The Impact of Intangibles on Value Creation

Comparative Analysis for USA Sectors

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Abstract

This article compared the proposal for measuring intangibles of Gu&Lev for the sectors of software (classified in services) and equipment and technology for computing (classified in industry) in the United States. The idea of comparing the sectors arose from the discovery in two previous articles of a discrepancy in the results mainly for the indices proposed by Gu&Lev to measure intangibility and their impact on value creation. The database used was Thomson-Reuters collected in Datastream, with information covering the period from 2001 to 2010. Gu&Lev (2003, 2011) [1] and [2] present a proposal that aims to calculate a variable, comprehensive value, which encompasses the tangible and intangible assets of the company and are therefore a proxy for their market value. If this variable explains the market value, it is a solution to a problem that afflicts accountants, which is how to account for intangibles in the balance sheet. They also propose two other variables, one that is a proxy for the flow of intangibles *(*Intangibles-Driven-Earnings- IDE), and another that is a proxy for the stock of intangibles (Intangible Capital -IC). They present a set of hypotheses that relate traditional variables linked to intangibility (research and development expenditures, selling, general and administrative expenses, and investment in fixed capital) with the flow (IDE), stock of intangibles (IC) and intangibility indicators that explain the shareholder return. We observed differences between the sectors, reinforcing the conviction that the sectors are important to explain differences in the intangibility indices. For the software sector the model presented research and development expenditures (RD) and selling, general and administrative expenses (SGA) as proxies for intangibility. However the strong correlation between and among the explanatory variables may have changed the RD signal. The same thing happens with the model where the two explanatory variables presented statistical significance to explain the stock of intangibles, but there may have been a change of signal of the RD variable. The model that sought to explain the contribution of the flow and of the stock of intangibles in the determination of the total shareholder return did not present significance for any of the explanatory variables. We believe that the result of the model that explains the market value by the sum of stocks of tangibles and intangibles is more relevant, as if it is corroborated for more sectors and countries it will lend considerable credibility to the methodological proposal of Gu&Lev (2003, 2011) [1] and [2], who claim to have a solution for approximating the book values (found in financial statements) to the market value of a company. The result was auspicious for the software sector, since the comprehensive value (which considers the sum of the book values with a Proxy for the intangibles) explains the market value. This result leaves room for the pursuit of market values for unquoted companies based on the methodology proposed by Gu&Lev. This calls for a broader study, involving all the sectors to assess the impact of the angular coefficients at the sectoral level, as well as at the level of size.

As concerns the intangibility indices, the only indicators that presented explanatory power (at 5%, however) were ICBV and RI, a disappointing result. It was to be expected that ICBV would present explanatory power, since the stock of intangible capital (as well as the flow - model 4) had explanatory power over the market value (it is expected that the higher the market value, the higher the total shareholder return). The same applies to the variable RI, obtained from the division of the stock of intangibles by the research and development expenditures. The stock of intangibles explains the market value (model 4) and the RD expenditures exhibit high correlation with IDE. We did not manage to find a justification for the lack of statistical significance of the other intangibility indices (ICM, IDEM, ICOM; MtCV). The comparison with the hardware sector enabled us to verify that there are no repeated results. The hypothesis test for the hardware sector showed that as far as traditional hypotheses are concerned (models 1 to 4 of those proposed by Gu&Lev) the model that presented research and development expenditures (RD), capital expenditures (CAPEX) and selling, general and administrative expenses (SGA) as proxies for intangibility was significant for all the variables. However, two of the variables (RD and CAPEX) presented negative signals, which was unexpected. The correlation between RD and CAPEX is not high; the strong correlation between SGA and RD may have changed the RD signal. The other two models did not present significance for any of the explanatory variables. As mentioned previously, the result of the model that relates the sum of intangibles and tangibles to the company's market value is the most relevant and the hypothesis was corroborated. As concerns the intangibility indices, the results diverge from those found for the software sector. The only indicators that presented explanatory power at 1% were MtCV, ICM and RI; a disappointing result. We did not manage to find any justification for the lack of statistical significance of the other intangibility indices (IDEM, ICOM; ICBV). The comparison with the software sector indicated that intangibility indicators are not repeated when we carry out a sectoral analysis.

Key Words: Intangible Assets, Value Creation, Total Shareholder Return, Intangibility Indices.

Introduction

Intangibles are being studied by various areas of knowledge. Bontis (2002) observed that concern about the topic is present in economics, sociology, psychology, administration (information technology, human resource administration, management research). Andriessen (2004) [3], supported by the work of Bontis (2002) and Bontis et. al. (1999), selected five important schools of thought for the study of intangibles. The intellectual capital community is interested in the definition and measurement of intellectual capital, one of the forms of intangibles. Andriessen (2004) [3] brought up 12 methodologies that seek to provide a response to the problems of definition and measurement ([4]; [5]; [6]; [7]; [8]; [9]; [10]; [11]; [12]; [13]; [14,15 and 16]; [17 and 18]. The accounting community is interested in the accounting of intangibles in the financial statements, on the basis that traditional financial accounting does not present a satisfactory response for the market value of companies that is very different from the value expressed in traditional financial statements ([19]; [20]; [1] and [21]). Andriessen (2004) [3] brought up seven methodologies that develop studies along this line of research. The performance measurement community incorporated the concept of intangibles to lend greater credibility to the focal points of performance measurement and according to [3] there are 2 methodologies that work with this concern ([22]; [23 and 24]; [25]; [26]). The valuation community, arising from financial studies, seeks to improve measurements (from the perspectives of the discounted cash flow and real options) of the

highly uncertain values that originate from intangibles. Andriessen (2004) [3] verified three methodological focuses that work along this line of research [27] and [28]. The human resources community, with a representative in the survey conducted by [3], seeks to reactivate human resources accounting techniques that developed in the 1960s and 1970s [29].

Gu&Lev are representatives of the accounting area, as they are interested in approximating the book values of a company to the market value. From this point of view they are close to the line of thought of normative accounting, which is concerned about establishing rules for the accounting of intangibles [29] and [30].

Proposal of Gu and Lev

Gu and Lev (2003; 2011) [1] and [2] base their proposal on an enlarged production function. In the simple production function, the factors that are included to achieve levels of production are capital and labor. The enlarged production function considers intangibles as a production factor, as expressed in the equation:

$$\text{Economic Performance} = \alpha * (\text{Physical Assets}) + \beta * (\text{Financial Assets}) + \gamma * (\text{Intangible Assets})$$

This equation expresses the fact that value creation (measured by the value added, i.e., the sum of profits and salaries in a simple economy) can be explained by the contributions of labor and capital. The empirical observation that these two factors alone did not explain the production of an economy led economists to include a third factor in the equation. This factor encompasses what it is not the contribution of capital and of labor and is generally designated intangibles. Where **α, β and γ** represent respectively the contributions of physical assets, of financial assets and of intangible assets. The algebraic manipulation of the equation shows that the value of intangibles can be obtained by subtracting the economic performance from the normal returns of the physical and financial assets. The result is the contribution of intangible assets, designated "Intangibles-Driven-Earnings", IDEs. Five steps are necessary to calculate the contribution of intangibles.

a) Calculation of the normalized economic performance. The normalized earnings (we will use EBITDA, earnings before interest, taxes, depreciation and amortization as a Proxy for economic performance) as it represents the company's gross value creation (in other words, before any deduction, and before any distribution to the stakeholders). To compose this variable the author recommends the use of past and prospective earnings. The reason is simple: intangibles increasingly act on the generation of future earnings. It is recommended to use the same number of years for the past and the future (3 to 5), whereas the higher weights should be reserved for the future.

b) The second step consists of calculating the physical and financial assets. Physical assets are defined as property, plant and equipment, [1]. Financial assets are defined as cash on hand, shares, and financial instruments, [1]. To calculate the contributions of physical and financial asset the author uses data already available in the economic literature. The rate of return of 7% for physical assets was based on the studies by [31] and [32]. For the financial assets, the rate of 4.5% was based on the 10-year average return of the US treasury. The values of the physical and financial assets should be restated using appropriate discount rates for restated values.

c) The third step consists of the estimation of IDEs. To obtain this amount the contribution of financial (β) and physical (α) assets, multiplied by the respective values of the physical and financial assets, are then subtracted from the company's Estimated Economic Performance. The result of this subtraction is the contribution of the intangible assets, which is defined by the authors as IDE (Intangibles- Driven-Earnings).

d) The fourth step consists of the calculation of prospective IDEs for three future periods [1]. The first period is composed of years 1 to 5, calculated in the previous stages. The second period covers years 6 to 10 and the projection of the IDEs is based on applying a linear growth (or decay) rate to the IDE obtained in year five, until the growth rate reaches 3%. The third period extends infinitely from year 11, and it is assumed that the IDE will grow annually at a rate of 3%, which is the growth rate expected from the economy.

e) The fifth step consists of determining the stock of intangible capital obtained by the deduction of the prospective IDEs using a rate that reflects the degree of risk of the IDEs; as they are a product of intangibles, the rate needs to be above average. Gu and Lev (2003) [1] are not very precise in their explanation of the determination of this rate. We used a rate of 7.5% in this paper.

Gu and Lev (2003) [1] also defined the comprehensive value of companies, which encompasses the tangible and intangible part, aiming to correct the differences observed in the book value of these companies. Comprehensive value is defined as the sum of the book value and of the intangible capital explained previously.

As a result, Gu and Lev (2003) [1], formulated a series of new company performance appraisal indices, based on public information: Intangible Capital Margin (ICM): (Intangible Capital / Sales); Intangible Capital Operating Margin (ICOM): (IDE / Operating Income - EBIT); Comprehensive Value (CV): (Intangible Capital + Book Value); Return on Investment of R&D: (RI) - (Intangible Capital / Investments in R&D); Market-to-Comprehensive Value (MtCV): (Market Value / Intangible Capital). Values close to 1.00 indicate the importance of the intangibles and the closeness of this indicator to the company's market value and; Intangible Capital to Book Value (ICBV): (Intangible Capital / Book Value). This will indicate to what extent the company or sector analyzed is based on intangible assets. These indicators were transformed into hypotheses by means of an association with shareholder value creation, represented by the total shareholder return.

Hypotheses

This study presents two novelties in relation to the articles of Gu&Lev [1] and [2]. The first is that we expanded the hypotheses in relation to the articles that we used as a reference. A first block of hypotheses is similar to the set of hypotheses tested by [1] and [2]. The traditional hypotheses are:

Hypotheses I: The higher the investment in research and development (RD), capital expenditures (CAPEX) and selling, general and administrative expenses (SGA), the higher the degree of intangibility (IDE) of the company.

Hypotheses II: The higher the investment in research and development (RD), capital expenditures (CAPEX) and selling, general and administrative expenses (SGA), the higher the intangible capital (IC) of the company.

Hypotheses III: The higher the degree of intangibility (IDE), the variation in the degree of intangibility, the operational performance (EARN) and the variation in the operational performance (EARN), the higher the total shareholder return (TSR).

Hypotheses IV: The higher the Comprehensive Value (CV) the higher the company's market value (MV).

We consider the fourth hypothesis the most relevant of the studies by Gu&Lev, since if it is corroborated we can obtain an approximation for the market value of companies, particularly for unquoted ones. For the estimates to be more accurate, we need to expand the

studies for all the sectors, as the values of the angular coefficients may be different for sectors with a high degree of intangibility in relation to those with a low degree.

The second block of hypotheses (that represented the innovation of this study) consisted of testing the model of Gu and Lev (2003) [1] for the intangibility indices proposed by the authors with value creation represented by total shareholder return. Gu and Lev created a series of indicators to measure intangibility; since intangible resources increasingly represent the largest portion responsible for value creation, a general hypothesis can be constructed:

The higher the intangibility (measured by an appropriate indicator) the higher the value creation. Using the indicators that Gu and Lev created we built a second block of hypotheses (we also present the equations that express the hypotheses).

Hypotheses V: The higher the Intangible Capital Margin (Intangible Capital/Sales) the higher the shareholder return.

Hypotheses VI: The higher the Intangibles Driven Earnings Margin (Intangibles-Driven-Earnings/Sales) the higher the shareholder return.

Hypotheses VII: The higher the Intangible Capital Operating Margin (IDE/Operating Income) the higher the shareholder return.

Hypotheses VIII: The higher the intangible capital to book value the higher the shareholder return.

Hypotheses IX: The higher the market to comprehensive value, the higher the shareholder return.

Hypotheses X: The higher the return on the investment in research and development, the higher the shareholder return.

We used the econometric methodology denominated panel data, which analyzes all the companies (cross section) in various periods of time (time period) to conduct the tests.

Analysis of Results

We decided to compare two sectors relevant to the US economy: that of software and that of hardware. The first presented 856 companies in the base and the second 551. After eliminating companies that did not present data for all the years, we arrived at 792 observations for the software sector and 591 for the hardware sector. The number of observations drops steeply when we test the alternative hypotheses (incorporating the intangibility indicators) because many companies do not present all the necessary data. Some variables were collected directly in Datastream and others were created to test the hypotheses.

Descriptive analysis

As we ignore a segmentation by size, the variables (in thousands of dollars) present considerable dispersion, which violates the assumptions of the regression model (normality); accordingly, the results need to be analyzed with extreme caution and are only an indication of the corroborated relations that should be tested using a segmentation by size to lend more credibility to the conclusions.

Correlation matrix

Interesting results are observed. In the software sector for the traditional hypotheses (models 1, 2 and 3 already tested by Gu&Lev) we observed high correlation between the independent variables: (i) model 1, RD with CAPEX correlation of 0.81, (ii) model 2, RD

with CAPEX correlation of 0.81, (iii) model 3, IDE with EARN of 0.99 which entails the phenomenon of multicollinearity between the independent variables, which may give rise to a change of signal of the explanatory variable.

Model four, which if corroborated presents an important contribution by Gu&Lev (2003;2011) [1] and [2] to the study of intangibles, as it proposes a Proxy for the market value of companies, relates the comprehensive value to the total shareholder return (presenting a positive correlation of 0.94).

The correlations of models 6 to 10 are related to the innovation of this study (testing of the intangibility indices proposed by [1] and [2]. The dependent variable, total shareholder return (TSR), in general, presents low linear correlation with the independent variables: ICM (0.016), IDEM (0.038), ICOM (-0.13), ICBV (0.024), MtCV (0.34) and RI (-0.04). Due to the low correlations it would not be surprising if the new hypotheses of the intangibility indicators were not corroborated.

In the hardware sector for the traditional hypotheses (models 1, 2 and 3 already tested by Gu&Lev) we observe correlations that diverge from the correlations found for the software sector: (i) model 1, RD with CAPEX correlation of 0.45 and a high correlation of RD with SGA (0.91); there is also a high correlation between IDE and SGA (0.86) indicating a high explanatory power for this variable, (ii) model 2, the correlation of RD with CAPEX (0.45) is much lower than that found in the software sector, (iii) model 3, IDE with EARN of 0.957, which entails the phenomenon of multicollinearity between and among the independent variables which could bring about a change of signal of the explanatory variable.

Model 4 presented high correlation (0.714) between MV and CV (comprehensive value), increasing our expectations regarding the explanatory power of CV as a Proxy for intangibility.

The correlations of models 6 to 10 are related to the innovation of this study (testing of the intangibility indices). The dependent variable, total shareholder return (TSR), in general, presents low linear correlation with the independent variables: ICM (0.15), IDEM (-0.023), ICOM (0.052), ICBV (0.093), MtCV (0.02) and RI (0.22). Judging by the low correlations it would not be surprising if the new hypotheses of the intangibility indicators were not corroborated.

Results – Analysis of the Hypotheses

Static panel data analyses were carried out for all the models. The results of the regressions associated with the ten hypotheses of this study (regressions for the two sectors) are presented in tables 1 and 2. It is possible to observe in the tables the results of the angular regression coefficients, as well as the values of R^2 within, R^2 between, R^2 overall, the F- and/or Chi-squared test statistic for general validity of the model, the value of the F, Breush-Pagan and Hausman tests (which allows us to decide between the pooled data grouping models, fixed or random effects models), the value of the Breusch-Pagan/ Cook-Wesberg test statistic that allows us to observe the existence of heterocedasticity and the Wooldridge test statistic to verify the existence of autocorrelation [33].

To analyze the fixed effects models (with a significant result for the presence of heterocedasticity in the Breusch-Pagan/ Cook-Wesberg test), we used the model with robust variance according to the Newey-West estimator that corrects the effects of the presence of heterocedasticity.

First we analyzed the software sector (Table 1); model 1 presented as proxies for intangibility both RD and SGA. However the strong correlation between the explanatory variables may have changed the RD signal. The same thing happens with model 2, where the two explanatory variables presented statistical significance to explain the stock of intangibles, but there may have been a change of signal of the RD variable. Model 3 did not present

significance for any of the explanatory variables. Model 4, which we consider the most important, as it proposes a methodology to approximate the book value to the market value, presented statistical significance at 1%. We consider the result promising if it is corroborated for other sectors.

As concerns the intangibility indices the only indicators that presented explanatory power (at 10%, however) were ICBV and RI, a disappointing result. It was to be expected that ICBV would present explanatory power, since the stock of intangible capital (as well as the flow - model 4) had explanatory power over the market value (it is expected that the higher the market value, the higher the total shareholder return). The same applies to the variable RI, obtained from the division of the stock of intangibles by the research and development expenditures. The stock of intangibles explains the market value (model 4) and the RD expenditures exhibit high correlation with IDE. We did not manage to find a justification for the lack of statistical significance of the other intangibility indices (ICM, IDEM, ICOM; MtCV).

Table 1: Results for the software sector

Variable	Model 1 (*)		Model 2		Model 3		Model 4 (*)		Model 5		Model 6		Model 7		Model 8		Modelo9 (*)		Model 10	
Dependent	**IDE**		**IC**		**TSR**		**MV**		**TSR**		**TSR**		**TSR**		**TSR**		**TSR**		**TSR**	
Constant	-9453,26		-315499		0,26	*	4370366	*	0,218	***	0,19		0,3	*	-0,28		-0,513		-0,35	
RD	-1,54	*	-25,58	*																
CAPEX	0,32		-6,13																	
SGA	1,19	*	17,69	*																
IDE					11100000															
ΔIDE					-25900000															
EARN					-11600000															
ΔEARN					826000000															
CV							0,053	*												
ICM									0,0018											
IDEM											0,15									
ICOM													-0,05							
ICBV															0,044	***				
MtCV																	1,17			
RI																			0,0059	***
N.B.	792		792		63		1025		63		63		63		58		63		58	
F-test	16,36	*	340,21	*	0,51	***	87,46	*	0,83	***	0,73	***	0,68	***	0,91	***	0,76	***	0,85	***
Breush-Pagan	344,7	*	1607,54	*	1,39	***	1961,74	*	0,99	***	0,94	***	0,66	***	0,69	***	2,15	***	1,14	***
Hausman	810,53	*	141,45	*	0,31	***	14,44	*	2,99	***	1,7	***	1,19	***	3,37	**	4,3	**	3,15	***
R^2 within	0,66		0,09		0,01		0,01		0,056		0,035		0,04		0,066		0,15		0,06	
R^2 between	0,85		0,24		0,1		0,3		0,0033		0,0002		0,08		0,006		0,34		0,03	
R^2 overall	0,84		0,24		0,02		0,29		0,0003		0,0015		0,01		0,0006		0,12		0,0026	
F model	28,86	*	20,83	*	1,4		0,86		0,02		0,09		1,11		3,12	***	1,71		0,85	
Heterocedasticity	3500,78	*	4,41	**	3,89	**	16,77	*	4,48	**	3,2	***	0,16	***	2,28	***	37,87	*	0,69	***
Autocorrelation	43,28	*	2676,89	*	17,68	*	16,24	*	14,23	*	22,01	*	18,89	*	12,43	*	25,78	*	15,68	*

(*) Robust Fixed Effect – According to Newey West estimator

N.B.: (*) statistically significant at the level of 1%, (**)statistically significant at the level of 5%, (***)statistically significant at the level of 10%.

The hardware sector (Table 2) did not present results similar to those of the software sector. As concerns the traditional hypotheses (models 1 to 4 of those proposed by Gu&Lev) model 1 presented as proxies for RD, CAPEX and SGA. However, two of the variables (RD and CAPEX) presented negative signals, which is unexpected. The correlation between RD and CAPEX is not high; the strong correlation between SGA and RD may have changed the RD signal. Models 2 and 3 did not present significance for any of the explanatory variables.

As mentioned previously, the result of model 4 is the most relevant, and the result is similar to that of the software sector; the comprehensive value explains the market value.

As concerns the intangibility indices the results diverge from those found for the software sector. The only indicators that presented explanatory power at 1% were MtCV, ICM and RI, a disappointing result. We did not manage to find a justification for the lack of statistical significance of the other intangibility indices (IDEM, ICOM; ICBV). The comparison with the software sector indicated that the intangibility indicators are not repeated when we carry out a sectoral analysis.

We believe that the result of model 4 is the most relevant, as if it is corroborated for more sectors and countries it will lend considerable credibility to the methodological proposal

of Gu&Lev (2011) [2] who claim to have a solution for approximating the book values (found in financial statements) to the market value of a company. This calls for a broader study, involving all the sectors to assess the impact of the angular coefficients at the sectorial level, as well as at the level of size.

Table 2: Results for the hardware sector

Variable	Model 1 (*)		Model 2		Model 3		Model 4 (*)		Model 5		Model 6		Model 7		Model 8		Model 9 (*)		Model 10	
Dependent	IDE		IC		TSR		MV		TSR		TSR		TSR		TSR		TSR		TSR	
Constant	403015	*	28400000000		0,418	*	-3566083	*	-0,11		0,228	*	0,196	*	0,172	*	-0,43	**	0,107	**
RD	-1,92	*	4482,08																	
CAPEX	-0,13	*	-180,48																	
SGA	1,03	*	-874,33																	
IDE					15100000															
ΔIDE					-0,0000003															
EARN					-0,00000017															
ΔEARN					0,00000012															
CV							0,656	*												
ICM									0,054	**										
IDEM											-0,061									
ICOM													0,138							
ICBV															0,0059					
MtCV																	1,032	*		
RI																			0,0016	*
N.B.	615		615		141		1218		132		132		132		132		132		132	
F-test	10,73	*	338,93	*	2,53	*	38,56	*	0,83	***	0,68	***	0,67	***	0,75	***	1,33	***	0,57	***
Breush-Pagan	337,89	*	1259,39	*	2,9	***	1866,22	*	1,44	***	1,52	***	1,74	***	1,62	***	1,23	***	2,71	***
Hausman	270,61	*	0,22	***	0,46	***	190,93	*	3,73	**	0,17	***	2,18	***	0,16	***	17,7	*	1,04	***
R^2 within	0,17		0,002		0,0186		0,379		0,05		0,0007		0,0015		0,007		0,12		0,029	
R^2 between	0,36		0,0006		0,0125		0,533		0,01		0,014		0,234		0,016		0,11		0,319	
R^2 overall	0,35		0,0006		0,0118		0,511		0,02		0,0005		0,0028		0,008		0,0004		0,052	
F model	10,73		0,34		2,25		6,37	*	5,99	**	0,07		0,36		1,13		15,04	*	7,24	*
Heterocedasticity	2190,49	*	35,74	*	5,53	*	12946,54	*	0,19	***	16,8	*	0,65	***	1,32	***	0,46	***	1,88	***
Autocorrelation	23,24	*	177000000	*	18,01	*	13,59	*	7,45	*	12,42	*	13,96	*	13,27	*	50,41	*	14,37	*

(*) Robust Fixed Effect – According to Newey West estimator

N.B.: (*) statistically significant at the level of 1%, (**)statistically significant at the level of 5%, (***)statistically significant at the level of 10%.

A criticism made of the Gu &Lev model is related to the arbitrariness of the choice of the discount rate for intangible capital. We conducted a sensitivity analysis varying the discount rate from 7.5% (the value that we used) to 15%.

The results remained the same (not presented here as they produce an excessive increase in the article size), which we consider a promising result since the managers can work with variation intervals for the idiosyncratic risk that they believe their companies to have and nonetheless find a Proxy for the market value, a methodology that can be applied to unquoted companies.

Conclusions

This article compared the proposal for measuring intangibles of Gu&Lev for the sectors of software (classified in services) and equipment and technology for computing (classified in industry) in the United States. The idea of comparing the sectors arose from the discovery in two previous articles of a discrepancy in the results mainly for the indices proposed by Gu&Lev to measure intangibility and their impact on value creation. The database used was Thomson-Reuters collected in Datastream, with information covering the period from 2001 to 2010. Gu&Lev (2011) [2] present a proposal that aims to calculate a variable, comprehensive value, which encompasses the tangible and intangible assets of the company and are therefore a Proxy for their market value. If this variable explains the market value, it is a solution to a problem that afflicts accountants, which is how to account for intangibles in the balance sheet. They also propose two other variables, one that is a proxy for the flow of intangibles (Intangibles-Driven-Earnings- IDE), and another that is a proxy for the stock of intangibles (Intangible Capital -IC). They present a set of hypotheses that relate traditional variables linked to intangibility (research and development expenditures, selling, general and administrative expenses, and investment in fixed capital) with the flow (IDE),

stock of intangibles (IC) and intangibility indicators that explain the shareholder return. We observed differences between the sectors, reinforcing the conviction that the sectors are important to explain differences in the intangibility indices. For the software sector the model presented research and development expenditures (RD) and selling, general and administrative expenses (SGA) as proxies for intangibility. However the strong correlation between and among the explanatory variables may have changed the RD signal. The same thing happens with the model where the two explanatory variables presented statistical significance to explain the stock of intangibles, but there may have been a change of signal of the RD variable. The model that sought to explain the contribution of the flow and of the stock of intangibles in the determination of the total shareholder return did not present significance for any of the explanatory variables. We believe that the result of the model that explains the market value by the sum of stocks of tangibles and intangibles is more relevant, as if it is corroborated for more sectors and countries it will lend considerable credibility to the methodological proposal of Gu&Lev (2011) [2], who claim to have a solution for approximating the book values (found in financial statements) to the market value of a company. This calls for a broader study, involving all the sectors to assess the impact of the angular coefficients at the sectoral level, as well as at the level of size.

As concerns the intangibility indices, the only indicators that presented explanatory power (at 5%, however) were ICBV and RI, a disappointing result. It was to be expected that ICBV would present explanatory power, since the stock of intangible capital (as well as the flow - model 4) had explanatory power over the market value (it is expected that the higher the market value, the higher the total shareholder return). The same applies to the variable RI, obtained from the division of the stock of intangibles by the research and development expenditures. The stock of intangibles explains the market value (model 4) and the RD expenditures exhibit high correlation with IDE. We did not manage to find a justification for the lack of statistical significance of the other intangibility indices (ICM, IDEM, ICOM; MtCV). The comparison with the hardware sector enabled us to verify that there are no repeated results. The hypothesis test for the hardware sector showed that as far as traditional hypotheses are concerned (models 1 to 4 of those proposed by Gu&Lev) the model presented research and development expenditures (RD), capital expenditures (CAPEX) and selling, general and administrative expenses (SGA) as proxies for intangibility. However, two of the variables (RD and CAPEX) presented negative signals, which was unexpected. The correlation between RD and CAPEX is not high; the strong correlation between SGA and RD may have changed the RD signal. The other two models did not present significance for any of the explanatory variables. As mentioned previously, the result of the model that relates the sum of intangibles and tangibles to the company's market value is the most relevant and the result, similar to that of the software sector, is promising, as we achieved statistical significance. As concerns the intangibility indices, the results diverge from those found for the software sector. The only indicators that presented explanatory power at 1% were MtCV, ICM and RI; a disappointing result. We did not manage to find any justification for the lack of statistical significance of the other intangibility indices (ICM, IDEM, ICOM; ICBV). The comparison with the software sector indicated that intangibility indicators are not repeated when we carry out a sectoral analysis.

Limitations and Further research

Like every study that seeks to corroborate hypotheses using econometric models, this study presents some limitations. The first concerns the sample, as we selected companies available in the two sectors analyzed (nonrandom sample). The second concerns the variable chosen to represent value creation, which is total shareholder return; in future studies we need to consider other variables such as profitability, Tobin's Q and the price to book (see [34]).

Another limitation is due to the use of static panels that do not capture the effect of lagged variables.

Two other limitations are due to the arbitrary choice of weightings and the arbitrary choice for the contribution of the physical and financial assets. For the calculation of economic performance, we arbitrarily assign weights to the annual EBITDAs. The contributions of the physical and financial assets for calculation of the Intangibles-Driven-Earning (IDE) were sought in the existing literature and may not reflect changes in the structural conditions of the economy. The discount rate used to calculate the Intangible Capital (IC) was also arbitrary. To verify whether the results remained the same, we varied the discount rate of the idiosyncratic risk in the range of 7.5% to 15% and verified that the results were the same. Thus the methodology appears promising for the theoretical line of thought that seeks models to record the value of intangibles, particularly for unquoted companies.

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