Schneider, 2004, Choong, 2008), the characteristics of intangibility and value creation can be derived from all the definitions. Thus most of the authors are of the view that intellectual capital is something in the firm that has no physical attributes but create value for the organization ((see Kaufmann and Schneider, 2004, Choong, 2008)). However, (Caddy, 2000) differentiates intellectual capital from intangible assets.

Measurement and recognition of intellectual capital of a firm has been highly discussed topic in the literature on IC. Traditional accounting and financial measurement and reporting systems failed to capture the value of intellectual capital of a firm (Vafaei et al., 2011, Rodov and Leliaert, 2002, Molodchik et al., 2012, Martin-de-Castro et al., 2010, Kaufmann and Schneider, 2004, Kannan and Aulbur, 2004, Guthrie, 2001). The current traditional accounting systems are based on the double entry system of recording transactions which does not suit accounting for intellectual capital (Gowthorpe, 2009). Although (Caddy, 2000) introduced the concept of intellectual liabilities and argued that they should be taken into consideration, however it is very difficult to recognize and report intellectual liabilities. Although majority of the researchers agree that there is a need to develop reporting systems for intellectual capital, some authors such as (O'Donnel et al., 2000), (Gowthorpe, 2009) and (Dumay, 2012) are of the opinion that the nature of intellectual capital is such that it cannot be fully brought into the accounting spheres.

Measuring intellectual capital gives various benefits to the firm and having the specific knowledge of intellectual capital would enable the management to devise a better strategy regarding the allocation of resources in order to get competitive advantage (Kannan and Aulbur, 2004, Guthrie, 2001). However, due to the abstract nature of IC, measurement of IC is not easy. Even though, researchers

have made attempts to measure intellectual capital of the firm and there are various measurement models available in literature. (Kannan and Aulbur, 2004) provides a good coverage of the measurement models. They divide the models into four categories including 'Perceptual models', 'Process models', 'Financial models', and 'Other measurement models'. However, they also point out various shortcomings in the current models and propose to develop an integrated measurement system that would consider all the above school of thoughts. (Tan et al., 2008) also provide a useful review of intellectual capital measurement models. They classify the models into Non-dollar valuation of IC and Dollar valuation of IC. However, the measurement models for IC are still in their infancy and more objective and applicable models are evolving (Tan et al., 2008). (Bontis, 2001) assesses some measurement models of IC in detail and concludes that there has been a great development in this regard. However, as the field is still in embryonic stage, there is a need for more comprehensive and collaborative models to be developed (Bontis, 2001). However, one greater challenge for the IC research is the lack of empirical studies. Most of the researchers just document the existing measurement models but there are very less studies that attempt to study the validity of these models (Bontis, 2001).

The lack of clear measurement models makes it very difficult to empirically study the role of intellectual capital. However, it should be acknowledged that the nature of intellectual capital is such that it makes it almost impossible to completely objectify it, especially in dollar terms (O'Donnel et al., 2000). Therefore, instead of opening the Pandora Box of developing new accounting systems and measurement models to measure intellectual capital to its exact dollar value (Dumay, 2012), empirical studies should be carried out in order to test the existing models and to point out their shortcomings and improve them. Allocating resources and efforts to develop measurement systems would not do any good to the theory of intellectual capital (O'Donnel et al., 2000).

Nevertheless, the current models for capturing the value of IC are failed in achieving their objectives and are inadequate for the measurement of IC (Molodchik et al., 2012, Kaufmann and Schneider, 2004, Kannan and Aulbur, 2004). These frameworks are often too qualitative in nature, as they make the use of proxy indicators for measuring IC, and do not say anything about the importance of each component or indicator to the performance of the firm (Kaufmann and Schneider, 2004). Another issue with these models is their lack of comparability (Kaufmann and Schneider, 2004). Each model has its own structure and uses firm specific proxies and indicators of IC making it difficult to compare the results obtained from two different models. However, the use proxies and indicators for measuring IC are inevitable due the nature of intellectual capital. Therefore, there is a need select one model with better proxies and indicators of the value of intellectual capital and use it in empirical studies with data from different firms and different economic environments in order to test its validity.

Various researchers have conducted empirical studies to study the importance of intellectual capital for the firm using different measurement models. These studies have produced different results, sometimes contradictory (Clarke et al., 2011). (Clarke et al., 2011) provides a good literature review of the empirical studies and their results. However, in this paper, there is no study that attempts to understand the causal relationship among intellectual capital, its components and firm performance or market value. All the studies investigate the impacts of intellectual capital on performance

indicators. One study that is conducted for studying the cause and effect relationship is by (Wang and Chang, 2005). Their study uses the Partial Least Square (PLS) method to study the cause-effect relationship among components of intellectual capital (human capital, customer capital, innovation capital, and structural capital) and the impacts of each on the performance of the firm. However, this study investigates only the unidirectional causality from the components of intellectual capital to performance and from human capital to other components of intellectual capital. Their results indicate that the three components of intellectual capital, other than human capital, directly affect performance of the firm while human capital indirectly influence performance by affecting the other three components. They also found the cause-effect relationship among the components of intellectual capital where human capital influenced innovation and process capital, innovation capital influenced process capital and process capital influenced customer capital.

Some other relevant empirical studies such as; (Firer and Williams, 2003) studied data from 75 publically traded companies from South Africa, using the Value Added Intellectual Coefficient (VAIC) model as a measure of intellectual capital, in order to find the relationship of intellectual capital and the three traditional measures of corporate performance i.e. profitability, productivity, and market value. Their findings indicated mixed results failing to prove any significant impact of any component of VAIC, except for the physical capital, on the corporate performance of the firms under study.

(Bollen et al., 2005) conducted a questionnaire based study in order to find out the relationship of IC and its components; HC, SC, RC, and IP, with the performance of companies in the German pharmaceutical industry. The results showed that there is a positive relationship between the company performance and IC of the firm. They also found that a correlation exist among the components of IC i.e. HC, SC, and RC and IP. IP serves as an interface linking the other components of IC to the company performance.

(Chen et al., 2005) studied the data from Taiwanese listed companies in order to find the impact of IC on the market value and firm performance. Their final sample included 4254 firms. They used Public's Value Added Intellectual Coefficient (VAIC) model to measure intellectual capital, Market-to-book ratio to measure market value, and ROA, ROE, growth in revenue (GR) and employee productivity (EP) to measure performance of the firm. Results of the multiple regression models indicate that market value of the firm is positively associated with VAIC and its two components HCE and CEE. VAIC was found to have significant and positive relationship with all the four indicators of performance. Same results were found for HCE and CEE while SCE was found to have positive relationship with only ROE. While regressing lagged independent variables, the authors found that only VAIC and CEE has positive relationship with all the four indicators of performance. Based on their results, they concluded that investors give an increasing weight to intellectual capital efficiency and that firms with higher intellectual capital perform better in terms of profitability and revenue growth. They also concluded that the intellectual capital developed in previous years has a positive impact on the proceeding year performance of the firm.

(Muhammad and Ismail, 2009) conducted an empirical study on investigating the efficiency of intellectual capital and impacts on the performance of firms in Malaysian financial sector. Using

Pulic's Value Added Intellectual Coefficient (VAIC) model, they studied data collected from 18 firms in the financial sector including banks, insurance companies and brokerage firms. Their results indicate that there is a positive and significant relationship between intellectual capital and firm performance (measured by profitability and ROA). During examining the impacts of component of intellectual capital, using multiple regression models, they found that human capital and structural capital have insignificant and negative relationship with the performance while capital employed showed significant and positive relationship with profitability and ROA.

(Orens et al., 2009) conducted a content analysis of corporate websites of the companies belonging to Belgium, France, Germany, and the Netherlands in order to find whether the presence of IC information on these websites affect the market value of the firm. They found that companies tend to provide more information relating to customers as compared to other components of IC. The results of analysis indicated a strong positive relationship between firm value and IC disclosures.

Murali(V and Ashrafali, 2010) studied data from 13 firms of the IT industry of India using VAIC as the measure for intellectual capital and found a positive relationship between corporate financial performance of the firm and VAIC and all its three components.

(Clarke et al., 2011), following the methodology of (Chen et al., 2005), examined the effects of intellectual capital on the performance of Australian companies. They used the data from listed Australian companies for the years between 2004 and 2008. Their sample consisted of 1676 firms. Measuring intellectual capital with Public's VAIC model, they used multiple regression models to examine the relationship between intellectual capital and performance, which they measured through ROA, ROE, Revenue Growth, and Employee Productivity. Results indicated the existence of a relationship between overall IC and performance of the firm. Examining the individual impacts of components of IC, results showed that HC and CE have significant and positive relationship with performance whereas SC is not found to have significant relationship with any performance measure. While examining the effects of previous year's IC on the current year's performance, they found positive relationship with all performance measures except revenue growth. HC and SC of previous years were found to have significant relationships with performance indicators of the current year.

(Maditinos et al., 2011) studied data from 96 Greek companies listed on Athens stock exchange using VAIC model as the measure of intellectual capital. Their results were failed to support the hypothesis that intellectual capital enhances market value of the firm. They found significant relationship between only HCE and market-to-book ratio. Results were failed to explain any significant relationship between VAIC and its three components and the measures of performance (ROA, ROE and GR) except for HCE that was found to have significant relationship with ROE.

(Lu, 2012) studied public universities in Taiwan in order to find whether intellectual capital influence the operating efficiency of these universities and concluded that intellectual capital plays a very important role in the performance, especially in teaching and research areas of public universities in Taiwan.

(Molodchik et al., 2012) studied a number of companies for European countries including Germany, Finland, Denmark, Spain and others, using their Intellectual Capital Transformation Evaluation

Model (ICTEM). They concluded that IC has a positive effect on the performance of the company. The analysis showed that HC is relevant only in long term while SC, to their surprise, is not important in the value creating process for the companies. Some of the SC indicators were found to be negative drivers of performance in short-term while positive drivers in long-term. Relational capital produced similar results as structural capital where the effect is different for different indicators.

(Mehralian et al., 2012) studied pharmaceutical companies in Iran to study what relationship exists between intellectual capital and performance of the firm indicated through profitability, productivity and market valuation. Measuring intellectual capital through VAIC, profitability through ROA, productivity through ATO, and market valuation through M/B ratio, they found that VAIC has a positive relationship with ROA and ATO but significant negative relationship with M/B ratio. Same results were found for SCE while CEE was found to have negative relationship with ATO as well. HCE was found to have no significant relationship with any of the dependant variable.

(Komnenic and Pokrajcic, 2012) used data from 37 MNCs conducting business in Serbia using VAIC method to investigate the relationship between intellectual capital and corporate performance (measured by ROA, ROE, and productivity). They found human capital to be positively associated with all the three measures of performance, structural capital only with ROE, while capital employed strongly associated with all the three measures.

1. Theoretical framework and hypotheses

The theoretical framework for this study is presented in the following figures:

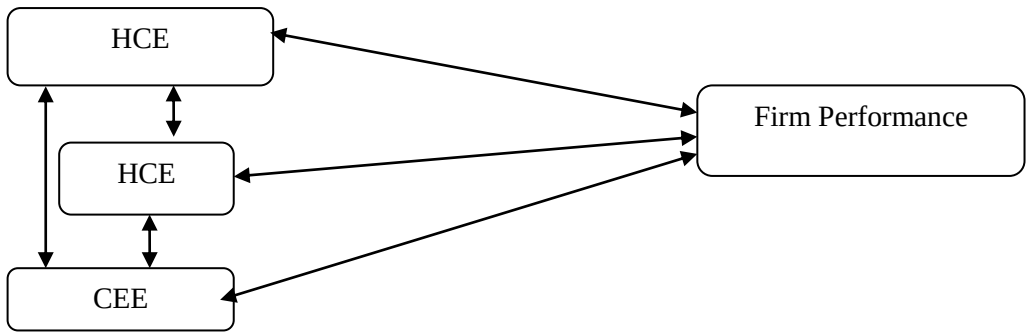


Figure 1: Relationship among components of intellectual capital and firm performance

Figure 1, shows the inter-relationship among the components of intellectual capital i.e. HCE, SCE and CEE and their relationship with the performance of the firm. It is assumed here in this study that each component of intellectual capital impacts the other components. If a firm has highly educated and skilled employees, it will cause the firm's structural capital to be high. In turn, higher structure capital would help employees in developing their knowledge and skills and would facilitate them in the process of intellectual capital creation. Capital employed is assumed to have the same relationship with the other components. Furthermore, all the components are supposed to have, individually, the same relationship with performance of the firm.

The following hypotheses are tested in this study:

**$H_1$:** Presence of intellectual capital (VAIC) causes improved performance in the firm (ROE)
**$H_2$:** Improved performance of the firm (i.e. higher value of ROE) cause the value of intellectual capital in the firm to be greater.
**$H_3$:** There is a relationship among the components of intellectual capital i.e. different components of intellectual capital causes each other.

## 3. Methodology

The study employs the VAR Model established with the attention of Panel data structure. The relationship between disaggregate intellectual resources and its impact on the profitability at the firm level is never studied before which employs such a unique and diverse estimation technique. The panel data is the two dimensional approach that leads to analyze particular variables by cross sectional as well as time behaviors. The empirical investigation is based on the three step procedure; firstly, the unit root test for panel data is applied to obtained the order of integration among the variables; second, the long run association of the variables is scrutinized by employing the panel cointegration test suggested by (Pedroni, 1999) and at third, the causality test is applied based on the VECM.

### 3.1. Panel Unit Root Test

In order to secure the statistical weight and to raise the weight of their opposite variable's univariate, the test of unit root is applied (Breitung and Pesaran, 2008). There are several tests suggested by the authors that are structured according to panel data. In this regards our study employs the two test presented by the Levin, Lin and Chu-LLC (2002) and Im, Pesaran and Shin-IPS (2003). The LLC model structure assumes the constant individual heterogeneity in the panel and can be defined as under:

$$\Delta y_{it} = \delta_i y_{it-1} + \sum_{j=1}^{n_i} \rho_{ij} \Delta y_{it-j} + \alpha_i + e_{it} \quad \ldots\ldots\ldots (1)$$

Where, $y_{it}$ is the particular variable observations for $i= 1 \ldots .N$ firm at time t=1 . . . . T periods, $\Delta$ represents the first difference operator and $e_{it}$ is the residual that follows $IDD\ (0,\sigma_e^2)$ . The null hypothesis of panel unit root is that all the units of the panel have unit root problem against the alternative hypothesis of stationary in all the units of the panel. Later on, IPS extends the similar model of LLC and allows the individual heterogeneity among the cross sectional units. The null hypothesis of their test follows that the each individual unit of series hold unit root. Moreover, two model structures are developed in order to analyze the unit root, the first at the level form and other at the first difference. And each model has been regressed with and without deterministic trend variable and the maximum lag length has been selected according to the information of AIC.

### 3.2. Panel Cointegration test

The second phase of our empirical analyses leads us to examine the long run association among the ROE, HCE, SCE and CEE. In this study, we followed the Pedroni (1999, 2000) cointegration test structured for the panel data. The advantage of using this technique over the conventional method of cointegration is that it allows the individual heterogeneity in the panel. The empirical model constructed for the adopted test of cointegration can be presented as follows:

$$ROE_{it} = \alpha_i + \delta_t + \gamma HCE_{it} + \beta SCE_{it} + \emptyset CEE_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots (2)$$

Where, ROE, HCE, SCE and CEE are the firms' Return on Equity, Human capital efficiency, structural capital efficiency and capital employed efficiency, respectively. The symbols $\gamma, \beta$ & $\emptyset$ are the elasticities of returns on equity with respect to HCE, SCE and CEE, respectively. Furthermore, $\alpha$ and $\delta$ show the firm individual specific effects and time trend variables, where as $\varepsilon_{it}$ represents the estimated residual that varies across time and firms.

The Pedroni (1999, 2000) proposed seven unlike statistics in order to investigate the existence of long run relationship among the variables under the null hypothesis of no cointegration. He suggested three statistics of group-mean namely, rho statistic, Pedroni statistic (PP) and Augmented Dicky Fuller (ADF) statistic. These statistics are also known as the between dimension. On the other hand, the null hypothesis of no cointegration is also encountered by the further four statistic, namely, Panel v-statistic, panel rho-statistic, Panel PP-statistic and Panel ADF-statistic. And these statistics are also known as within dimension statistics. The null hypothesis of no cointegration is rejected if the entire statistics show the high negative statistics except the panel v-stats. The panel v-stats follows the one sided test so if it has high positive value then null hypothesis can be rejected.

### 3.3. Panel Granger Causality Test based on VECM

As we are more interested to indentify the direction of causality between the firm performance and the disaggregate determinants of intellectual capital resources; however the equation 2 just answered to the question of existence of long run association between variables. In this regards, we have exploited the granger causality test based on VECM. At the first stage, we estimate the equation 2 and obtain the estimated residual as suggested by the Engle and Granger (1987). Then we investigate the direction of causality by incorporating the estimated residuals in the right side of equations and developed the models under the panel data structure as suggested by the Holtz-Eakin et al. (1988). The dynamic vector error correction model under the panel data can be described empirically as follows:

$$\Delta \mathrm{ROE}_{\mathrm{it}} = \alpha_{1\mathrm{j}} + \sum_{k=1}^{p} \gamma_{11ik}\, \Delta ROE_{it-\mathrm{k}} + \sum_{k=1}^{h} \gamma_{12ik}\, \Delta HCE_{it-\mathrm{k}} + \sum_{\mathrm{k}=1}^{z} \gamma_{13ik}\, \Delta SCE_{it-k} + \sum_{\mathrm{k}=1}^{z} \gamma_{14ik}\, \Delta CEE_{it-k} + \lambda_{1\mathrm{i}} ECT_{it-1} + u_{1\mathrm{it}} \quad \ldots\ldots\ldots\ldots (3)$$

$$\Delta \mathrm{HCE}_{\mathrm{it}} = \alpha_{2\mathrm{j}} + \sum_{k=1}^{p} \gamma_{21ik}\, \Delta HCE_{it-\mathrm{k}} + \sum_{k=1}^{h} \gamma_{22ik}\, \Delta \mathrm{ROE}_{\mathrm{it}-\mathrm{k}} + \sum_{\mathrm{k}=1}^{z} \gamma_{23ik}\, \Delta SCE_{it-k} + \sum_{\mathrm{k}=1}^{r} \gamma_{24ik}\, \Delta CEE_{it-k} + \lambda_{2\mathrm{i}} ECT_{it-1} + u_{2\mathrm{it}} \quad \ldots\ldots\ldots\ldots (4)$$

$$\Delta \mathrm{SCE_{it}} = \alpha_{3j} + \sum_{k=1}^{p} \gamma_{31ik}\ \Delta SCE_{it-k} + \sum_{k=1}^{h} \gamma_{32ik}\ \Delta \mathrm{ROE_{it-k}} + \sum_{k=1}^{z} \gamma_{33ik}\ \Delta HCE_{it-k} + \sum_{k=1}^{r} \gamma_{34ik}\ \Delta CEE_{it-k} + \lambda_{3i} ECT_{it-1} + u_{3it} \quad \ldots\ldots\ldots\ldots (5)$$

$$\Delta \mathrm{CEE_{it}} = \alpha_{4j} + \sum_{k=1}^{p} \gamma_{41ik}\ \Delta CEE_{it-k} + \sum_{k=1}^{h} \gamma_{42ik}\ \Delta \mathrm{ROE_{it-k}} + \sum_{k=1}^{z} \gamma_{43ik}\ \Delta HCE_{it-k} + \sum_{k=1}^{r} \gamma_{44ik}\ \Delta SCE_{it-k} + \lambda_{4i} ECT_{it-1} + u_{4it} \quad \ldots\ldots\ldots (6)$$

Here, Δ represents the first difference and k shows the optimal lag length of the respective variables and that is determined through the AIC. $ECT_{it-1}$ , denotes the speed of adjustment from long run disequilibrium, the statistical significance of this variable implies the long run association among the variables. The short-run causality can be determined from the equations 3 to 6. For example, if the all the estimated coefficients of HCE under the equation 3, jointly significant indicated the presence of causality from HCE to ROE, and reject the null of hypothesis of HCE does not granger cause to ROE. The similar results would be true for all remaining variables in all VECM equations, respectively.

## 4. Data and Variables

### 4.1. Data

For the purpose of studying relationship between intellectual capital and firm performance, data has been collected from 41 firms listed on Shanghai stock exchange. These firms are related to High-Tech industry of China. Data has been obtained from the annual reports and financial statements of these firms for the years 2005-2011. Thus this study is based on secondary data.

### 4.2. Variables

Firm performance and intellectual capital are the variables tested in this study. Firm performance is measured through Return on Equity (ROE) and intellectual capital through Value Added Intellectual Coefficient (VAIC) and its components HCE, SCE, and CEE. As the causality test is applied, all the variables are considered to be the endogenous variables. Thus, the number of equations would be same as number of endogenous variables.

#### 4.2.1. Return on Equity (ROE)

Return on Equity measures a firm's profitability by revealing how much profit a firm generates with the money invested by shareholders of the company. The ratio is calculated by dividing net income by the shareholder's equity, where shareholders' equity is calculated by multiplying number of shares outstanding with the book value per share. It is a common measure of profitability and is used to know the performance of the firm.

### 4.2.2. Value Added Intellectual Coefficient (VAIC)

Value Added Intellectual Coefficient (VAIC), and its components, is used as the measure of intellectual capital of the firm in this study. Value Added Intellectual Coefficient (VAIC) model was developed by Ante Pulic in 1998. It is the mostly used model to measure intellectual capital in various studies that aim to study relationship of intellectual capital with other variables. The point that it gives a numerical value to the intellectual capital of the firm is perhaps the reason for its application. It makes the use of accounting numbers, which are both reliable and easily extractable from the financial statements, in order to calculate the intellectual capital. The purpose of the model is to measure the ability of the company to produce added value on the basis of its intellectual resources. The VAIC model consists of three components:

### 4.2.3. Human capital (HC):

Human capital is the most important component as it is the intellectual resource of the firm. Human capital is defined as the explicit and implicit knowledge, skills, abilities, capabilities, and behavior of the employees. With such an abstract nature, it is almost impossible to measure human capital of a firm to its accurate number. However, the more a firm spends on the development of the employees' knowledge, skills and behavior, the higher can be the human capital of the firm. Thus money spent on employees can be a good indicator of human capital and VAIC model measures human capital efficiency (HCE) through the same logic.

HC = salaries and wages

### 4.2.4. Structural capital (SC):

Structural capital encompasses the enabling structures that allow the organization to exploit the intellectual capital. It includes all the things available in the organization that facilitate human capital to create value. It ranges from the tangible assets to the intangible structure and culture of the organization. Structural capital has been defined as all the things that remain in the firm when employees go home. Thus, in VAIC model, SCE is calculated as the difference between produced added value and human capital.

SC = VA – HC

### 4.2.5. Capital employed (CE):

Capital employed refers to the physical capital employed for attaining business goals. It is interpreted as the financial capital of the firm.

CE = Total assets – Intangible assets

In order to calculate the values of VAIC and its three components HCE, SCE and CEE, first value added (VA) of the company is calculated by subtracting all the expensed incurred from the revenue earned during the year. Thus VA can be defined as the net value created by the firm during the year.

$$VA = S – E = NI + T + DP + I + W$$

Where:

S = Sales revenue

E = Expenses

NI = Net Income after Tax

T = Taxes

DP = Depreciation Expense
I = Interest Expense
W = Wages and salaries.
Interest expenses (I) and Wages and salaries (W) are added to the Net Income (NI) because they are considered investments that create value rather than expenses.
After calculating VA, the three components of VAIC can be calculated as follows:
HCE, Human capital efficiency = VA/HC
SCE, Structural capital efficiency = SC/VA and,
CEE, Capital employed efficiency = VA/CE.
VAIC is the sum of the three components thus it can be calculated as follows:

$$VAIC = HCE + SCE + CEE$$

## 5. Results and Discussion

This section presents the results of the various tests that were applied to the data in order to analyze the validity of the hypothesis developed in this study. Following table shows the descriptive statistics of the data.

### 5.1. Descriptive statistics

*Table 1: Descriptive statistics*

| | ROE | HCE | SCE | CEE |
|---|---|---|---|---|
| Mean | 4.636184 | 45.06372 | 0.907507 | 46.19043 |
| Median | 4.072319 | 11.94908 | 0.924661 | 13.04000 |
| Maximum | 39.90909 | 1176.727 | 1.272882 | 1177.728 |
| Minimum | -26.30556 | -410.3760 | 0.340000 | -409.3784 |
| Std. Dev. | 7.228394 | 121.6538 | 0.115807 | 121.6163 |
| Skewness | 0.495920 | 4.826052 | -1.113736 | 4.827726 |
| Kurtosis | 11.76171 | 36.24124 | 7.653847 | 36.26592 |

Source: Authors' Calculation

The descriptive statistics shows that mean value of SCE is very low which means that Chinese high-tech companies are not investing enough as compared to the other components of intellectual capital. However, the average value of HCE and CEE is high which indicate that firms in the Chinese high-tech industry do invest in intellectual capital. The following section presents the results of the tests applied in order to study the relationship between the disintegrated intellectual capital and performance of the firm.

### 5.1.1. Unit Root Test Results

**Panel Unit root test**

Table 2: Panel Unit root test results

| Variable | LLC Test | | IPS | |
|---|---|---|---|---|
| | Intercept | Intercept and Trend | Intercept | Intercept and Trend |
| | | | | |
| ROE | -0.267 | 1.294 | 2.294 | 1.419 |
| ΔROE | -5.673** | -4.825** | -8.6034*** | -6.602*** |
| HCE | -1.669 | -3.483 | -0.402 | -0.053 |
| Δ HCE | -8.964*** | -8.428*** | -5.070*** | -3.926** |
| SCE | -1.370 | -3.075 | -1.801 | -0.537 |
| Δ SCE | -8.748*** | -9.379*** | -6.287*** | -4.872*** |
| CEE | -1.612 | -3.496 | -0.372 | -0.038 |
| Δ CEE | -9.016*** | -8.279*** | -5.089*** | -4.0185** |

Note: (i). ***, ** denotes the significance level at 1% and 5%. Δ Signifies the first difference and otherwise level

(ii) The maximum lag length has been selected according to SIC.

Source: Authors' Calculation

The result presented in table 2. shows the unit root test obtained through the LLC and IPS tests. Each of the tests is conducted with and without the intercept in the model. The results in both the tests confirm that the respective variables have got unit root at the level form and eliminated after taking the first difference or in other words we reject the null hypothesis of unit root in panel data at first difference at 1% and 5% significance level.

### 5.1.2. Panel Cointegration Test Results

The results related to panel cointegration test is presented in table 3 and 4. Table 3 shows the within and dimensions results and confirms the rejection of null hypothesis of no cointegration among the variables at the 1% significance level. Table 4 shows the kao cointegration test based on the residual that also supports the pedroni's panel cointegration test and rejects the null hypothesis with same level of significance. *Pedroni's Panel Co integration test*

Table 3: Pedroni's Panel Cointegration test results

| Statistics | No intercept no time trend | Intercept |
|---|---|---|
| Panel v-stats | -2.015741 | -1.562128 |
| Panel rho-stats | 0.857070 | 3.751466 |
| Panel PP-stats | -6.108539*** | -4.061929*** |
| Panel ADF-stats | -6.051788*** | -3.672972*** |
| Group rho-stats | 4.278661 | 6.819747 |
| Group PP-stats | -20.55781*** | -12.52686*** |
| Group ADF-stats | -13.46603*** | -6.196830*** |

*Note:* *** denotes the significance level at 1%.

Source: Authors' Calculation

**Kao Residual Cointegration Test**

Table 4: Kao residual cointegration test results

| Statistics | Intercept |
|---|---|
| ADF | -6.936425*** |

*Note:* *** denotes the significance level at 1%.

Source: Authors' Calculation

### 5.1.3. Short run Causality Test based on VECM

Table 5: Short term Causality test results

| | Δ ROE | Δ HCE | Δ SCE | Δ CEE | Δ VAIC | ECT |
|---|---|---|---|---|---|---|
| Δ ROE | - | 5.234*** | 4.290*** | 4.696*** | 4.998*** | -2.812*** |
| Δ HCE | 3.896** | - | 0.022 | 0.042 | - | -0.676 |
| Δ SCE | 6.313*** | 10.983*** | - | 10.976*** | - | -1.615* |
| Δ CEE | 3.907** | 0.044 | 0.023 | - | - | -0.679 |

***, ** & * denote the significance level at 1%, 5% and 10%.

Source: Authors' Calculation

Table 5, shows the results from the short run causality test based on VECM. The results signify bidirectional causality between ROE and HCE. This means that higher HCE results in higher ROE and vice versa. This confirms that performance of the firm is caused by knowledgeable and efficient employees. In turn, better performance of the firm helps employees to increase their knowledge and develop their skills. The results also show that ROE has bidirectional causality with all the other components of intellectual capital i.e. SCE and CEE.

However, the results show that there is unidirectional causality from HCE to SCE. This means that human capital causes structural capital but structural capital does not cause human capital. Similar result is shown for the relationship between CEE and SCE i.e. unidirectional causality from CEE to SCE.

### 5.1.4. Joint results of Short and Long run Causality-Strong Causality

Table 6 Joint results of Short and Long run Causality

| | Δ ROE & ECT | Δ HCE & ECT | ΔSCE & ECT | Δ CEE & ECT | Δ VAIC & ECT |
|---|---|---|---|---|---|
| Δ ROE | - | 206.727*** | 206.936*** | 206.683*** | 206.705*** |
| Δ HCE | 2.833** | - | 0.157 | 0.171606 | - |
| Δ SCE | 4.574*** | 7.824*** | - | 7.820*** | - |
| Δ CEE | 2.839** | 0.173 | 0.159 | - | - |

***& ** denote the significance level at 1% and 5%.

Source: Authors' Calculation

The results of joint causality in short and long run are presented in table 6. The results of joint causality confirm the causality pattern both in short-run and long-run and validate each other. This enables us to reject the null hypothesis that the components of VAIC do not granger cause ROE. This means that there is granger causality between intellectual capital and performance of the firm. As a result this leads us to accept our hypothesis that a firm with a higher value of intellectual capital

will perform better. It also confirms the hypothesis that a firm with higher performance will possess higher intellectual capital. The results presented in table 6 also reject the null hypotheses that HCE, SCE and CEE does not granger causes ROE.

## 6. Conclusion and recommendations

The previous studies on this subject tried to analyze the one way impacts of intellectual capital on the performance and the market value of the firm. So the research focus was limited to how the performance and the market value of the firm is influenced by the presence of intellectual capital. However, studies investigating the causes of intellectual capital or the factors that can influence the intellectual capital of a firm are rare. Therefore, in order to fill this research gap and to introduce unique research insight, this study attempts to investigate the influence of intellectual capital on firm performance and market value on 41 Chinese companies listed in Shanghai Stock Exchange. This paper employs Vector Auto-Regressive (VAR) model on panel data structure to assess the relationship between disaggregate intellectual resources and its impact on profitability at the firm level. This study empirically analyses both cross-sectional and time behavior of data, using unit root tests, cointegration, and granger causality tests respectively to obtain the results. This type of empirical technique is unique and used first time in the research rea of Intellectual Capital.

The results of the data analysis provide useful implications for the theory of intellectual capital. The results indicated, as found by previous researchers, that the presence of intellectual capital causes a firm to attain better performance. Thus intellectual capital is a valuable resource for the firms and they should manage it in a good manner in order to boost performance. The results also show that higher performance causes higher intellectual capital in the firm. This means that in order to create and develop its intellectual capital base, a firm has to improve its performance.

The results also show that all the components of intellectual capital i.e. HCE, SCE, and CEE have bidirectional causality with performance of the firm. However, HCE and SCE have unidirectional causality from HCE to SCE. This result supports the proposition proposed earlier that human capital is the intellectual resource that initiates the process of creating intellectual capital. Thus the firm has to try to develop the knowledge and skills of the employees and to modify their behavior in a positive way so to accumulate its base of intellectual capital.

This study produced some useful results for theory of intellectual capital by testing causality among different variables and not just one-sided relationship. However, there is a need for conducting more such studies in order to generalize these findings. The future researchers can use the method to investigate causality on some other country data and check whether the same results are produced. Few more such studies would produce the generalized conclusion about causality among intellectual capital and firm performance. Also it is important to study the causality among the different components of intellectual capital.

This study used Value Added Intellectual Coefficient (VAIC) model as the measure of intellectual capital. Although the model has been quite intensely used by researchers, it has some serious drawbacks. The most important of them is that it does not include relational capital in the model. Future researchers can modify this model to incorporate relational capital in it.

As this study uses the data of only 41 firms for 8 years, but future researchers can test the hypotheses on a sample of larger scale, so that to ascertain the findings.

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