Interaction Effects of Intellectual Capital in Company's Value Creation Process

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Abstract: "Intellectual capital" is a new term for key resources of a firm that enable it to compete on challenging market. Such assets as IT-systems, brand, employees' knowledge and competencies are crucial for any company. However, large stocks of these resources do not lead to success automatically. The main purpose of this paper is to find out how interconnections between intellectual capital components contribute to company value. We test empirically linear and non-linear relationship between intellectual capital components and business performance with the assumption of their mutual influence on each other. From the theoretic point of view we combine the theory of intellectual capital with Value-Based Management concept and Resource-Based View in order to investigate the way that firm's intellectual resources transform into its value. There are two main problems when dealing with intellectual capital. The first one is intellectual capital evaluation. Previous papers on this topic are usually based on either questionnaire data or information from financial reports. However, questionnaire survey has significant disadvantage as the data obtained include subjective opinion of respondents. Financial reports lack for information about amount of firm's intellectual capital. Therefore we propose another way to estimate intellectual capital components. Each of three components – human capital, structural capital and relational capital – is measured through the set of financial and non-financial proxy indicators which are collected from company's reports and its web-site. Further these data are aggregated in first principal components through factor analysis to obtain the comprehensive view of intellectual capital structure. The second problem is to measure the value that has been created by intellectual resources. We chose two measures – market capitalization and market-to-book ratio. Proposed method of analysis of intellectual capital is used on the sample of 59 firms from European countries with high level of economic and knowledge development. The sample covers five year period (from 2005 to 2009). We used the LS method to assess the direct and indirect relationships between intellectual capital and corporate value. This study contributes in different ways. Firstly, it helps researchers and management to understand what synergetic effects between intellectual capital's components take place. Secondly, it proposes an application of principal components method for investigating intellectual capital. Also it helps to recognize the level of homogeneity of intellectual capital elements that are combined in human capital, structural capital or relational capital and therefore are interpreted as describing one aspect of firm's activity.

Keywords: intellectual capital, value creation, components interconnection

1. Introduction

According to the theory of intellectual capital, its components are knowledge and skills of employees, IT systems, and established relationships with stakeholders. Intellectual capital combines a lot of various knowledge-based elements. Namely, they have a set of characteristics that are extrinsic to physical and financial assets: intangibility, lack of physical depreciation, inexhaustibility, the ability to create new knowledge. In this paper the term «intellectual capital» refers to «intellectual assets, knowledge assets, total stock of knowledge-based equity possessed by a firm» (Dzinkowski, 2000).

The review of existing research on intellectual capital shows that its significance grows with the course of time (Lev, 1999). Meanwhile there is a lack of ways to monitor and manage it, as well as methods for assessing its effectiveness because of the immateriality of the main part of knowledge-based assets. All this make intellectual capital an actual object of analysis.

Some empirical researches evidence that traditional resources become mobile due to active interaction between regions and countries, available for all companies, and cease to create competitive advantages for companies (Huang, Liu, 2005; Tseng, Goo, 2005; Zeghal, Maaloul, 2010). Therefore intellectual resources have a key role in knowledge economy.

The purpose of this paper is to examine the relationship between intellectual resources and company value, and to determine the interaction effects that take place. This helps to make assumptions about the nature of return on investments in intellectual capital and the sustainability of their impact on value added. In addition the interdependence between the intellectual capital components should be taken into account to make investment decisions.

As already mentioned, the intellectual capital has high degree of heterogeneity. Following the majority of papers in this area we classify it into 3 components: human, structural and relational (Bontis, 1996, 1998, 1999; Roos et al., 1998; Stewart, 1991, 1997; Sveiby, 1997, Edvinsson and Malone, 1997; Edvinsson, Sullivan, 1996).

2. Literature review

In this paper knowledge-based assets are considered as value drivers that are interrelated in the process of value creation. Consequently it is necessary to understand the model of interaction in order to manage them efficiently.

In the framework of a theoretical analysis of O'Donnell and Berkery it is pointed out that the value of intellectual capital is a function of intellectual capital components, but this relationship is most likely non-additive (O'Donnel, Berkery, 2003). The reason for this is based on the fact that the elements of intellectual capital are not perfect substitutes. For example, the intellectual capital theorists often suggest that the relational and structural capital can be used only if the company employees have certain skills and knowledge (Edvinsson, Malone, 1997).

The linkages between intellectual capital components vary greatly throughout studies. The simplest model of intellectual capital's influence on performance is the direct impact of each component (Wang, Chang, 2005; Diez, 2010; Kamukama et al., 2010; Chang, Hiesh, 2011). Other frequently used assumption is that human capital is a basic component that combines other resources to produce goods or services. Svieby states that «all assets and structures, whether tangible physical products or intangible relations, are the result of human action and depend ultimately on people for their continued existence» (Svieby, 1997). Edvinsson and Malone characterise human focus as the soul of Scandia Navigator model (Edvinsson, Malone, 1997). Chang and Hiesh discuss how human capital arbitrates the relationships between other groups of intangible resources and market performance (Chang, Hiesh, 2011). They consider mediating and moderating effects of human capital between market performance and intellectual capital components and conclude that both effects take place. Thus it can be assumed that human capital has an impact on the contribution of other knowledge-based assets. The strongest assumption about the interaction between intellectual capital components is that all components have an impact on relations of other ones with company performance (Wang, Chang, 2005).

Also there is evidence that intellectual capital has non-linear relationship with company value. Not-constant return on capital was considered in Arthur's paper «Increasing returns and the new world of business», in which it was asserted that intellectual resources are characterized by increasing returns on capital, opposed to material ones such as land, labor and capital (Arthur, 1996). Bontis and Daum hold the opinion of the possibility of increasing, rather than constant returns in their analysis (Bontis, 2000; Daum, 2001). Recent theoretical works and empirical studies in the field of intellectual capital usually do not use such an unambiguous appraisal (Huang, Liu, 2005; Shiu, 2006; Huang, Wang, 2008). Huang and Liu found out that R&D expenditures have non-linear relationship (inverted U-shape) with firm performance (Huang, Liu, 2005).

Empirical studies in the field of the influence of intellectual capital on company's activity use different measures of company's activity. Short term indicators measure performance over one period, such as return on assets (Firer, Williams, 2003; Chen et al., 2005; Shiu, 2006; Ting, Lean, 2009), return on equity (Chen et al., 2005) or EVA (Huang, Wang, 2008). Long-term measures are based on firm's value and can be absolute – market value of equity) (Tseng, Goo, 2005; Diez et al, 2010; Brynjolfsson et al., 2002), or relative – market-to-book value ratio (Firer, Williams, 2003; Chen et al., 2005; Shiu, 2006; Chang, Hiesh, 2011). Following to the value-based management concept we orient on company value as the target indicator of company's performance.

In this paper we want to test the hypothesis of interaction between components of intellectual capital based on the analysis of two opposite cases:

- The direct impact of all components on company value. This implies a linear relationship, and the case where the components of intellectual capital are perfect substitutes;
- Interdependency between all components on company value. In this case, we assume that the human, structural and relational forms of capital are imperfect substitutes and interaction effects between components exist.

3. Data

The sample of companies for survey consists of European companies of the wholesale and retail trade, whose shares are traded on the stock exchange. Although the most studies on intellectual capital are based on national level data, we extend our sample by including EU countries. High mobility of resources within the EU ensures the homogeneity of the sample. Further, we wanted to take into account different levels of economic, technological and IC level of development. To assess these macroeconomic characteristics affecting the performance of companies, a number of indicators were developed: World Bank's Knowledge Economy index and Knowledge index (overall indices of Knowledge Assessment Methodology), IC-dVAL approach (Bounfour, 2003), National intellectual capital's model of Lin and Edvinsson (Lin, Edvinsson, 2008).

The choice of countries is based on the World Bank's Knowledge Economy index (KEI), which measures the efficiency of generating, adopting and diffusing of knowledge and its application to economic development. We selected the countries from the highest quintile of the KI. It is expected that high KEI ensures accurate data on knowledge-based assets and enables us to identify the transformation of intellectual capital into company value. We focused on one industry because it consists of companies with similar types of intangible assets, required competencies of employees, nature of relationships with customers and suppliers. Therefore, testing the model on one industry produces more consistent results. The wholesale and retail trade industry was chosen because companies in this industry have the most homogeneous activity arrangement in all countries and regions. In addition, entry barriers usually are not high in this industry, therefore companies face intense competition. Consequently, analysis of intellectual resources that create competitive advantages is highly relevant for trade companies.

The research period is from 2005 to 2009. The time window was limited so that inflation has not affected financial parameters significantly. Also companies were limited in size. Companies' employment size should be in the range from 500 to 20 000. This feature provides an exception of the smallest and the largest firms, which have specific features of activity. In the final sample consists of 280 observations (64 cross-sections included). Data for the survey have been obtained from Amadeus database (Bureau Van Dujk), where financial reports are presented in unified Global format.

4. Methodology

Dependent variables were estimated as follows:
MV - market capitalization;
MBR = MV/BV
where: MBR - market-to-book ratio; MV - market capitalization; BV - book value of company's equity.

Measuring intellectual capital is challenging because there is no integral measure for it or even for each of its components. Two types of data are generally used to estimate the components - proxy indicators and questionnaire survey results. In this paper, we focus on the information available for shareholders and potential investors – data from financial reports and bare sources.

Proxy indicators of human capital were chosen in consistency with previous research (Bontis, 2000; Tseng, Goo, 2005; Carlin, 2006; Bayburina, Golovko, 2008; Garanina, 2009). In this paper, they were evaluated on the basis of publicly available information as follows:

- *Salaries and wages* characterise how much the company is prepared to pay for its human resources. This implies that workers adequately estimate their skills and time required to complete the work and receive wages in compliance with their contribution. The disadvantage of using wages as a proxy of the amount of human capital is the underestimation of the company's management bonuses and non-monetary ways of motivating staff.
- *Number of employees* allows us to estimate the number of "carriers" of human capital. This allows taking into account the fact that there may be distortions in wages. For instance this can take place in the case of young workers that may climb the ladder, but at the considered point of time have low wages.
- *Experience and education of the board members* reflect the company's management skills. Since the top managers make strategic decisions in the company, as well as organize activities of other workers, their competence may be a key resource for the organization. Qualification was

estimated by categorical variable which possess the value from 0 to 2. The maximum value means that more than 2/3 of directors from the board have PhD and significant work experience.

Relational capital is the most heterogeneous in nature. It combines the set of various elements that are almost independent: relationships with company's customers, shareholders, suppliers, financial institutions, government, society, etc. Therefore, the proxy indicators of relational capital should reflect the level of reliability, intensity and tightness of relationships with at least the major groups of stakeholders. The choice of indicators was based on review of empirical research on intellectual capital and value added (Zickgraf, Mertins et al, 2007; Starowiz, Marr et al, 2005; Mouritsen, Bukh, 2003).

- *Company age* - the common measure of relational capital. The longer a company operates in the market, the wider and more stable the network of relations with stakeholders become. Furthermore, long life characterizes the company as viable and able to adapt to new circumstances.
- *Brand awareness* reflects the company's reliability in customer service and customer loyalty towards company. The company's brand was regarded as well-known if it is included in international rating Global 1000, which is based on financial, environmental and social factors. The variable is a binary.
- *The portion of owners among the board of directors* can be interpreted as the closeness of communication with investors and correspondence of management solutions with long-term goals of the company.
- *Site quality* - it is assumed that a company with a high level of relational capital has more comprehensive and user-friendly website. The core users of company's site are actual and potential customers and investors. Four criteria were used: presence of section for investors, availability of choice of site language, usage of animated images, number of site pages. Each criterion is evaluated as 1 if it is met and 0 otherwise. The final parameter is calculated as a sum of criteria values, therefore the maximum value of this parameter is 4.
- *Citation of the company's website* describes the intensity of site usage by stakeholders and provides insight into the relevance of its content. This indicator is based on the Googlerank. It takes into account the number of queries, direct and cross references, and had a value from 0 to 10.
- *Office location* reflects the closeness of relationships with customers, suppliers and other stakeholders, because if it is located in a big city or regional center it makes the company more accessible for personal contact. Center of the country, territorial district or region usually is characterized by the high concentration of companies, partners, suppliers and customers. Therefore office location in the center is an indicator of relational capital. Similarly location in the city with more than 1 million citizens assumes a greater degree of relational capital because there are more potential stakeholders. These indicators are defined as binary values.

Structural capital is capital that is not directly related to economic agents, and owned by the company in the form of documents and software. It can be assumed that if balance sheet assessment is adequate, much of the structural capital is reflected in the balance sheet account "Intangible assets". Contentious issue is whether this amount should include goodwill, which can be interpreted as intellectual resources previously purchased by companies. In this paper we used following proxies of structural capital:

- *Value of intangible assets* - amount of company's intellectual resources that are appraised in the balance sheet.
- *Number of patents* allows us to estimate the amount of intellectual resources on which company has property rights. Also, it describes company's innovative activity.
- *Enterprise Resource Planning system* is necessary for large organization in order to monitor and manage resources. It facilitates the flow of information between all business functions inside and outside the organization. The presence of such a system is expected to characterize a high degree of strategic focus of company's resources usage. It is binary variable, which characterizes the presence of (1) or absence (0) of integrated enterprise resource planning systems, based on information technologies («ERP», «Oracle», «NAVISION», «NAV», «SQL», «SAP », etc.).
- *R&D expenditures* give an evaluation of company's innovative activity.

Thus, each component of intellectual capital should be evaluated with at least several proxy indicators that outline its different aspects. We assume that each of these sub-components contributes to value creation independently. Therefore integral measure that accumulates the most relevant information about them can be represented as a linear combination. In this paper, an integral measure obtained by principal components analysis. Usage of this mathematical procedure results in that these components take both positive and negative values. The negative value of the component for some companies actually means that the company's intellectual capital component is below the sample mean. However, in terms of essence of variable and convenience for analysis of the relationship with company value, it is preferable to use variables that take only positive values. Because the original proxy indicators and integrated measure of intellectual capital components are related by monotone increasing dependency, then this characteristic can be achieved by unifying transformation (Ayvazyan, 2003):

$$\widetilde{x} = \frac{(x - x_{\min})}{(x_{\max} - x_{\min})}$$

To minimize the impact of other variables that may explain observed relationships with company performance, dummy variables are included within the regression models: year, country.

5. Empirical models

The two hypotheses to be empirically tested are reflected in the following three equations relating intellectual capital components to company value in linear (Model 1) and multiplicative (Model 2) dependency.

$$Y_{ij} = \alpha_0 + \alpha_1 HC_{ij} + \alpha_2 RC_{ij} + \alpha_3 SC_{ij} + \alpha_4 Fixed\_assets_{ij} + \\ + \sum country\_dummy_i + \sum year\_dummy_i + \varepsilon_{ij} \quad \text{(Model 1)}$$

$$\log(Y_{ij}) = \alpha_0 + \alpha_1 \log(HC_{ij}) + \alpha_2 \log(RC_{ij}) + \alpha_3 \log(SC_{ij}) + \\ + \sum country\_dummy_i + \sum year\_dummy_i + \varepsilon_{ij} \quad \text{(Model 2)}$$

Where:
Y – dependent variable: firm's market value or market-to-book ratio;
HC – unified first principal component of human capital variables;
RC – unified first principal component of relational capital variables;
SC – unified first principal component of structural capital variables;
country_dummy – dummy variables for countries;
year_dummy - dummy variables for each year in considered period.
Fixed assets are included in the model in order to take into consideration the influence of material assets.

6. Results

Firstly, we present descriptive statistics for variables. The data is not normally distributed and displayed extreme values. To improve the distribution for statistical testing, extreme values were excluded from the sample. Table 1 presents descriptive statistics for the dependent and independent variables.

Table 1: Descriptive statistics for variables

	MV, mln. euro	**MBR**	**HC**	**RC**	**SC**	**FIXED_ASSETS, mln. euro**
Mean	506.72	2.51	0.28	0.37	0.16	319.07
Median	271.27	1.77	0.20	0.26	0.08	137.98
Maximum	3647.19	16.14	1.00	1.00	1.00	2841.48
Minimum	6.08	0.09	0.00	0.00	0.00	2.88
Std. Dev.	661.13	2.42	0.22	0.26	0.17	474.33
Skewness	2.41	2.32	1.32	0.97	2.44	2.84
Kurtosis	9.51	9.89	3.92	2.83	9.33	12.23

Variables HC, RC and SC are obtained due to unification of first principal components. Their description is the presented in Table 2. The proportion of total proxies' variable explained is small for relational capital because of its heterogeneity. The largest proportion corresponds to human capital.

The most proxies contribute to amount of intellectual capital components positively. The negative influence of top-management qualification and number of patents should be interpreted as their weak interdependence with other characteristics.

Table 2: First principal components

Human capital		Relational capital		Structural capital	
Proxy	Loadings	Proxy	Loadings	Proxy	Loadings
Salaries and wages	0.69	Company age	0.15	Intangible assets	0.61
Qualification of the board members	-0.20	Brand awareness	0.26	Number of patents	-0.11
Number of employees	0.70	The portion of owners among the board	0.37	ERP system	0.66
		Site quality	0.16	R&D expenditures	0.43
		Citation of the website	0.24		
		Office location (center)	0.61		
		Office location (population)	0.56		
Proportion	0.65	Proportion	0.25	Proportion	0.39

To analyse the linear association between the dependent and independent variables, a correlation analysis is undertaken and the results are presented in Table 3. Spearman correlation is used due to non-normal distribution of variables. High correlation between human capital and fixed assets is conditioned by their dependency with company's size. Therefore, fixed assets value should be excluded from linear model.

Table 3: Spearman correlation analysis

	MV	MBR	HC	RC	SC	FIXED_ASSETS
MV	1.0					
MBR	0.3	1.0				
HC	0.6	-0.1	1.0			
RC	0.3	0.2	0.3	1.0		
SC	0.5	0.0	0.4	0.3	1.0	
FIXED_ASSETS	0.7	-0.1	0.8	0.3	0.7	1.0

Testing of linear model shows that structural and human capitals have significant positive relationship with market value (Table 4). Thus the substitution effect takes place. The significance of dummy variables for 2008 and 2009 years is foreseen as far as during this period economic crisis influenced on stock market severely. Nevertheless we assume that functional dependence does not change. Market-to-book ratio reflects the efficiency of equity usage. However results shows that human capital decreases the market-to-book ratio. Probably, it can be explained by the fact that large companies usually are expected to have lower growth rates.

Table 4: Regression results for linear relationship between company value and intellectual capital (Model 1)

Dependent Variable				
	MV		MBR	
Independent variables	Coefficient	Std. Error	Coefficient	Std. Error
C	14.59	103.09	3.29***	0.55
HC	1316.57***	212.78	-0.88	0.66
RC	294.92*	174.98	1.54**	0.72
SC	918.07***	267.97	-0.34	0.64
C_GERM	-75.73	59.47	-1.37***	0.27
C_FINL	71.07	203.57	-1.43***	0.31
Y_2006	106.40	107.87	0.12	0.51
Y_2007	-93.53	92.57	-0.64	0.50
Y_2008	-377.82***	87.02	-1.75***	0.45
Y_2009	-282.16***	94.20	-1.45***	0.47
Adjusted R-squared	0.46		0.18	

*** indicates significant at the 1% level; ** indicates significant at the 5% level; * indicates significant at the 10% level

Multiplicative dependency was tested by taking the logarithm of the function (Table 5). The correlations between logarithms of independent variables are within 0.3. Coefficients estimated reflect that human and structural capitals interact, and it positively influences company's capitalisation. The role of relational capital is uncertain. Market-to-book ratio is positively connected with relational capital, but human capital moderates this effect. To compare results of Model 2 with Model 1 adjusted R-squared* was calculated. Both market capitalisation and market-to-book ratio are better predicted by linear dependency with intellectual capital.

Table 5: Regression results for multiplicative relationship between company value and intellectual capital (Model 2)

Dependent Variable				
	ln(MV)		ln(MBR)	
Independent variables	Coefficient	Std. Error	Coefficient	Std. Error
C	7.38***	0.30	1.07***	0.17
ln(HC)	0.59***	0.16	-0.11**	0.05
ln(RC)	0.04	0.12	0.18**	0.08
ln(SC)	0.32***	0.09	0.04	0.05
C_GERM	-0.42	0.26	-0.64***	0.16
C_FINL	0.68***	0.21	-0.56***	0.12
Y_2006	0.19	0.22	0.13	0.15
Y_2007	-0.07	0.22	-0.13	0.15
Y_2008	-0.90***	0.24	-0.83***	0.17
Y_2009	-0.64**	0.25	-0.59***	0.17
Adjusted R-squared	0.30		0.23	
Adjusted R-squared*	0.32		0.11	

*** indicates significant at the 1% level; ** indicates significant at the 5% level; * indicates significant at the 10% level

7. Conclusion

The results of this research demonstrate that intellectual capital contributes to value creation. Moreover two of three distinguished intellectual capital components have linear and multiplicative influence on the value. This means that these components are imperfect substitutes and some complementarity takes place. Therefore structure of intellectual resources has effect on the value, and managers should take the ratio between intellectual capital components into consideration. Multiplicative dependency can be interpreted as the existence of interaction effects. Empirical tests evidence that such effects, both positive and negative, take place. However these effects explain a smaller part of company value than linear combination of intellectual capital components.

The method of analysis proposed in this paper can be applied to further investigation of functional dependency between intellectual capital and company value. Principal component analysis enable us to reduce the dimensionality of data, and therefore to use smaller and more homogeneous sample of companies. However it restricts our analysis, because this method needs the prior assumption about the influence of each intellectual capital element measured by proxy. In the case of non-linear dependency between amount of human, structural and relational capitals and their proxies, some distortion may occur. The extension could be related with addition of new proxies for elements of intellectual capital. Also more complex functional dependency can be used in order to analyse more comprehensive interrelation between components.

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