The Relationship between Innovation and Financial Performance

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Introduction

The aim of this article is to broaden the understanding of the relationship between innovation and value creation at companies operating in Brazil.

It furthers a study that we conducted previously, introducing a variable that expresses the result of the innovation process, patents.

The relationship between innovation and value creation presents contrasting results in the literature. There are surveys that corroborate a positive relationship while others do not.

Surveys are hard to compare for at least four reasons. The first concerns the concept of innovation. The second refers to the measurement of the concept. The third addresses the difficult task of defining and measuring financial economic performance. And the fourth reason is related to the issue of how to test the relationship as there is general agreement that the impact of innovation is not instantaneous and affects a company's financial result in periods subsequent to the introduction of an innovation. The article is divided into three sections: a first that retrieves the studies that sought to relate innovation with value creation, a second with the methodological procedures and a last with the main results. Our models and respective tests corroborate a positive relationship between innovation and financial economic performance, but we should warn that surveys are in a very incipient stage as concerns the definition and measurement of the constructs proposed for innovation and financial performance as well as in the discussion of the best statistical procedures to test the relationship.

Theoretical Benchmark

The development of innovation in products and processes has been widely used by companies as a means of obtaining competitive advantage.

Several authors such as Porter (1986, 1989), Freeman (1994) Dosi (1988), and others, have emphasized the importance of innovation as a tool for the obtainment of a superior performance by companies.

However, the empirical studies that seek to verify the relationship existing between innovation and performance indicate various difficulties in the establishment of this relationship. These difficulties lie in the definition and measurement of innovation, and in the definition and measurement of financial performance in the best way to establish this relationship. For illustration, the large-scale use of multiple regression models assumes that we seek a relationship between various independent variables and one dependent variable. First of all, we are assuming linear relationships, which might not be the case. Secondly, there might be significant relationships between various independent variables and various dependent variables, which can be verified with the structural equation models. We reviewed 22 surveys that sought to qualify and quantify the relationship between innovation and performance **(Cainelli et el. (2004; Andressi (2000); Morbey (1989); Morbey and**

Reithner. (1990); Brener and Rushton (1989); Chaney et al. (1991); Chaney and Devinney (1992); Wolff (1995); Schrer (1965); Haneda & Odagiri (1997); Odagiri (1983); Branch (1974); Leonard (1971); Geroski et al. (1993); Eisenhardt and Schoonhoven (1990); Gopalakrishnan (2000); Toivanen (2002); Pakes (1985); Diedren et. al (2002); Sony et al. 1992); HO et al. (2005); Chauvin and Hirshey (1993).

For this purpose we should be concerned with the innovation construct used, with the measurement of this construct, with the definition of financial performance and with the measurement of this construct. There is no consensus on any of the 4. This hinders the understanding, as we are not talking about things that can be compared. Upon the elaboration of an innovation construct, we verified in the studies analyzed that the concern is with the inputs for the innovation process such as the expenditures with R&D and human capital, as well as the results of the innovation process, mainly patents. In the measurement of innovation, the metrics adopted in the empirical studies are sometimes based on investments in innovation, such as expenses with research and development (R&D), number of employees in the R&D area, expenses with the purchase of technology etc., and sometimes on the results of innovation efforts, such as patents, turnover with new products, announcement of new products etc. There is no consensus as concerns the definition and measurement of financial performance either; we verified that the most commonly used measures were growth of sales, annual growth of profits and profitability, which may signal the concern with available data and not with the obtainment of more sophisticated economic performance measures such as economic value added and the cash flow return on investment.

As regards statistical techniques used, most of the studies used a regression analysis to link innovation with performance, and a considerable number of these studies used panel data.

We sought to innovate in the methodology of this study, using structural equation modeling that seeks to link various independent and dependent variables at the same time, although we recognize that the observation that we made in relation to the previous studies reviewed by us also applies now, i.e., the inability to compare the results.

Methodological Procedures

As a matter of priority, we used two methodological procedures to test our model. The multivariate quantitative methods used were the factor analysis and structural equation modeling. The concern was not to propose a new theory, but to confirm models proposed by the literature presented in the theoretical benchmark.

Factor analysis

The aim of the factor analysis was to confirm an innovation model proposed by the international literature. This model resulted in PINTEC and it was the

variables collected in this survey of the Brazilian Institute of Geography and Statistics - IBGE that we used here. We used the recommendations of Hair, et al. (2005), who states that the sample should not be below 50 observations, preferably a number above 100, and that each variable has from 10 to 20 observations for each variable. Barlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test that compares the magnitude of the observed correlation coefficient with the magnitude of the partial correlation coefficient are recommended for fitting the model. The values of the KMO test are between 0 and 1, while low KMO values (below 0.50) indicate the unsatisfactoriness of the analysis and values close to 1.0 indicate that the method is appropriate for processing the data. The interpretation of results took place through the correlation matrix and the rotation matrix. To evaluate whether a factor loading was significant we used the recommendations of Hair, et al.(2005) (Table 1).

Table 1 – Suggested relationship between factor loading and sample size.

Factor Loading	Necessary Size of Sample
0.30	350
0.35	250
0.40	200
0.45	150
0.50	120
0.55	100
0.60	85
0.65	70
0.70	60
0.75	50

Source: (HAIR, et al., 2005, p. 107)

Structural equation model

The structural equation model was chosen as it enables us to simultaneously test various relations between independent and dependent variables, which does not apply to multiple regressions. The model also stands out as it allows us to test relations between independent variables as well as between dependent variables.

Using the recommendations of Hair, (2005) we concentrated on verifying the existence of transgressive estimates and on the goodness-of-fit measures of the models. Table 2 presents a summary of the tests that should be carried out with the respective values so that the fits can be considered acceptable.

Table 2 – Model fitness tests

Goodness-of-Fit Measures	Analysis	Acceptable Fit Level
Likelihood ratio chi-squared statistics (x^2)	Significance test provided	Between 1% and 10%.
Goodness-of-Fit Index (GFI)	Higher values indicate better fit.	Must be higher than 0.90

Normed Fit Index (NFI)	Increment fit measure. Higher values indicate better fit.	Recommended level > 90
Tucker-Lewis Index (TLI) or NNFI.	Incremental fit measure. Higher values indicate better fit.	Recommended level > 90
Normed Chi-square	Ratio between the chi-square and the degrees of freedom	Lower limit: 1.0 Upper limit: 5.0.
Root Mean Square Error of Approximation (RMSEA)	Mean difference by degree of freedom that is expected to occur in the population, not in the sample.	Acceptable values below 0.08.

Source: The authors

Kelloway (1998, pp. 27 and 28) and Schumacker and Lomax (2004, p. 82) recommend that the GFI, NFI, TLFI and AGFI tests present the best fit when the indices present values above 0.95 and that the RMSEA test shows that the model is well fitted when it presents values below 0.05.

Kelloway (1998, p. 20) emphasizes that SEM (structural equation modeling) calls for a very large sample (above 200 observations) and that a value of 100 observations should be established as a minimum. Schumacker and Lomax (2004, p. 113) state that the sample size directly affects the x^2, which implies that samples over 200 observations present a higher x^2.

Data sources and sample construction

This survey used four data sources. The construct that represents financial performance (dependent variable) was obtained from balance sheet data provided by SERASA (periods from 2001 to 2006), whose contribution we are grateful for, and by Gazeta Mercantil (1998 to 2006). As innovation affects financial performance with a lag, the financial data is related to the years 2005 and 2006. The total number of companies sent to IBGE surpassed four thousand (4,000) firms, and the institute cross-referenced this data with the PINTEC base, through the CNPJ (National Corporate Taxpayers' Register) number. As IBGE does not allow work on data off its premises due to confidentiality issues (the data of individual companies cannot be made available under any circumstance) a team of statisticians carried out the work for us on the premises of IBGE. The statistical treatment was performed using SPSS software in its version 15.0 and its AMOS application in version 18.0 to work on the structural equation modeling.

The data relating to patents and patent registrations (which represent the result of the innovation process) was provided by the Department of Geosciences of UNICAMP (Universidade Estadual de Campinas). We are grateful to Prof. Ruy Quadros Carvalho for his part in providing the data. This data is produced by the National Institute of Industrial Property, INPI, and the data collection is

extremely time-consuming, which might have delayed the conclusion of the survey, if we had not had help.

The data for the obtainment of variable that characterize the innovative effort was obtained at IBGE, and we are also very grateful for its help. Every two years IBGE conducts an innovative survey on innovation called PINTEC (Technological Innovation Survey). The data used is related to the last survey made available to the public, the survey of 2005.

PINTEC was structured having the Oslo Manual as a conceptual reference, and to prepare the PINTEC questionnaire, IBGE used the model applied by the Statistical Office of the European Union - EUROSTAT, the third version of the Community Innovation Survey - CIS 1998 - 2000 (IBGE, 2007, p. 13). The Brazilian survey, similarly to the European one, aims to build sectoral, national and regional indicators of the innovation process of firms set up in Brazil.

Capacity to Innovative Construct

We came across two alternatives to elaborate the Capacity to Innovate construct. The first was to assume that the latent variables "Human Capital", "Innovative Effort" and "Relational Capital" represent the Capacity to Innovate, that the Capacity to Innovate entails the Results of the Innovation Process (measured by the result in number of patent registrations) and that this has a positive impact on value creation measured by the latent variable "Profitability". As we did not know whether this model would be validated by the data, the second alternative was to ignore the distinction between the latent variable Capacity to Innovate and the latent variable Result of the Innovation Process, and to assume that both merge to form a latent variable called Innovation (or rather, Innovativeness) and that this is responsible for value creation (latent variable profitability). Figures 1 and 2 present the two path diagrams.

Figure 1: Capacity to Innovate Construct
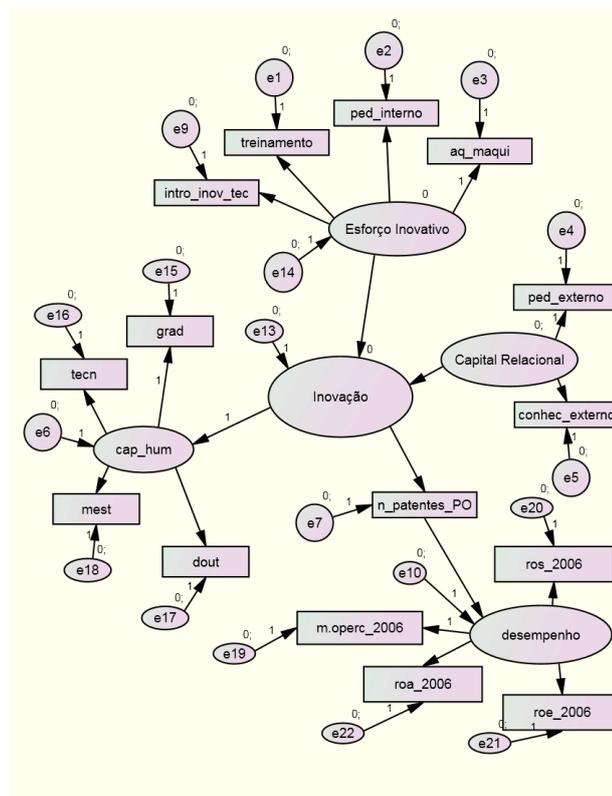
Training – Innovative Effort – Innovation – Relational Capital - performance

Figure 2: Capacity to Innovate Construct
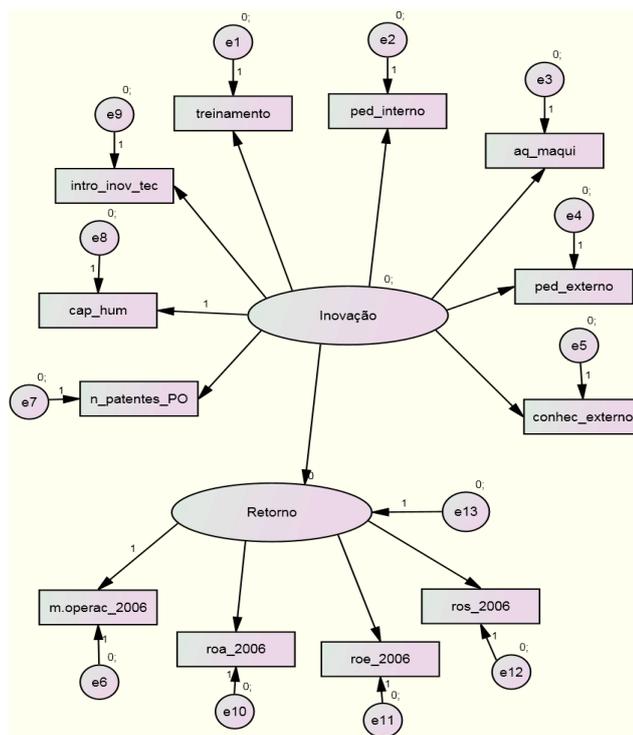
Training – innovation – return

Tables 3, 4, 5, 6 and 7 represent the variables that compose the latent variables.

Table 3 – Variables that compose HUMAN CAPITAL.

Nomenclature	Description	Unit of Measurement	Source
Dout	Total number of **doctors** dedicated exclusively to R&D in comparison to the total staff.	%	PINTEC
Mest	Total number of **masters** dedicated exclusively to R&D in comparison to the total staff.	%	PINTEC
Grad	Total number of **graduates** dedicated exclusively to R&D in comparison to the total staff.	%	PINTEC
Tecn	Total number of **technicians** dedicated exclusively to R&D in comparison to the total staff.	%	PINTEC
Total_hum_ped	Total number of people dedicated to R&D in comparison to the total staff.	%	PINTEC

Source: Prepared by the authors based on PINTEC

Table 4 – Variables that compose Innovative Effort.

Nomenclature	Description	Unit of Measurement	Source
Training	Total expenditures in **training** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA
PeD_Interno	Total expenditures in **internal R&D** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA
Aq_Maq	Total expenditures in **acquisition of machinery** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA
Intro_inov_tec	Total expenditures in **introduction of technological innovations** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA

Source: Prepared by the authors based on PINTEC

Table 5 – Variables that compose RELATIONAL CAPITAL.

Nomenclature	Description	Unit of Measurement	Source
PeD_Externo	Total expenditures in **external R&D** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA
Conhec_Externo	Total expenditures in acquisition of **external knowledge** divided by the revenue of the firm.	%	PINTEC / SERASA AND GAZETA

Source: Prepared by the authors based on PINTEC

Table 6 – Variables that compose FINANCIAL PERFORMANCE.

Nomenclature	Description	Unit of Measurement	Source
ROA	Net income for the period divided by total assets.	%	SERASA AND GAZETA
ROS	Net income for the period divided by total revenue.	%	SERASA AND GAZETA
ROE	Net income for the period divided by shareholders' equity.	%	SERASA AND GAZETA
Margem_Operacional	Operating income for the period divided by total revenue.	%	SERASA AND GAZETA

Source: prepared by the authors

Table 7 – Variables that compose the result of the innovative process

Nomenclature	Description	Unit of Measurement	Source
n_patentes_PO	Patents and/or patent registrations divided by the occupied staff (PO)	%	INPI/DEPARTMENT OF GEOSCIENCES OF UNICAMP and PINTEC

Source: prepared by the authors

The variables that involve financial values were divided by one thousand (1,000), to facilitate identification and analysis.

The data was standardized and some variable were transformed into logarithms to help the "data normalization" process, a recommendation of SEM (the variables when standardized will appear with the expression "Zscore" before the defined nomenclature and "Ln" for logarithm).

THE BUILDING OF THE SAMPLE

We needed to cross-reference the SERASA/Gazeta Mercantil bases with PINTEC - 2005 and with the INPI base, a task that was performed by IBGE. This procedure caused the base to record 1304 companies. When we introduce the INPI base, the number of companies with patents and/or patent registrations represents 18.3% (238 companies).

Tables 8, 9, 10 and 11 present the results for the sample. Table 8 indicates that the most statistically significant industries are those of Manufacturing of food products and beverages (15), Manufacturing of chemical products (24), Manufacturing of steel products (27) and Manufacturing of Machinery and Equipment (29), which account for more than 40% of the total.

Table 8 – Frequency distribution of the companies according to CNAE (National Classification of Economic Activities).

CNAE_FINAL	frequency	percent	valid %	cumulative %
11	1	0.08%	0.08%	0.08%
13	5	0.38%	0.38%	0.46%
14	10	0.77%	0.77%	1.23%
15	199	15.26%	15.27%	16.50%
16	2	0.15%	0.15%	16.65%
17	85	6.52%	6.52%	23.18%
18	20	1.53%	1.53%	24.71%
19	58	4.45%	4.45%	29.16%
20	41	3.14%	3.15%	32.31%
21	69	5.29%	5.30%	37.61%
22	4	0.31%	0.31%	37.91%
23	61	4.68%	4.68%	42.59%
24	122	9.36%	9.36%	51.96%
25	24	1.84%	1.84%	53.80%
26	38	2.91%	2.92%	56.72%
27	109	8.36%	8.37%	65.08%
28	56	4.29%	4.30%	69.38%
29	92	7.06%	7.06%	76.44%
30	33	2.53%	2.53%	78.97%
31	65	4.98%	4.99%	83.96%
32	59	4.52%	4.53%	88.49%
33	49	3.76%	3.76%	92.25%
34	34	2.61%	2.61%	94.86%
35	27	2.07%	2.07%	96.93%
36	39	2.99%	2.99%	99.92%
37	1	0.08%	0.08%	100.00%
Total	1303	99.92%	100.00%	
Missing System	1	0.08%		
Total	1304	100.00%		

Source: The authors based on the selected sample

Tables 9, 10 and 11 present the descriptive statistics for the latent variables human capital, relational capital and economic performance.

Table 09 – Variables for HUMAN CAPITAL. Base year: 2005.

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
grad	504	0.00	0.44	0.02	0.05
tecn	504	0.00	0.27	0.01	0.03
total_hum_ped	504	0.00	0.56	0.04	0.08
mest	504	0.00	0.11	0.00	0.01
dout	504	0.00	0.19	0.00	0.01
Valid N (listwise)	504				

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
grad_tecn	504	0.00	0.44	0.03	0.07
total_hum_ped	504	0.00	0.56	0.04	0.08
mest_dout	504	0.00	0.19	0.00	0.01
Valid N (listwise)	504				

Source: Authors

Table 10 – Variables for EFFORT and RELATIONAL CAPITAL. Base year: 2005.

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
intro_proj_tec	583	0.00	0.35	0.01	0.03
intro_inov_tec	490	0.00	13.84	0.03	0.63
treinamento	783	0.00	3.00	0.00	0.11
ped_interno	565	0.00	8.12	0.03	0.34
aq_maqui	831	0.00	78.41	0.15	2.85
ped_externo	186	0.00	0.05	0.00	0.01
conhec_externo	242	0.00	0.16	0.01	0.02
rec_empr_novos	1304	0.00	2.00	0.11	0.27
rec_bra_novos	1304	0.00	1.80	0.04	0.16
rec_mund_novos	1304	0.00	1.80	0.01	0.08
Valid N (listwise)	46				

Source: Authors

Table 11 – Variables for PEFORMANCE. Base year: 2005.

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
roa_2006	1300	-1.42	1.34	0.04	0.15
roe_2006	1250	-1.49	1.46	0.10	0.32
ros_2006	1286	-1.36	1.01	0.03	0.15
margem_operacional_2006	1295	0.00	0.98	0.11	0.11
Valid N (listwise)	1231				

RESULTS OF THE FACTOR ANALYSIS

The first step towards conducting the factor analysis is the estimation of the number of **m** factors, and for this purpose it is necessary to estimate the theoretical correlation matrix, through the sample correlation matrix. To perform the estimation we extract the eigenvalues from the sample correlation matrix and arrange them in order. We then observe which eigenvalues are most important in terms of numerical quantity, using the following criteria:

Criterion 1: the analysis of the proportion of total variance related to each eigenvalue. Those that represent larger proportions of total variance remain, and therefore the value of m will be equal to the number of eigenvalues retained.

Criterion 2: the comparison of the numerical value of the eigenvalues, with the value 1. The value of m will be equal to the number of eigenvalues greater than or equal to 1. The basic idea of this criterion is to maintain in the system new dimensions that represent at least the variance information of an original variable. This criterion was proposed by Kaiser (1958).

Criterion 3: observation of the scree-plot graph (Cattell, 1966). Since eigenvalues are arranged in descending order, under this criterion, we seek a "jump point" in the graph, which would be representing a decrease of importance in relation to the total variance. The value m would be equal to the number of eigenvalues before the "jump point".

The criteria described take into account only the numerical quantity of the eigenvalues. An appropriate choice of the value of m should, therefore, take into account the interpretability of factors and the principle of parsimony, i.e., the description of the structure of variability with a small number of factors.

As emphasized previously the objective of the factor analysis was to verify whether the constructs proposed by the theory were supported by the empirical data. Tables 12 and 13 present the descriptive statistics and the breakdown of factors.

The KMO test came close to the indicated value (0.5) at 0.421 (see appendix), and most of the factor loadings in each component were of that required by the literature at 0.35.

Table 12 – Descriptive analysis. Base year: 2005

Descriptive Statistics	Mean	Std. Deviation(a)	Analysis N(a)	Missing N
roa_2006	0.04	0.15	1304	4
roe_2006	0.10	0.31	1304	54
ros_2006	0.03	0.15	1304	18
margem_operacional_2006	0.09	1.23	1304	9
n_patentes_PO	0.00	0.01	1304	0

intro_inov_tec	**0.03**	0.38	1304	814
training	**0.00**	0.08	1304	521
ped_interno	**0.03**	0.23	1304	739
aq_maqui	**0.15**	2.28	1304	473
ped_externo	**0.00**	0.00	1304	1118
conhec_externo	**0.01**	0.01	1304	1062
grad	**0.02**	0.03	1304	800
tecn	**0.01**	0.02	1304	800
mest	**0.00**	0.01	1304	800
dout	**0.00**	0.01	1304	800
total_hum_ped	**0.04**	0.05	1304	800

Source: The author

We made some attempts to arrive at a satisfactory model, removing the variables that did not present factor loadings above 0.35 ("training", "ped_externo" and "conhec_externo"). The results are in Table 14

Table 14 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.496**
Bartlett's Test of Sphericity	Approx. Chi-Square	4059.276
	Df	78
	Sig.	**0.000**

Source: prepared by the authors

The KMO test came close to the indicated value (0.5) at 0.491 (Table Y) and the factor loadings in each component were well above that required by the literature at 0.35, thus the model has a statistically adequate fit.

Table 14a – Rotation Matrix. Base year: 2005

Variables	Component			
	1	2	3	4
roa_2006	-0.005	0.018	0.860	-0.037
roe_2006	-0.006	0.042	0.639	0.027
ros_2006	-0.002	-0.019	0.859	0.010
margem_operacional_2006	0.005	0.014	0.609	0.038
n_patentes_PO	-0.007	-0.073	0.063	0.719
intro_inov_tec	0.993	-0.015	-0.001	-0.004

12

	Factor 1	Factor 2	Factor 3	Factor 4
ped_interno	0.990	0.022	-0.002	0.003
aq_maqui	0.977	-0.016	-0.005	-0.005
Grad	0.001	0.829	-0.012	0.224
Tecn	-0.011	0.768	0.047	-0.145
Mest	0.002	0.732	0.024	-0.034
Dout	0.003	0.197	-0.025	0.762
total_hum_ped	-0.003	0.970	0.008	0.170

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Source: The authors

The results suggested 4 factors to categorize the variables, where factor 1 was characterized as innovative effort, factor 2 as human capital, factor 3 as performance and factor 4 as "result of the innovative process", including the number of patents; however, this factor is composed of number of patents and number of doctors, and the number of doctors is not a result; thus we should make it clear that, for lack of a better name, we opted for "result of the innovative process", but the theory needs to be discussed in more depth. The 4 factors represent 70.67% of the data variability.

The criterion for selection of the number of factors observed the criterion of observation of the scree-plot graph, (Graph 01). As the eigenvalues are arranged in descending order, the jump point represents the decrease in importance in relation to the total variance. The quantity of factors is equal to the number of eigenvalues before the "jump point".

GRAPH
01

Scree Plot
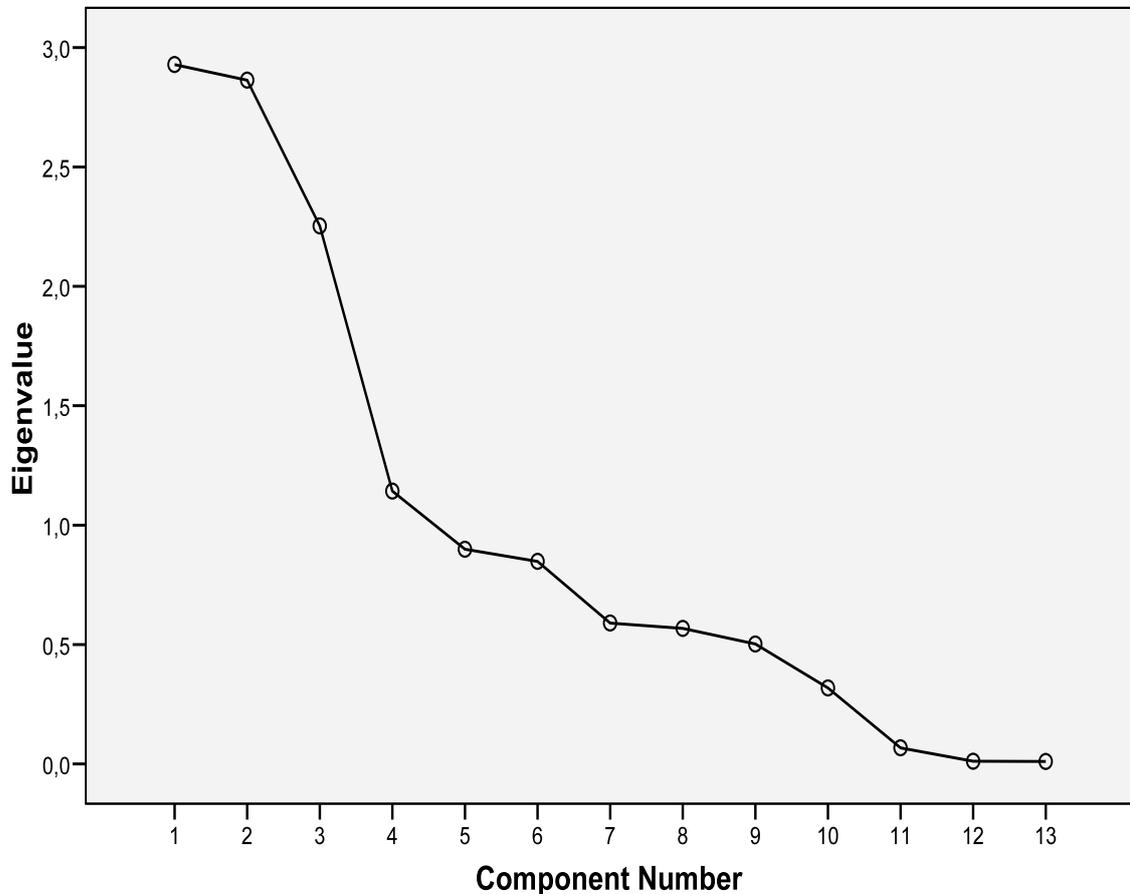
Factor 1, innovative effort, is composed of the variables, acquisition of machinery, internal R&D and introduction of technological innovation, which corroborates the understanding of these variables as inherent to the firm's innovative effort activity. The variable training was excluded, improving the model. It is noteworthy that the variable training did not show any correlation with the variables relating to human capital either. A hypothesis that can be put forth is that companies are not concerned about training human capital as it is easier to replace staff, hiring people with a certain level of qualifications in the market.

Factor 2, human capital, presented good correlation with four variables: masters, graduates, technicians and total number of people dedicated to R&D. The variable doctors presented less correlation with the abovementioned

variables, showing better correlation with the variable of factor 4 (relational capital).

We draw attention to an unusual fact. Companies set up in Brazil do not use doctors in the innovation process. Two plausible explanations: innovations in Brazil are primarily characterized as innovations of processes not needing highly qualified staff; when companies acquire new technologies in the market (new innovations) they need to train people to make the best possible use of these technologies, so they rely on doctors. If this is true, then Brazil is on the right track when it proposes public policies to introduce doctors in companies. The battled-scarred old State is making a comeback to improve our innovative effort. We can ask ourselves: for how long will "saving packages" be necessary due to the shortsightedness of companies?

As regards factor 3, performance, the firm profitability indicators ROA, ROE, ROS and Operating Margin exhibit a correlation, forming a business result factor. We did not find a factor that we could call "relational capital", as we did not find a good level of correlation between the variables external R&D and acquisition of external knowledge.

We opted to call factor 4 "result of the innovation process", recognizing the unstableness of this name. Note the presence of the variable doctor in this factor with a good level of relationship, as well as the presence of the variable Patents, suggesting that the number of doctors is directly linked to the number of patents.

We will use the two variables, patents and number of doctors, in this survey to form the latent variable "result of the innovation process".

STRUCTURAL EQUATION MODELS

Three structural equation models were fitted. The evaluation of the model fit can be carried out in two parts: the examination of the local fit and the examination of the global fit. The evaluation of the local fit is accomplished through the "t" test statistic. Thus it can be verified whether the parameters are significantly different from zero. The evaluation of the global fit of the model can be accomplished through the exact goodness-of-fit test, using the chi-square test statistic, and through the approximate goodness-of-fit test, using the RMSEA statistic, the root mean square error. There are other approximate fit criteria available, such as the goodness-of-fit index (GFI), the comparative fit index (CFI), and the normalized fit index (NFI).
There are specific indicators that serve to compare and consequently to determine which model is the best: i) the cross-validation index (ECVI), ii) the Akaike-AIC measure and iii) the Bozdogan-CAIC measure. The best model will be the one that presents lower values in the three indicators. We present here only the model that presented the best results.

Figure 5 – Path Diagram 3
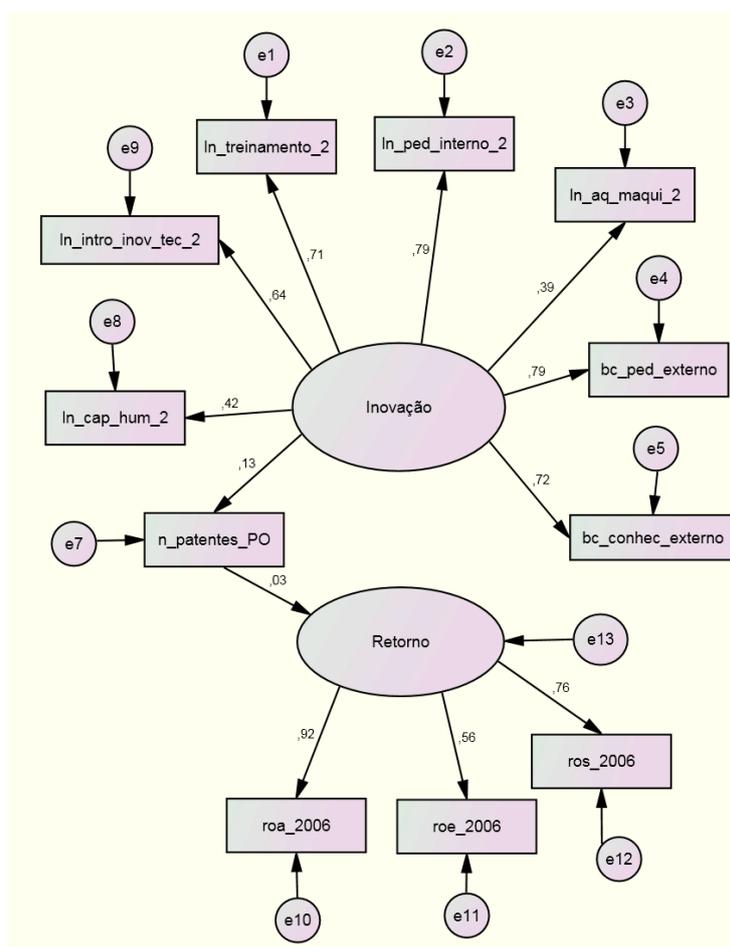
Innovation -return

Table 21 – Regression Weights

			Estimate	S.E.	C.R.	P
n_patentes_PO	<---	Innovation	0.002	0.001	2.774	0.006
Return	<---	n_patentes_PO	0.416	0.392	1.062	0.288
ln_cap_hum_2	<---	Innovation	1.000			
ln_intro_inov_tec_2	<---	Innovation	1.657	0.291	5.688	***
ln_treinamento_2	<---	Innovation	1.728	0.296	5.844	***
ln_ped_interno_2	<---	Innovation	1.712	0.284	6.038	***

ln_aq_maqui_2	<---	Innovation	1.020	0.206	4.939	***
bc_ped_externo	<---	Innovation	0.997	0.178	5.596	***
bc_conhec_externo	<---	Innovation	2.223	0.415	5.364	***
roa_2006	<---	Return	1.000			
roe_2006	<---	Return	1.286	0.074	17.464	***
ros_2006	<---	Return	0.846	0.041	20.774	***

*** P < 0.001

Source: prepared by the authors

Table 22 - Standardized Regression Weights

			Estimate
n_patentes_PO	<---	Innovation	0.130
Return	<---	n_patentes_PO	0.031
ln_cap_hum_2	<---	Innovation	0.423
ln_intro_inov_tec_2	<---	Innovation	0.638
ln_treinamento_2	<---	Innovation	0.711
ln_ped_interno_2	<---	Innovation	0.794
ln_aq_maqui_2	<---	Innovation	0.391
bc_ped_externo	<---	Innovation	0.789
bc_conhec_externo	<---	Innovation	0.717
roa_2006	<---	Return	0.923
roe_2006	<---	Return	0.562
ros_2006	<---	Return	0.758

Source: prepared by the authors

Table 23 – Goodness-of-Fit Measures

Goodness-of-Fit Measures	Analysis	Acceptable Fit Level
Likelihood ratio chi-squared statistics (x^2)	242.711	<0.001
Goodness-of-Fit Index (GFI)	0.898	Must be higher than 0.90
Normed Fit Index (NFI)	0.880	Recommended level > 0.90
Tucker-Lewis Index (TLI) or NNFI.	0.843	Recommended level > 0.90
Normed Chi-square	5.644	Lower limit: 1.0 Upper limit: 5.0.
Root Mean Square Error of Approximation (RMSEA)	0.060	Acceptable values below 0.08.

Source: prepared by the authors

This model presents an interesting result; it proves the "theoretical justifications" that a relationship exists between the innovation process and the result of the innovation process, represented by the patents; it also indicates that the result

of the innovation process has a favorable impact on value creation. Noteworthy is the fact that value creation is represented by a variable with several dimensions (rate of profit) (ROA, return on assets), (ROS, return on sales), and (ROE, return on equity), which is in accordance with those that maintain that performance is a variable that should be understood as being intrinsically multidimensional (Hofer, 2006).

We also realized that we were unable to elaborate latent variables for human capital, relational capital and innovative effort, which had already been suggested by the factor analysis; we achieved a latent variable that we can call "innovativeness" that produces the result of the innovation process (patents), which in turn is related to performance.

The theory being tested here is still in an incipient stage and all the results should be evaluated very cautiously. But these preliminary results serve as encouragement for us to seek to refine the theory.

If better fitted models prove the relation between the result of the innovative process (represented here only by the patents, ignoring a fundamental variable that needs to be incorporated into the model, the number of brands) and the financial performance of companies, then the effort made by the Brazilian government in creating public policies that act by retaining doctors at companies, to accelerate innovation processes, is praiseworthy. What is not praiseworthy is the shortsightedness of the Brazilian private sector, which scarcely innovates, in not realizing that innovations can guarantee a sustainable competitive advantage.

CONCLUSIVE COMMENTS

This survey aimed to elaborate a construct to express a company's capacity to innovate, using data from two bases hardly explored in Brazil, PINTEC (Technological Innovation Research) of IBGE and the patent registration of INPI, worked on and supplied by the Geosciences Department of UNICAMP. It also sought to test a positive relationship between capacity to innovate and value creation, represented by another latent variable formed by return on sales, profitability (return on assets) and return on equity. As a promising result we can point out the discovery of a model that presented a good fit for the expected relation. This model presents an interesting result; it proves the "intuition" that there is a relationship between the innovative effort and the result of the innovation process, represented by the patents; it also indicates that the result of the innovation process has a favorable impact on value creation. Noteworthy is the fact that value creation is represented by a variable with several dimensions (rate of profit) (ROA, return on assets), (ROS, return on sales), and (ROE, return on equity), which is in accordance with those that maintain that performance is a variable that should be understood as being intrinsically multidimensional (Hofer, 2006). The theory being tested here is still in an incipient stage and all the results should be evaluated very cautiously. But these preliminary results serve as encouragement for us to seek to refine the theory.

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companies, to accelerate innovation processes, is praiseworthy. What is not praiseworthy is the shortsightedness of the Brazilian private sector, which scarcely innovates, in not realizing that innovations can guarantee a sustainable competitive advantage. This survey presented another result that we believe to be interesting: we did not confirm the weights proposed by researchers who elaborated and built the Brazilian Innovation Index.

To our surprise, the variable "doctors", which should be part of the human capital construct, cannot be maintained in the latent variable. This result creates space for the pursuit of more robust relations (corroborated empirically) for the capacity to innovate construct. The old discussion reappears here: is it the model that is inappropriate (in emphasizing the importance of doctors to the innovation process, or is it the Brazilian reality that does not adapt to what is advocated by the theories tested and corroborated in developed countries?

The **factor analysis** also presented unexpected results. The results suggested 4 factors to categorize the variables, where factor 1 is characterized as innovative effort, factor 2 as human capital, factor 3 as performance and factor 4 as "result of the innovation process", relating number of patents and number of doctors. The 4 factors represent 70.67% of the variability of the data. We did not find a factor that we could call relational capital, as advocated by the theory.

Factor 1, innovative effort, is composed of the variables, acquisition of machinery, internal R&D and introduction of technological innovation, which corroborates the understanding of these variables as inherent to the firm's innovative effort activity. The variable training was excluded, improving the model. It is also noteworthy that the variable training did not show any correlation with the variables relating to human capital either. A hypothesis that can be put forth is that companies are not concerned about training human capital as it is easier to replace staff, hiring people with a certain level of qualifications in the market.

Factor 2, human capital, presented good correlation with four variables: masters, graduates, technicians and total number of people dedicated to R&D. The variable doctors presented less correlation with the abovementioned variables, showing better correlation with the variable of factor 4 (relational capital).

The observations indicated previously also apply here. Companies set up in Brazil do not use doctors in the innovation process. Two plausible explanations: innovations in Brazil are primarily characterized as innovations of processes not needing highly qualified staff; when companies acquire new technologies in the market (new innovations) they need to train people to make the best possible use of these technologies, so they rely on doctors. If this is true, then Brazil is on the right track when it proposes public policies to introduce doctors in companies. The battled-scarred old State is making a comeback to improve our innovative effort. We can ask ourselves: for how long will "saving packages" be necessary due to the shortsightedness of companies?

As regards factor 3, performance, the firm profitability indicators ROA, ROE, ROS and Operating Margin exhibit a correlation, forming a business result factor.

Factor 4, "result of the innovation process", presented a good level of correlation between the variables, "patents" and "number of doctors", suggesting that the number of doctors is directly linked to the number of patents. However, doctors are clearly not a result of the innovation process and we need a broader discussion to verify our result.

This survey has a shortcoming that we intend to remedy in a future survey. The use of 4 databases with different data collection methodologies. The financial data collected by IBGE (value added, for example) follows a methodology originating from Keynesian models and the data collected by SERASA and Gazeta Mercantil is derived from from traditional accounting. Thus it would be wise to replicate the results obtained here using financial data originating from IBGE itself, replacing the data of SERASA/Gazeta Mercantil with the data from IBGE's PIA (Annual Industrial Survey).

We also intend to compare the results, replacing the variable that was used to relativize the variables (revenue) with another three variables: expenditures with raw material (intermediate consumption), value added and total assets. This was not possible in the present survey as we could not obtain the data on value added and raw materials (which is collected in another survey by IBGE, called PIA (Annual Industrial Survey). IBGE also collects total assets, which will enable us to conduct the tests using a single database (that of IBGE).

The explanation for the need to relativize with other variables is justified by the nature of the innovation process. Innovations are costly and this affects the company's assets and the outlay with raw materials; therefore the ideal is to measure the impact of innovation on the value added by the company and not just on revenues, which may be growing, but are involving higher costs and new assets.

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