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RESEARCH ARTICLE

WHAT YOU MEASURE IS WHAT YOU GET! INTELLECTUAL CAPITAL AND BIBLIOMETRY RESEARCH IN PORTUGAL RESEARCH UNITS

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ABSTRACT

The purpose of this paper is to examine the relationship between Intellectual Capital (IC) and the evaluation of the Portuguese Research Units (RU) given by the Foundation for Science and Technology (FCT). In particular the aim is to argue that in these Research Units, the evaluations of IC is related to financial support (FS) and bibliometric indicators (BI). The article tests the BI/FS relationship at the Research Units in Portugal, by surveying the *inputs* products of full time researchers members. The survey addresses, in particular, the financial support given by Portuguese FCT to Researcher Units measured by bibliometry. The results suggest that RU evaluations are indeed related to thematic scientific area and not with IC. The survey addresses, in particular, the factors that promote the RU evaluations and their perception, like bibliometric indicators as *input* products, of IC in ours Universities.

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INTRODUCTION

Intellectual capital is a concept that is achieving researcher's attention day by day. Education sector especially universities were selected because it plays a critical role for the development and growth of knowledge intensive sector. In this research study our sample are composed by the financial support and evaluating, number of researchers and bibliometric indicators in research units in Portugal. Reliability analysis is conducted to check the reliability of constructs and Pearsons correlation is applied to explore the relationship of thesevariables. Results indicate that the relation of human capital is more prominent with intelectual capital and can be interpreted us a product (Publications) and measured like a input. The aim of this paper is to analyse some fundamental challenges regarding the measurement of the intellectual capital (IC) of Units Research (UR). The paper reviews the main initiatives concerning the measurement, management and disclosure of intellectual capital (IC) in UR. Those organisations also are facing the challenge of managing intangible in their value creation process. Several researches have linked some elements of IC (human, structural and relational capital) to performance indicators in firms. However, IC is still not being sufficiently implemented in universities and similar knowledge-based organisations. Three main initiatives are remarkable throughout the academic literature: (1) the ICU-Report; (2) the Danish IC Guidelines (Industry, 2000); (3) the Austrian Research Centres initiative. There are a lack of a more holistic model for managerial purposes, however there are original matrix including performance indicators of the three missions of a university (teaching, researching and transferring), trying to relate them with their possible causal IC elements. European public policies regarding Higher Education are highlighting the role of such institutions in the knowledge-based economies. As stated by(Commission, 2003) the main goals of universities must be production, diffusion and knowledge transferring. Other authors, who define the main goals of a university today, state similar idea (Gibbons, M.; Limoges, C.; Nowotny, H.; Schwartzman, S.; Scott, P. and Two, 1994); Bueno Campos 2007)

Literature review

The human capital construct still does not present a definition that is firmly and consensually established and can be approached from different perspective and approaches. According to the Organization for Economic Co-operation and Development (OCDE, 1996), human capital can be viewed as one of the driving forces behind a country's economic activity, competitiveness and prosperity. An interesting

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conceptualization proposal arises with Gratton and Ghostal (2003). According to these researchers, human capital is defined by its components, more properly understood as three types of resources that all people possess and that collectively constitute human capital. According to (Gratton, L.; Ghoshal, 2003) human capital (Roos, J.; Roos, G.; Dragonetti, N.C. and Edvinsson, 1997) (McGregor, J.; Tweed, D. and Pech, 2004)consists of three types of resources (figure 1): Intellectual Capital hich encompasses attributes such as lifelong knowledge, learning and skills; Social capital(Roos, J.; Roos, G.; Dragonetti, N.C. and Edvinsson, 1997) (Boisot, 2002) (Ordóñez de Pablos, 2004) that includes sociability and trust and emotional capital (Bontis, 1996) (Stewart, 1997) that adds factors such as self-awareness, ambition and resilience.

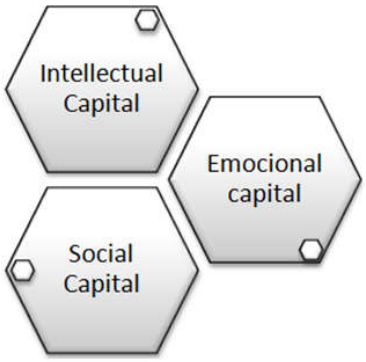

Figure 1. Component of Human Capital

According to this perspective, the three constituents are interrelated and their contribution, the competitive advantage they bring to the organization, stems from their connectivity, their ambition and the loops introduced by feedback ((Stewart, T.A. and Kirsch, 1991) (Saint-Onge, 1996) (Edvinsson, L. and Sullivan, 1996) (Bontis, 1996) (Sveiby, 1997) (Commission, 2006). Intangible assets are enablers, as they transform productive resources into value-added assets (Hall, 1992), and this should be a key issue for universities. Moreover, the Bologna Declaration´s challenges for universities go beyond the simple statement of a European Higher Education Area. It suggests the path to achieve the excellence in the educational and, in a lesser extent, in the research function of any university. Consequently, public sector starts developing systems to acquire and assure the quality of the universities. Nevertheless, those systems are too focused in evaluating the human capital (the researcher-professor) and they do not pay attention to other intangible elements (e.g. relational capital). Intangible and, more specifically, knowledge management in firms are widely recognised as key factors in the creation and the maintenance of sustainable competitive advantages (Sveiby, 2001). Intellectual Capital is referred to those intangible, hidden assets and knowledge resources, which help in the process of value creation in organisations, increasing their competitive capacity (Stewart, 1997); (Sveiby, 2001); (Yi, A. and Davey, 2010). It is stated that every time a knowledge transfer or a conversion is done, the organisation´s value grows (Sveiby, 2001). The most successful firms are those that use their knowledge assets best and quickest than their competitors do(Bontis, 1999); (Teece, D.J.; Pisano, G. and Shuen, 1997). Therefore, adequate system to measure the IC through the management performance indicators are required (Roos, J.; Roos, G.; Dragonetti, N.C. and Edvinsson, 1997), because "what you measure is what you get" (Kaplan, R.S. and Norton, 1996). It is emphasised the relevance of outcome and return of the universities to meet the needs of their diverse stakeholders: business system, society, public sector and academia (Sánchez, M.P. and Elena, 2006). Consequently, there is a clear need for management systems to identify and to measure one of the main assets of any organisation: the value of its knowledge.

It has been necessary to support the intellectual capital to enhance efficiency and the quality of research, because it can help identify strengths and weaknesses and it can be used as a controlling and monitoring instrument and not just us unoutput(Cañibano, L. and Sánchez, 2009). There are five research topics that were developed by the Intangible Management theories developed in the 90s (Fig. 2).

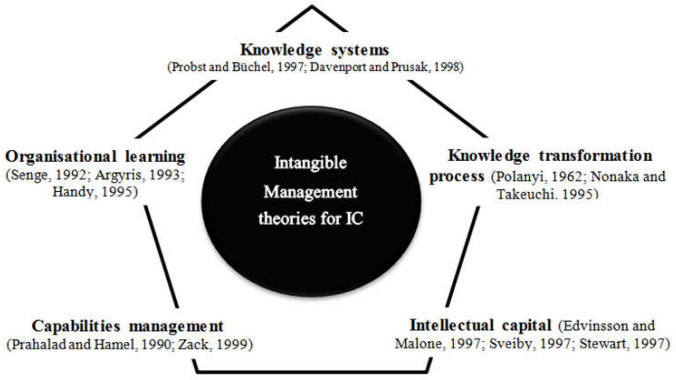

Figure 2. Intangible Management theories

There are two main approaches for measure the IC. One is the strategic approach, dealing with classification, creation, management and use of IC and the other concerns to the measurement approach, which develops metrics and measurement models to determine IC status(Roos, G. and Roos, 1997), (Tan, H.P.; Plowman, D. and Hancock, 2008).

We strongly believe that the financial support given by the portuguese FCT evaluations to Research Units are influenced only bibliometric indicators as a metric to measure researchers IC. The intellectual capital of universities should be measured to improve transparency of public institutions and funds, and should be measured to develop relationships between academics and industrial partners forming partnerships with the community and industry. Althorough revision of all the methods for measuring intellectual capital developed, one of the most promising frameworks was developed in Denmark by the Danish Agency for Trade and Industry. It presents intellectual capital in the form of resources, activities and results. The intellectual capital of a university consists of human capital and structural capital. The human capital relates to individual competencies of researchers. Intellectual capital has a very significant influence on the performance of an organization.

Intellectual capital can be defined as factors consisting of knowledge, experience, information and skills, which have a strong influence and effect on the current and future progress of an Research Unit and as a result with respect to intangible assets such as patents, knowledge system, license agreement, and copyrights, increase an organization ranking among its competitors. Similarly according to(Edvinsson, L; Malone, 1997)intellectual capital is a knowledge and information that can be changed into value. Sullivan (2000) defined IC as knowledge that can be changed into profits. In the context of education sector especially universities (Ramırez, Y., & Gordillo, 2014) define intellectual capital with the help of definition given by European commission. Universities are

encouraged to manage their intangible assets such as the study of(Cañibano, L. and Sánchez, 2009)suggested that various other entities also demand and encourage universities to properly report their intangible assets to society due to the greater power and autonomy given to them by society.

whereas Exact Sciences and Engineering accounted for 35% of the institutions. The percentage of units in Life and Health Sciences and Natural and Environmental Sciences was 13% and 11%, respectively. We could analyze through figure 4 the way financing has evolved from 2003 to 2013.

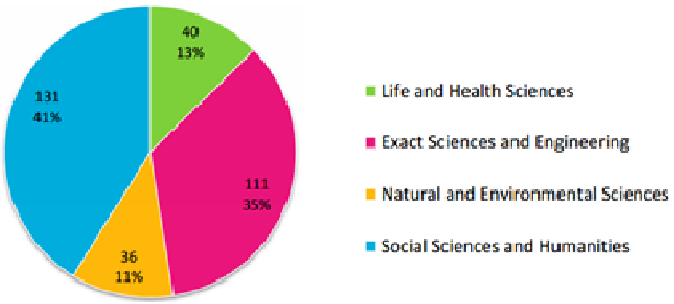

Figure 3. R&D Units and Associate Laboratories) in Portugal

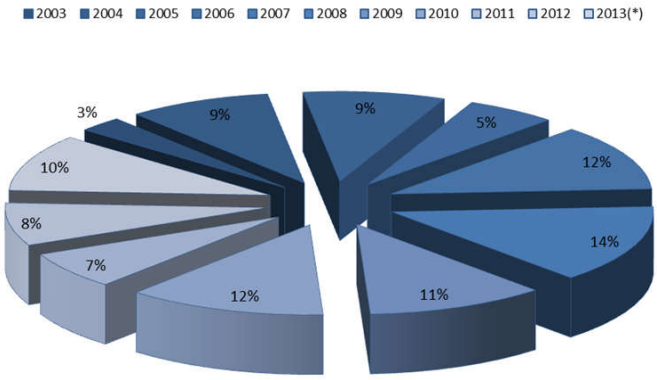

Figure 4. Financial Founding from FCT 2013 – 2014

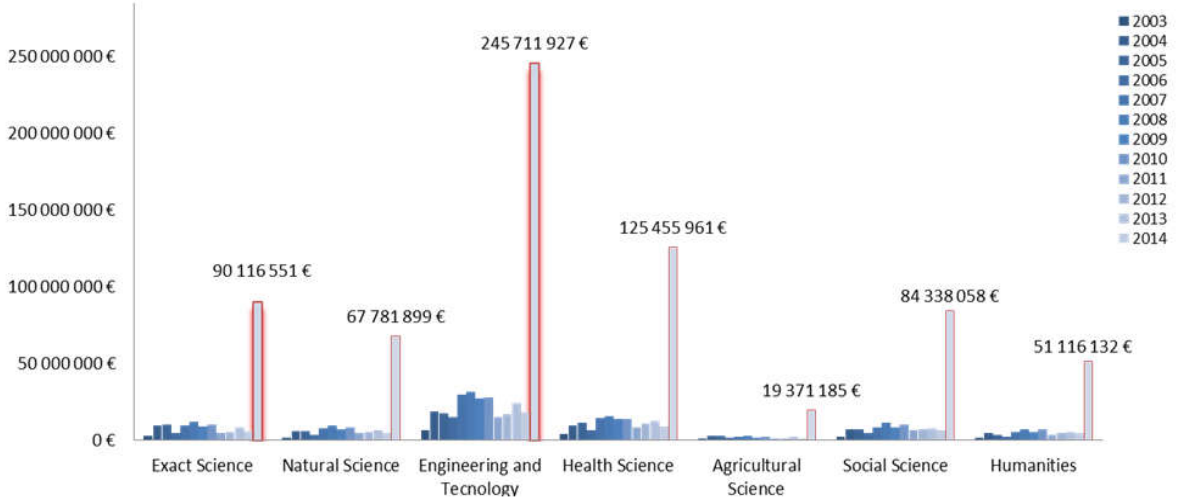

Figure 5. Total amount of FCT funding to R&D Institutions

Direct measurement of human capital is difficult because of its intangible nature, so that the most common approaches are to use proxies (such as education and work experience) or the creation of human capital relate it to the financial results of the organization. Fitz-enz (2000) suggests the elaboration of a human capital scorecard contemplating two dimensions: financial and human. The financial dimension is measured by indicators such as returns, costs and return on investment, and the human dimension portrays indicators in the development of the organization. (Nkomo, 1987)also based on the financial and human dimension, but proposes four indicators for traditional measures of financial performance and two indicators of human resources to measure human capital. The traditional measures of financial performance are sales growth and human measures centered profits per employee.

MATERIALS AND METHODS

Descriptive statistics

In 2014, more than 22000 researchers worked in the 319 R&D Institutions (Fig. 3) that were supported by FCT (293 R&D Units and 26 Associate Laboratories). Forty-one per cent of the R&D Institutions were in the Social Sciences and Humanities,

Between 2003 and 2014, the funding of R&D Institutions decreased in the Exact Sciences (-3.2%), Agricultural Sciences (-1.9%) and Medical and Health Sciences (-2.3%). It increased in Engineering and Technology (+3.6%), Humanities (+2.4%) and Social Sciences (+1.5%). According to FCT, in 2013,3 M€ of the Incentivo Programme were distributed among 92 institutions and in 2014, 6 M€ were distributed among 133 institutions. The total amount of FCT (fig.5) funding to R&D Institutions exceeded 68 M€ in 2003 and 2014 exceeded 53 M€ (Incentivo Programme plus multi-annual funding and strategic projects).However according to data, only Natural Science and Humanities had a positive regression between publications and the awarded funding. In the period between 2007 – 2010, according to data Research Units with more publications (fig.6) registrated were connected to Engineering and Exact Siences. In this period, Engineering and Tecnology produced 7218 products, Exact Science Centers produce 1232 products, Health Science Center's have produced 317 products, Natural Science Center's produced 310 products, Social Sciences Center's 167 products, Humanities 78 products and Agricultural Science Centre's have produced only 26 products in bibliometric indicators. However the highest founding (fig.7) given by our Public Foundation – FCT, in this period, to Research Units were Research Centers related to Engineering and Health

Science. The second best research center unit – Exact Science Research Units - indicated by bibliometry research were third with best financial support.

are iqual for all research units; H_2:*Financial Normal distribution on all research units*. The inter-item coefficients cronbach alpha in for all variables were above 0.69.

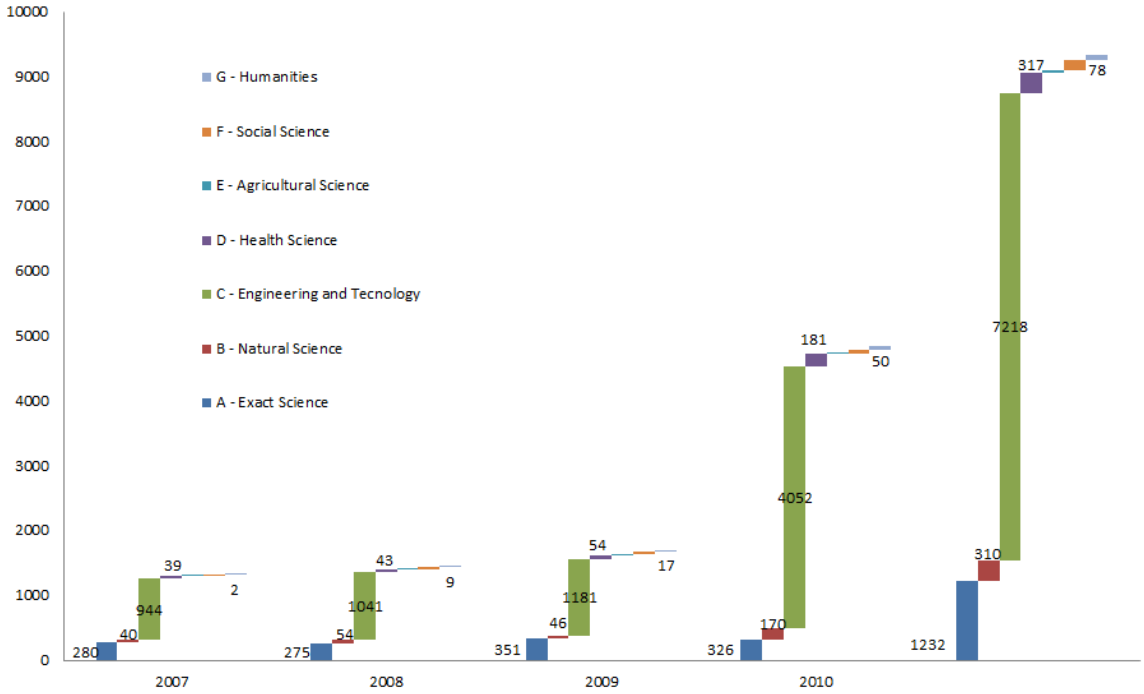

Figure 6. Research Units with publications 2003 – 2007

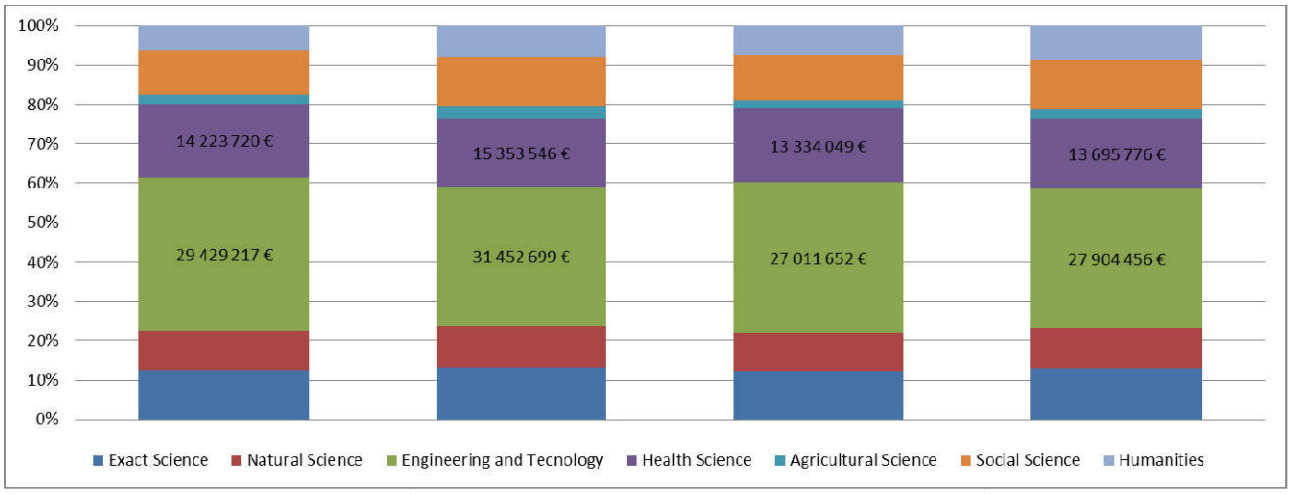

Figure 7. Public Foundation – FCT 2003 – 2007

FINDINGS AND ANALYSIS

Relationship between variables

It was discussed before, that there is a significant positive correlation among the three dimensions of intelectual capital (human, structural and relational) on performance and a positive correlation among these three capitals. However, in our sample, we only want to demonstrate the influence of the bibliometric indicators in the procedures of financial support of Research Units. The study is interested in examining causal effect of independent variables on dependent variables.It's our goal to demonstrate that the evaluation given by Foundation of Science and Technology doens't support the relational capital or even strutural capital. However it will be demonstrated that they only understand intelectual like a produt wich can be measured. Therefor our hypotheses used for this theory are H_1:*Distribution of Financial support/publications/researchers*

In first step of structural equation modeling the confirmatory factor analysis was conducted to check the reliability and covariance of variables. The value of Chi Square is 17.337, p<001, and the Kaiser – Meyer – Olkin (KMO), wich compares simple correlations with partial correlations observed in the variable has a value 0,599 at a significance level 0,001.To infer the distribution of variables we apply the test One Sample Kolmogorov Semirnov, and since p-value<0,001, the null hypothesis is rejected. Therefore there is statistical evidence to assume the distribution of financial support/publications/researchers are not equal for all research units, and there is no normal distribution for financial support in portuguese research units.

Correlation analysis

Correlation coefficient analysis is the initial statistical technique used to analyze the association between the

dependent and independent variables. Table 1shows the findings from Pearson pair wise analysis which indicate that the Research Area is significantly negatively associated ($p < 0.01$) with financial support/performance (FS), and also with Publications. Only Publications (P) index is significantly positively associated ($p < 0.05$) with FS and R. Finally, it is interesting to notice that RA index has no significantly correlation with R.

Table 1. Correlation analysis of selected variables

Variables	P	*FS*	*R*	*RA*
Product (Publications)P	1	,783*	,613*	-,664*
Financial Support- FS	,783*	1	,561*	-,486*
Researchers- R	,613*	,561*	1	,095
Research Area -RA	-,664*	-,486*	,095	1

Note: *Correlation is significant at the 0,01 level

Linear multiple regression results

Table 2 exhibits the results of the regression coefficient for all explanatory variables, using operating *number of researchers* as the dependent variable. The adjusted R^2 is 0.446 for the whole sample, indicating that the model is able to explain about 45% of the variance in the dependent variable for the whole sample. In the table shows that the Product (Publications) has a significantly positive association with operating researchers while Financial Support are not. The results confirm thathuman capital us a number of reseachers invested in Units Research and Development, plays a major role in production. Table 3 exhibits the results of the regression coefficient for all explanatory variables, using operating *Publications*as the dependent variable.

Table 2. Linear multiple regression results for operating *number of researchers*

	Unstandardized Coefficients		Standardized Coefficients		
Variable (constant)	*B*	*Std. Error*	*Beta*	*t*	*Sig*
	1454,4	152,8		9,518	,000
Product(Publications)	,606	,157	,602	3,850	,001*
Financial Support	7,121	,000	,158	1,01	,321
Adj. R^2	0,446				
F	10,06				

Note: Significant at *10, and **2 percent levels, respectively.

The adjusted R^2 is 0.657 for the whole sample, indicating that the model is able to explain about 66% of the variance in the dependent variable for the whole sample. In the table shows that reseachers has a significantly positive association with publications while Financial Supportare not. Model 2 of Table 4ilustrates the results of regression coefficient for all explanatory variables, using financial research area as the dependent variable, respectively. The adjusted R^2 is 0,495 for the whole sample, indicating that the model is able to explain about 49,5 percent of the variance in the dependente variable for the whole sample, respectively. This model demonstrat that the financial support have a significantly negative association with research area while only in this model the variable financial support has a significant relation. The negative sing on financial support and research area may be due to the fact that the capital employed (especially in physical investment) may generate additional expenses for research and finally, it could reduce the net profit in the end of the year. However, there is not significant association among publications and number of researcher in Researchers Units and the variables of financial and are a composition.

Table 3. Linear multiple regression results for operating *Publications*

Unstandardized Coefficients			Standardized Coefficients		
Variable (constant)	*B*	*Std. Error*	*Beta*	*t*	*Sig*
	-806,182	288,8		-2,792	,010
Researchers	,614	,160	,618	3,850	,001*
Financial Support	4,21	,000	,094	,588	,562
Adj. R^2	0,657				
	9,471				

Note: Significant at *10, and **2 percent levels, respectively.

Table 4. Linear multiple regression results for operating *Research Area*

	Unstandardized Coefficients		Standardized Coefficients		
Variable (constant)	*B*	*Std. Error*	*Beta*	*t*	*Sig*
	3,493	,994		3,514	,002
Researchers	,001	,001	,331	1,389	,178
Financial Support	-4,7	,000	-,419	-2,207	,037**
Publications	-,001	,001	-,337	-1,432	,167
Adj. R^2	0,495				
	2,598				

Note: Significant at *10, and **2 percent levels, respectively.

Conclusions

The prime assets of universities are human capital (faculty) and relational capital (students) besides strutural capital. In popular belief Intellectual Capital is associated with "humancapital" or "knowledge." The term Intangible Assets encompasses not only the contents of researcher's minds but also the complex intangible structure that surrounds them and makes the organisation function. There is no measurement corresponding to the monetary unit on a balance sheet.It is marked by ethical concerns about including human capital on a balance sheet. Placing a price on individuals research can send a message that reseachers may be substituted for other forms of capital.Intellectual capital measures should take into account the different qualities of output – the output of the organisation (e.g. publication, a training course), and the output of the researcher/user (e.g. problem solved). The system should help the organisations involved to identify what works and what does not work. Results should not be punitive. From the presented elements it is possible to uncover a plurality of operations and measurement methods related to intellectual capital. It should be noted that none of these forms of operationalization and measurement is consensually chosen as the best way to operationalize and measure this concept. It is non financial capital.

Finally, by taking sample from data of Portuguese FCT, the findings have several important implications. First, the results demonstrated a significantly positive association betweenthe Reseachers and publications, financial support and research areawhile researcher's and research area are not significant.
Additionally, the results indicatesthat traditional financial support have a negative association with the research area, it underlines the bibliometric research used by the FCT to justify the funding provided is a lack of public funding and requires a better scientific framework. Nevertheless, the findings subvert the prevailing understanding that human capital, structural capital, and social capital are the significant roles in creating value for stockholders as well as for other stakeholders.

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