INTELLECTUAL CAPITAL AND VALUE CREATION IN THE METAL PRODUCTS MANUFACTURING SEGMENT

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ABSTRACT

The historical evolution of the ratio of investments in intangible assets over GNP in the US economy from 1959 to 2007 – which reached 8 to 10% in 2007 - indicates a positive long term trend that is as relevant as the rate of investments in tangible assets in terms of the GNP, during the same timeframe. The most surprising fact however, was the expansion beyond expectations over the last 40 years. The purpose of this line of research was to test Pulic´s Value Added Intellectual Coefficient Model (2000), so as to evaluate its significance in creating value, as applied to the Metal Products Manufacturing segment, utilizing an adjusted data base obtained from the Brazilian Geography and Statistics Institute´s (IBGE) Annual Industrial Research (PIA) for the period 2000 to 2006, comprising companies with more than 100 employees throughout Brazil, resorting to a panel of static data. Results obtained demonstrate a positive relationship between VAIC and value creation as well as between the Calculated Intangible Value – CIV, (explanatory variable) and value creation.

Key-Words: Intellectual Capital. VAIC. Value Creation. IBGE (Brazilian Geography and Statistics Institute).

CAPITAL INTELECTUAL E CRIAÇÃO DE VALOR NO SETOR DE FABRICAÇÃO DE PRODUTOS DE METAL

RESUMO

A evolução histórica da taxa dos investimentos em ativos intangíveis pelo Produto Nacional Bruto (PNB), no período de 1959 a 2007, na economia dos EUA, mostra uma tendência positiva em longo prazo, alcançando o porcentual de 8% a 10% em 2007, tão importante quando a taxa dos investimentos em ativos tangíveis pelo PNB na mesma data. O que surpreende é o crescimento além das expectativas nos últimos 40 anos. O propósito desta pesquisa é testar o Modelo do Coeficiente Intelectual do Valor Adicionado proposto por Pulic (2000), com o objetivo de avaliar sua significância na criação de valor, aplicando-o ao setor de produção de manufaturas de metal, a partir de uma base de dados ajustada, obtida da pesquisa industrial anual do IBGE, no período de 2000 a 2006, compreendendo empresas com mais de 100 empregados, em todo o Brasil, por meio e um painel de dados estático. Os resultados obtidos mostram uma relação positiva entre o coeficiente intelectual do valor adicionado e a criação de valor, assim como entre o valor intangível calculado (variável de controle) e a criação de valor.

Palavras-Chave: Capital Intelectual. VAIC. Criação de Valor. IBGE.

1 INTRODUCTION

This study´s purpose was to test the relationship between intellectual capital and value creation in the metal products manufacturing segment (*CNAE-2*, Brazilian Geography and Statistics Institute (IBGE) sector 28, classification in force until 2007), during the 2000 to 2006 timeframe, via the "Value Added Intellectual Coefficient – VAIC" theory (Pulic, 2000, 2002a, 2002b). The sample data made available by the IBGE called for a series of adjustments, resulting in a non-balanced panel totalling 4191 companies, 15106 observations and for the target segment of this investigation, a sum total of 808 observations. The econometric model also included as an explanatory variable, inventory criteria as per the Luthy (1998) model for calculated intangible values.

2 BIBLIOGRAPHICAL REVISION

Ackoff (1981) suggests that the post-industrial revolution era has been characterized by an unprecedented technological advance, allowing for the manufacturing of new instruments, particularly with the introduction of electronics, of the sonar and the radar, ensuring these devices, once used for observation, become representative symbols of their respective properties or of events related to them. It´s this author´s understanding that such symbols ended up being named "data" and that this instrumentation technology replaced that of mechanization. The XIX Century´s telegraph later replaced by the telephone poses such an example, subsequently surpassed by wireless communication, followed by radio, television and so forth. This technology is not related to that of mechanization but rather to those of symbol transmission and communication.

According to Kurzwell (2008), the technology integration revolution, in numerous sciences such as biotechnology, nanotechnology, molecular electronics, computing, artificial intelligence, standards recognition, virtual reality, reverse engineering applied to the human brain, robotics and others have lead to a rapid and profound impact in all economic fields, changing the until then known environment.

This era has been characterized by four distinct points: a) the revolution in information technology; b) the increasing importance of knowledge; c) the change in paradigm concerning corporate resource level management; and d) the emerging of innovation as the major competitiveness determinant factor (Mortensen, 2000).

Willigan (2001) believes that to succeed, corporations must supplement administration with tangible assets such as land, capital and work with the effective management of intellectual property (patents, brand name and technology rights). According to the author (op.cit.), the company of the future (*The Knowledge Company*) is made up of human capital (knowledge, relationship, people´s personalities, suppliers and customers), to which the author adds distribution and marketing resources.

The expansion of the intangible economy results in a combination of three types of trends, according to Andriessen (2004)

- ✓ Globalization: there has been an increased interdependency of the international flow of goods and services, direct investments, technology, transfer of capital and corporate cost reductions. New products and services demand a regular renovation of technologies and the updating of knowledge. Companies need to be unique on the market, up-to-date and their brands ought to be acknowledged worldwide;

- ✓ Deregulation of markets: the long range of this kind of measure has triggered relevant effects in key segments such as those of telecommunications, transport, power and financial services. Tariff and non-tariff barriers have been reduced thus enabling the global flow of final and intermediate goods and services with greater international ease; and

- ✓ Exponential growth of technological changes: the rapid evolution of technology, particularly those relative to information and telecommunications have resulted in a price reduction of both processing and information, in the integration of communication and computing and in the rapid growth of international electronic networks.

According to Mortensen (2000), in the US, in 1929, 35% of total stocks of invested capital were relative to intangible assets, whilst in 1990, this had increased to some 54%, a positive evolution confirming the herein mentioned trend (see Figure 1, p.44).

This "dematerialization" of the economy had already advanced reaching the point whereby at the end of the XX century, approximately 79% of jobs and 76% of the US´s GNP derived from the services segment as was also the case in Western Europe (Contractor, 2001).

Surveys compare evolution rates of investments in intangible and tangible assets over the gross national product of North America´s economy during the 1959 to 2008 period. Curves demonstrate that there has been more than a proportional expansion of investments in intangible assets over the gross national product (GNP), in relation to active investments in tangible assets over GNP in this economy, during the 1959 to 2008 period, most notably: in 1959, intangible rates barely accounted for 4% of the GNP whilst that of tangibles already exceeded 9%; ever since the 70´s, growth in intangible asset investments has been proportionately greater, having both levelled off in 2007, at in and around 7 to 8% of the GNP. This evolution is pictured in the graph that follows, per Figure 1 (Nakamura, 2008).
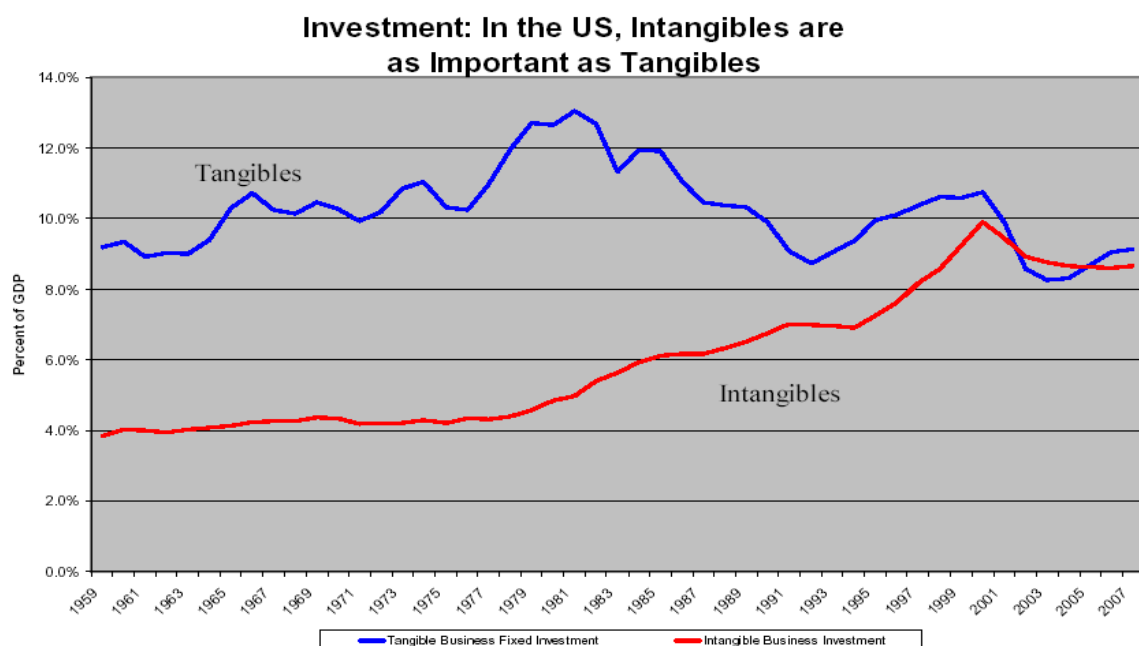

Figure 1: Investments have pointed towards intangible assets

Source: Nakamura (2008) .

For Bowersox, Closs and Cooper (2002), ever since the 90´s, expressive change has been noticed in corporate commercial practices in view of the availability of information, thanks to the impacts of computing, of communication over the internet between market players, reducing time and costs, bringing customers and suppliers closer, as is the case of business to business and business to consumer operations, ensuring quality is the norm to be followed. It´s the author´s understanding that a global economy rapidly emerged, directed by these fundamental forces, changing entirely commercial practices and giving rise to supply chains, sometimes known as value chains or demand chains.

Margareth Blair, from the Brookings Institute, an American private research institution, having analysed over 1000 non-financial corporations listed in the stock exchange market over a period of 20 years, and making use of data from *Compustat,* demonstrated that, during the period, there was an increase in the value of the contribution made by intangibles to the total corporate value: a) in 1978, 80% of the market value of companies was linked to the value of tangible assets and 20% to those intangible; b) in 1988 (10 years later), 45% was given to tangible assets and 55% to intangibles and c) in 1998, approximately 30% of the value of companies was credited to tangibles, whilst 70% was on account of intangible assets (Sullivan, 2000).

According to Andriessen (2004, p.56): "the subject matter intangibles has attracted the interest of several disciplines, such as accounting, information and technology, sociology, psychology, administration, training and development". Despite sharing perspectives in common with the mentioned author, others however, such as Lev (2001), consider that notwithstanding evidence of their prime relevance, intangible assets have been evaluated in a deficient manner.

Contractor (2001) points out the need to evaluate intangibles given the increasing internationalization process of companies, almost always followed by some kind of strategic alliance that calls for it´s market valuation. For the author, these assets must be analysed in the following cases: a) sale, or merge and acquisition of a company; b) sale, purchase or licensing of separable intangible assets such as brand names, patents, rights, access to data banks and technology; c) juridical issues concerning property or rights to property; d) tributary issues as to the transfer of intangibles of a company between countries; e) formation of strategic alliances and joint ventures; f) valuation and management of investments in research and development, amongst others.

The relevance of intangible assets to the largest companies has called for a new strategic attitude, reiterated by Roos et al. (1997, p.14): "the paradigmatic change is that companies have to start managing all their assets and all their processes and not only those that are visible". Along the very same lines, Sveiby (2000, p.39), suggests: "in reality, intangible assets are so important that if executives aren´t capable of adequately managing them they might even lead their companies into facing financial difficulties". Authors might be referring to the management of the corporate image, of brand names, of patents, of their relationship, etc.

According to Reilly and Schweihs (1999) the *Financial Accountant Stantandard Board* has classified intangible assets into 5 categories, namely: 1) related to marketing; 2) related to clients; 3) reactive to artistic contracts; 4) hired assets e 5) relative to technology. Reilly and Schweihs (1999) further suggest 10 intangible groups, namely:

- ✓ Marketing: brand names, commercial names;

- ✓ Technology: process patents, application patents, technical documentation such as laboratory notebooks, technical know-how;

- ✓ Art: artistic and literary work authorial rights, musical compositions;

- ✓ Data processing: rights concerning software, routine automation softwares, integrated circuits and similar software;

- ✓ Engineering: industrial and engineering designs, product patents, commercial secrets, proprietary contracts;

- ✓ Clients: lists of clients and of contracts with clients, customer relationship and purchase orders in open status;

- ✓ Suppliers: favourably based contracts, licensing contracts, franchising agreements, non-competition agreements;

- ✓ Human Capital: grouped and trained workforce, work contracts and agreements with syndicates;

- ✓ Rental: leasehold right contracts, of mineral exploration, "easements", aerial and water provisioning rights; and

- ✓ Goodwill: institutional goodwill, goodwill professional practices, personal and professional goodwill, celebrity goodwill and business consensual value (*going concern*).

Hitchner (2003) mentions the care when performing residual value evaluations, which may or not be amortized, according to the intangible´s nature, depending on the need to estimate it´s useful life. Blair and Wallman (2001) apud Hitchner (2003, p.762) explain the difficulty in evaluating intangible assets, with the following words:

> Given one can´t see, or touch, or weigh intangibles, one cannot directly measure them but only validate them by means of proxy variables or utilizing indirect measures that in turn might express something concerning the influence of the referred intangibles upon measurable variables.

According to Jensen (2001), a persistent search for results has influenced the flow of investments in new technologies. Part of these resources has been channelled to technology companies and differentiated returns. This increased interest in the measuring of intangibles has driven an academic debate concerning both the need for new evaluation methods and for a more adequate definition of it´s composition (Andriessen, 2004). Krogh, Ichijo and Nonaka (2000) emphasize a parallel movement, valuing intangible assets within many organizations, by creating an increasing discrepancy between it´s accounting and market value, as was the case with "Skandia" for instance, a Swedish insurance company that has been considered pioneer in treating the management and accounting of these assets in a differentiated manner.

Companies invest their resources in a variety of assets that include tangibles, such as the production plant and the machinery and in intangible assets, as is the case of managerial contracts and patents; these companies aim at investing in real assets whose value exceed cost. Therefore, so that intangibles might produce economic value, they must match other assets, promoting in this manner, a positive effect (Brealey; Myers, 2000). According to Reilly and Schweihs (1999, p.9) intangible assets must:

a) Generate a measurable economic benefit for its owners, that might be quantified by means of financial measures such as net operational profit, profit before income tax, gross or net cash flow amongst other parameters;

b) Potentially increment the value of other assets to which they are linked, which might include for instance, tangible assets such as personal and real properties or other tangible assets.

Researchers have noticed an increased movement of international investors to locate investment opportunities so as to generate value, as suggested by Saunders (2000) and Chesnays (1999).

Krogh, Ichijo and Nonaka (2000) emphasize the specific case of Skandia, a global Scandinavian company in the field of insurance that, ever since 1980, had already understood that an intense in services enterprise´s competitive forces ought to focus on intangible factors such as individual talent, synergic market relationships and on the capability of administering the flow of individual abilities and competencies to the extent that as early as in 1991, they created a Director of Intellectual Capital functional position.

According to Hoskin (1997), this kind of operation generates tremendous goodwill values as accounted for in their financial statements, as is the case for instance at General Electric with US$ 8 billion dollars in 1994 and Black & Decker with an extra US$ 2,3 billion, 42% of it´s total assets. To meet the interests of all stakeholders that care to become acquainted with corporate financial statements – even the more so when holding activities on a global basis – the authorities of major countries have dedicated special effort with views to the converging of accounting principles. This target is of great relevance given it shall lead to an increase of activities, via increments in the movement of creditors and investors between the various countries (Ernst & Young; Fipecafi, 2008). Per the authors, more than 100 countries already adopt the international financial reporting norms - *International Financial Standard Reporting* (IFRS) – originally based on accounting principles of countries that comprise the European Economic Community.

The US has followed it´s own principles known as the "Generally Accepted Accounting Principles in the USA" (USGAAP), but discussions have been held to converge accounting norms on a global basis.

This study´s objective is to supply subsidies for the debate by testing Pulic´s theory (2000, 2002a, 2002b), as applied to the metal products manufacturing segment. The study further includes the theoretical reference (as focused on intellectual capital), the criteria utilized for the choice of the segment, the hypothesis, the econometric procedures, the analysis and the conclusion. The objective is to contribute with the theory that has sought means to define and evaluate intangible assets, focusing on an essential component of the same, the intellectual capital.

According to Bontis (1998, p.67): "intellectual capital is not merely about a static intangible in itself, but rather an ideological process, a means of obtaining a given purpose". In the beginning of the eighties, executives, consultants and scholars from all over the world gradually noticed that the intangible assets of a company, it´s "intellectual capital" per Sullivan (2000, p.13): "was, frequently, the core determinant of corporate profits".

To Andriessen (2004), there isn´t as yet a unanimous opinion as to the best definition of intellectual capital, however, difficulties seem to persist as mentioned by Yang (1997). The author surveyed major theories proposing definitions for intangibles, verifying 25 distinct models, 22 of which were based on the checking of financial and non-financial metrics. Four of these models, amongst eight that propose a definition for intellectual capital, are presented, in suit:
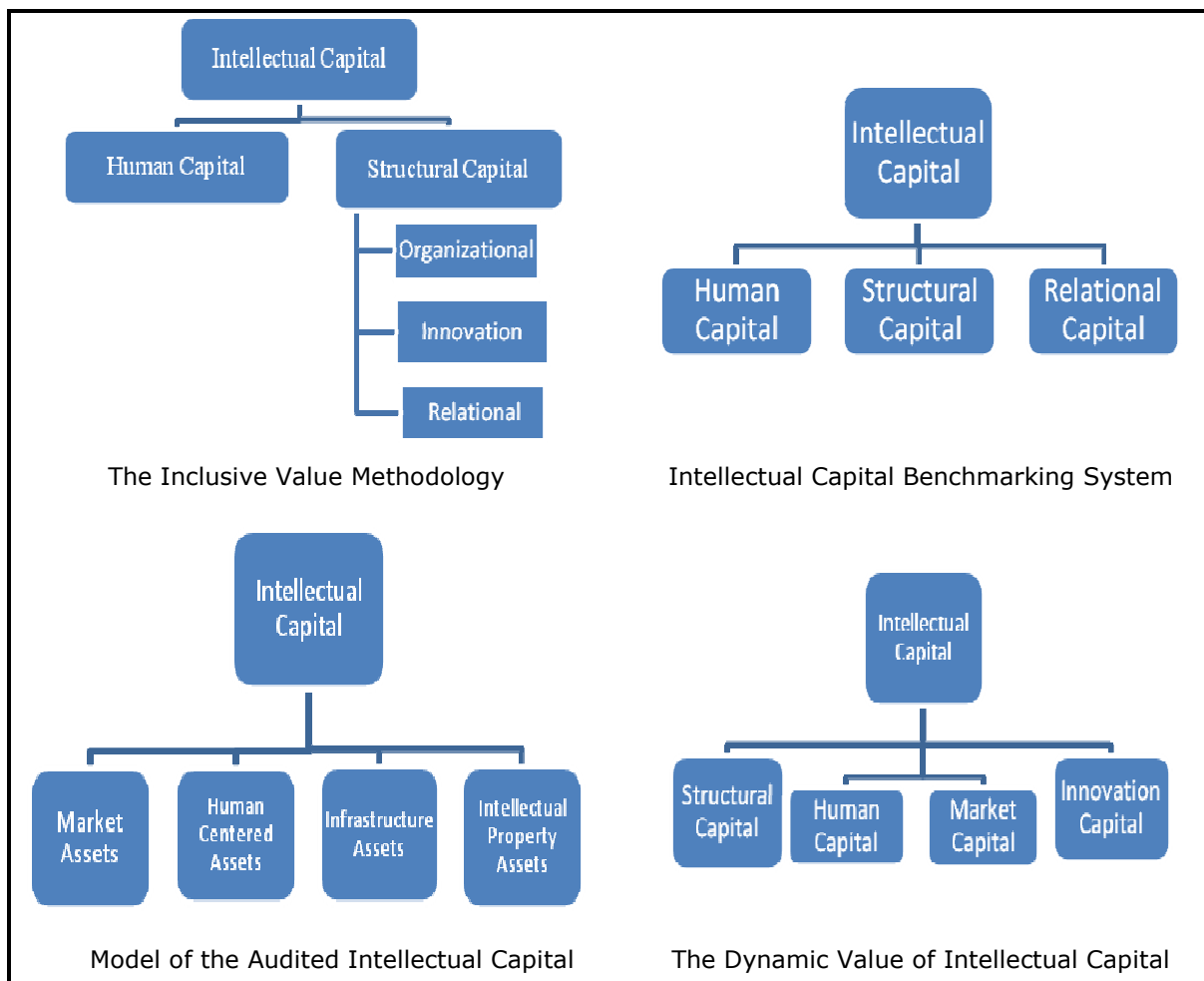

The Inclusive Value Methodology

Intellectual Capital Benchmarking System

Model of the Audited Intellectual Capital

The Dynamic Value of Intellectual Capital

Figure 2: Description of four intellectual capital models

Source: the author based on models referred in Andriessen (2004)

A description of four models that define intellectual capital is henceforth presented:

a) Inclusive Value Methodology: The model was developed by M'Pherson and Pike (2001) who suggest that the company and its internal and external activities are reflected in it´s market value that in turn parts into net property value (or financial capital) and intellectual capital. The model´s financial capital classifies into physical and financial capital and intellectual capital (human and structural capital). Thus, structural capital would comprise three parts: organizational, that of innovation and relational. The proposal aims at facilitating estimates concerning the value of intangibles so as to promote it´s specific management and allow for the composing of the company´s value for the shareholder (M'Pheson and Pike, 2001).

b) The Intellectual Capital Benchmarking System: Viedma (2004) starts off based on general assumptions of the resource based vision (RBV) and from the corporate need of maintaining competitive advantage. This author understands that company´s resources are of two kinds, tangible and intangible. Meanwhile, intellectual capital classifies into human, structural and relational capitals, namely:

   – Human capital: knowledge, skill, motivation and communication abilities;
   – Organizational capital: technology, knowledge, reputation and culture
   – Relational: clients, suppliers, stakeholders, competitors and other members.

   The author emphasises the role of social capital, which amounts to the sum of resources and capacities that belong to the network of organizations that the "intelligent company" has built so as to compete in a successful manner.

c) Audited Intellectual Capital: According to Van den Berg (2005), the model was ideated by Annie Brooking (1996). For Bontis (2001), Annie Brooking´s (1996) model, later refined by Van der Berg (2005), portrays four categories:

– Market assets, which represent the potential of an organization; here intangibles pertain to the market, such as brand names, clients and businesses that repeat themselves, niches, distribution channels, contracts and agreements, licenses and franchises;

– Human centred assets, which represent a collective experience, creative capacity and that of solving problems, leadership and entrepreneurial and administrative abilities of those within the organization;

– Infra-structure assets which are the technologies, methodologies and processes that tool the organization from a functional perspective, and includes the corporate culture, risk evaluation methods, methods to manage the sales force, the financial structure, market or client and communication system information data bases, and;

– Intellectual property assets, which comprise know-how, secret commercial agreements, patents, rights concerning drawings, designs, commerce and services.

d) Intellectual capital´s dynamic value (IC–dVAL): The model was developed by Bonfour (2002). According to this author, companies might prepare intellectual capital strategies by building a connection so as to integrate the financial value of assets and their internal performance. In analytical terms, according to the author´s perspective, four major competitiveness dimensions call for integration, namely: a) intellectual capital (core); b) resources and competencies; c) products and d) processes. Furthermore, it´s his understanding that a company´s intellectual capital is made up of four parts, namely structural capital, human capital, market capital and innovation capital. Intellectual capital may be compiled by combining it´s intangible resources. This combination may produce specific results such as collective knowledge, patents, brand names, reputation, specific routines and cooperation networks; specific metrics can be produced for each of these results (Bounfous, 2002).

3 METHODOLOGY

Amongst the eight models revised, special mention must be made to the fact that only three might be tested resorting to financial parameters and from these, only two are prepared to be subjected to statistical tests as of public information available to those interested beyond corporate frontiers, whether such companies are of open or closed capital: *Value Added Intellectual Coefficient* by Ante Pulic (University of Zagreb and Graz).

✓ Calculated Intangible Value (Internal Revenue Service - EUA)

This study placed greater emphasis on centering it´s purpose on Pulic´s intellectual coefficient value added theory (2000, 2002a, 2002b). In a subsidizing manner, some of the models include the calculated intangible value variable, according to Luthy (1998), an estimate of the intellectual capital inventory.

Hypothesis were extracted from two theoretical proposals that sought to explain value creation as of intellectual capital: a) Pulic´s "Value Added Intellectual Coefficient – VAIC", theory (2000, 2002a, 2002b) and that of b) Luthy, "Calculated Intangible Value - CIV" (1998).

The dependant variable was the return on total corporate asset obtained from the financial statements of the companies and represented by the gross profit over total assets. Choice fell upon gross profit given the theoretical justification that intellectual capital is not only accountable for the generation of operational profit, but also for the appropriation of value that might be obtained when defining sales prices (*markups*).

 Models presented included independent variables, according to both mentioned theories in addition to dummies for each year researched, namely:

✓ Major variables: extracted from the VAIC theory, applied jointly or in separate, depending on the stated hypothesis, with the following workflow characteristics:

– Value Added Intellectual Coefficient: VAIC (CEE + ICE) or (CEE+HCE+SCE)

– Intellectual Capital Efficiency: ICE (HCE + SCE)

– Human Capital Efficiency (HCE);

- Structural Capital Efficiency (SCE) e

- Capital Employed Efficiency (CEE)

✓ The complementary variable Calculated Intangible Variable – CIV, the explanatory or control variable used to estimate corporate intellectual capital inventories, as defined in Luthy (1998).

Models were estimated by ordinary minimal quadrants, in panel, in both static and dynamic forms, as per Asteriou and Hall (2006). The sample extracted from PIA comprised the data bank for the research and this is represented by the companies operating in the machine and equipment manufacturing segment in Brazil. Regression, static and dynamic models were applied, in data panels with views to testing the mentioned hypothesis.

Given the considerable number of models which could be run, (static and dynamic), the chosen option was to run the models closest to Pulic´s theory (2000,2002a, 2002b), in addition to the models with the individual regressors, in light of Andriessen´s (2004) arguments concerning the structural capital concept, deemed of relevance.

The selected models were run on static and dynamic options in the following order, for the stated hypothesis:

$$ROA4_{it} = \beta_1 + \beta_2 LnCIV_{it} + \beta_2 VAIC_{it} + \beta_{I\,\alpha\,06}Dummy\,ano + \epsilon$$

where $VAIC_{it} = \left(\frac{VA_{it}}{CE_{it}} + \frac{VA_{it}}{HC_{it}} + \frac{VA_{it}-HC_{it}}{VA_{it}}\right)$

$$ROA4_{it} = \beta_1 + \beta_2 LnCIV_{it} + \beta_3 CEE_{it} + \beta_4 ICE_{it} + \beta_{I\,\alpha\,06}Dummy\,ano + \epsilon$$

where $CEE_{it} = \left(\frac{VA_{it}}{CE_{it}}\right)$ and $ICE_{it} = \left(\frac{VA_{it}}{HC_{it}} + \frac{VA_{it}-HC_{it}}{VA_{it}}\right)$

$$ROA4_{it} = \beta_1 + \beta_2 LnCIV + \beta_2 CCE + \beta_2 HCE + \beta_2 SCE + \beta_{I\,\alpha\,06}Dummy\,ano + \epsilon$$

where $CEE_{it} = \left(\frac{VA_{it}}{CE_{it}}\right)$, $HCE_{it} = \left(\frac{VA_{it}}{HC_{it}}\right)$ and $SCE_{it} = \left(\frac{VA_{it}-HC_{it}}{VA_{it}}\right)$

$$ROA4_{it} = \beta_1 + \beta_2 VAIC_{it} + \beta_{I\,\alpha\,06}Dummy\,ano + \epsilon$$

4.where $VAIC_{it} = \left(\frac{VA_{it}}{CE_{it}} + \frac{VA_{it}}{HC_{it}} + \frac{VA_{it}-HC_{it}}{VA_{it}}\right)$

$$ROA4_{it} = \beta_1 + \beta_2 LnCIV_{it} + \beta_{I\,\alpha\,07}Dummy\,ano + \epsilon$$

$$ROA4_{it} = \beta_1 + \beta_2 ICE_{it} + \beta_{I\,\alpha\,07}Dummy\,ano + \epsilon$$

where $ICE_{it} = \left(\frac{VA_{it}}{HC_{it}} + \frac{VA_{it} - HC_{it}}{VA_{it}} \right)$

$ROA4_{it} = \beta_1 + \beta_2 SCE_{it} + \beta_{I\,a\,07} Dummy\,ano + \epsilon$

where $SCE_{it} = \left(\frac{VA_{it} - HC_{it}}{VA_{it}} \right)$

$ROA4_{it} = \beta_1 + HCE + \beta_{I\,a\,07} Dummy\,ano + \epsilon$

where $HCE_{it} = \left(\frac{VA_{it}}{HC_{it}} \right)$

$ROA4_{it} = \beta_1 + CEE_{it} + \beta_{I\,a\,07} Dummy\,ano + \epsilon$

where $CEE_{it} = \left(\frac{VA_{it}}{CE_{it}} \right)$

Each model was run under five specifications, of which one was on the static model, two in the dynamic models and two on dynamic models with the first difference to eliminate the fixed effect.

The population is composed of the Brazilian transformation industry, a universe as of which the Brazilian Geography and Statistics Institute – IBGE registers companies based on certain requirements such as their registry at the Federal Corporate Identification Number – CNPJ, IBGE´s registry number before the Federal Classification of Economic Activities – CNAE (IBGE, 2005). As of this universe, the IBGE performed yearly researches between 1968 and 1979, known as the Annual Industrial Survey – PIA, which has been refined in terms of criteria. Several adjustments to original PIA-IBGE data base were necessary. The starting point of this paper´s study were the 81185 companies of 22 sectors and 281615 observations, which fell under PIA´s Transformation Industry CNAE 2, between the years 2000 and 2006.

Next, general information concerning the adjustment of the sample:

✓ Although the IBGE offered PIA information covering a period of 11 years from 1995 to 2006, it was only between 2000 and 2006 that data included corporate total assets, a key component for the ROA (Return on Total Assets) estimates, introduced in the PIA questionnaire as of the year 2000;

✓ IBGE´s registries do not display company names but rather the CNAEs (Federal Classification of Economic Activities). In CNAE-3 there were very small companies and in CNAE-1 very large ones. At first, a more ample base was chosen, composed of CNAE-2 and small companies with more than 30 employees, but the descriptive analysis presented greater distortions (average elevated mean deviation). The final choice made was for companies with more than 100 people;

✓ There was a relevant group of mid-sized companies (smaller than 1000 employees) that appeared and disappeared from the survey during the analysed period. This accounted for the loss of data on the panel, one of the main reasons grounding it´s imbalance.

The adjustment of the sample called for a series of eliminations that culminated in the formation of a data bank covering of 4.191 companies and 15.106 observations, comprised of companies with over 100 employees scattered throughout the country.

The study utilized a multiple regression estimate via a data panel. This technique, according to Asteriou e Hall (2007), is often considered an efficient analytical method for the treating of econometric data; the technique combines a complete series over time for each element of the cross-section, allow for the application of a variety of estimate methods in addition to contributing with a greater number of observations.

The data panel model was applied in two phases, namely:

✓ Static Effects model and tests to select the best model

   – Common Equal Model (Polled OLS Method)

   – Fixed Effects model

   – Random Effects model

   – Residue Variance Robust Estimator

   – Dynamic Effects model and tests to select the best model

   – GMM Estimator

   – Arelano and Bond Estimator

   – Residue Variance Robust Estimator

Information was collected from the Annual Industrial Research (PIA) data base by IBGE interviewers. The information does not contemplate all major account balances of financial statements, neither is it displayed according to the Shareholder´s Equity Law, therefore some variables were estimated by means of formulas, as was the case, for instance, for gross profits. Amongst others, third party capital values, permanent assets and net profit, for example, are likewise, not available. On the other hand, PIA presents advantages such as greater transparency in profit and loss statements (DRE), as is the case with salaries and social benefits accounts - a critical variable for the estimate of a company´s human capital and one of the key variables of the tested model.

4 DATA PRESENTATION AND ANALYSIS

Table 2 below displays the descriptive statistics for the segment. From the sample, profit rates above 150% were eliminated given that to our understanding such high rates express an underestimate of assets.

Table 2: Variable description of the tested model for sector 28

VARIABLE	OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
ROA4	898	0.5823933	0.221643	0.190248	1.323.753
LnCIV	396	1.615.737	1.596.721	10.409.922	2.127.269
VAIC	898	32.631	21.144.061	1.209.743	2.758.873
VARIÁVEL		ROA4		VAIC	ICE
ROA4		1			
VAIC		-0.0053		1	
LNCIV		-0.0369		0.4048	1
Source: the authors based on STATA SE/10 outputs					

From the descriptions, one notices that VAIC and LnCIV variables are positively related under a correlation grade of 0,41 to one. The correlation matrix also depicts a negative association, though minor, in separate form, between ROA4 and each of the VAIC and LnCIV independent variables, an unexpected event. In the fixed effects regression, the predominant type, coefficients of both variables run in the robust manner are positive, as expected according to theory.

Table 3 that follows presents tests for Sector 28 static panel model, which pertains to the metal product manufacturing sector, excluding machinery

and equipment.

Table 3: Static model : ROA4 = f(LnCIV; VAIC;Dummy year 2001 to 2006).

Variables and Data	Results and Significance Tests				
	OLS Pooled	Random Effect	Fixed Effect Wt. c/1ª Dif.	Fixed Effect Within	Fixed Effect Within w/ Robust Var.(2)
Dependent Var. ROA 4 (1)					(continues)
Independent Var.					
Ln CIV	-.0106184	.0064008	.0257781**	.0438067*	.0438067* (continues)
VAIC	.0030204	.0174284*	.0712357*	.0342004*	.0342004*
Dummy of 2001-2006	Yes	Yes	Yes	Yes	Yes
Equal	.7915	.4911304*	-0941698*	-.156538	-.1565384
Statistics/ Tests					
FIV Factor	1.92				
Heteroscedasticity (8).	chi2(1) = 0.00 (Prob > chi2 = 0.9807)				
Serial autocorrelation (8).	F(1,46) =0.277 (Prob > F = 0.6013)				
Observations	396	396	222	396	396
Adjusted/Within R2 (3)	0.0081	0,1446	0,2548	0,2039	0,2039
Between R2	nd	0,0082	Nd	0,0385	0,0385
Overall/Squared R2	0,0282	0,0033	0.2784	0,0005	0,0005
F Regression Test (4)	1.40(0,19)		11,7(0,0)	7,52 (0,0)	4,04(0,0)
Degrees of Freedom	F(8,387)	Wal(8)=21,7	F(7,214)	F(8, 235)	F(8, 235)
			p-value	Result	Significance 1% * 5% ** 10% ***
F Test F(152,235) (5)	4,51		0.0000	Fixed Effect	
Breush-Pagan chi2(1)(6)	63,40		0.0000	Random Effect	
Hausman (7)	52,84		0.0000	Fixed Effect	

(1) ROA4 = Return (Gross Profit) over Total Assets

(2) According to the Newey West estimator, as per Yafee (2008)

(3) Adjusted R2 for the Pooled OLS, R2Within for the remainder

(4) F Joint Significance test of Regression Coefficients, the same for the Wald Random Effect test

(5) F Test according to the decision made between Fixed Effect and Pooled OLS models: if significant, Fixed Effect prevails

(6) Breush-Pagan test comparing Random Effects with Pooled OLS Effects, whereby if significant, the Random model prevails

(7) Hausmann test comparing Random to Fixed Effects, whereby if significant, the Fixed Effects prevails.

Source: prepared by the author based on Stata. SE/10 and PIA (IBGE) ouputs.

Statistical tests indicated:

- ✓ An inflationary variance factor (FIV) of 1,92 revealing a certain level of multicollinearity in the model;
- ✓ The heteroscedasticity test (Breusch-Pagan / Cook-Weisberg) did not reject the null hypothesis that variances of residues are equal;
- ✓ Wooldridge´s residue autocorrelation test for data in panel did not reject the null hypothesis concerning the absence of first order autocorrelation in the residues, thus there is autocorrelation of residues; and
- ✓ Hausman´s test indicated the presence of fixed effects at a 1% significance.

Test F rejected the null hypothesis of non existence of the robust variance regression at 1% significance and the test rejected the null hypothesis validating the VAIC coefficient and that of LnCIV in White e Newey-West´s robust option (that treats autocorrelation and heteroscedasticity effects). Both present a positive sign for value creation.

Dynamic models in panel were tested but results were not considered conclusive.

5 FINAL CONSIDERATIONS

In general, results obtained indicate that the VAIC model is of relevance when explaining value creation by companies, the same holding true for the representative variable of the calculated intangible value (LnCIV) in the static models. The coefficients of both variables have a positive sign confirming its positive association with value creation considering that the 0,034 VAIC coefficient is lower than that of the 0,044 LnCIV. These coefficients are low suggesting that, for a 100% value creation one might accredit to intellectual capital, this low percentage alone, less than 5%, might be captured by each and every variable, giving rise to suspicions as to the need to reconfigure the model/variables.

As far as the dynamic models are concerned, statistic tests did not present an improved statistical significance, which explains why they were not reported.

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