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Game Theory: The Nash Equilibrium Point Identification In Bi-Matrix Games Of Economic And Social Indicators

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ABSTRACT

Currently companies have to think about its management system to meet not only their economic interests but also their social interests aiming at the activities' sustainability and longevity. In this research, the goal is to identify the Nash equilibrium point in the bi-matrix game of economic and social indicators of the companies of Public Utilities sector listed on the BM & FBovespa. The research was conducted with a sample of 26 companies. To evaluate the economic performance it was used the profitability and market indicators; for evaluating the social performance, it was used the indicators derived from the VAD (Value Added Statement). In the estimation of earnings among indicators, it was used the standard parameters of the multiple linear regression. The obtained results highlighted the existence of at least one point of equilibrium for the years analyzed and, especially in the models, two points of equilibrium were proposed for 2009 and 2011 and three for 2010. It is noteworthy that, in the proposed model it was confirmed the hypothesis of the existence of at least one point of equilibrium. Thus, it was possible to meet the research objective, namely, that it is possible to meet both economic aspects and the social aspects of the companies when the indicators are taken as basic information.

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Game Theory: The Identification of the Nash Equilibrium in Bi-Matrix Games in Economic and Social Indicators

RESUMO

Atualmente as empresas precisam pensar dentro de seu sistema de gestão em satisfazer não apenas seus interesses econômicos, mas também seus interesses sociais visando à sustentabilidade e à perenidade das atividades. Nesta pesquisa, o objetivo é identificar o ponto de equilíbrio de Nash no jogo bimatricial de indicadores econômicos e sociais das empresas do setor de Utilidade Pública listadas na BM&FBovespa. Realizou-se a pesquisa com uma amostra de 26 empresas. Para avaliar o desempenho econômico utilizaram-se os indicadores de rentabilidade e mercado; para a avaliação de desempenho social, utilizaram-se indicadores oriundos da DVA (Demonstração do Valor Adicionado). Na estimação dos ganhos entre os indicadores, utilizaram-se os parâmetros padronizados da regressão linear múltipla. Nos resultados obtidos, destacou-se a existência de pelo menos um ponto de equilíbrio para os anos analisados, e em especial nos modelos propuseram-se dois pontos de equilíbrio para 2009 e 2011, e três para 2010. Destaca-se que, no modelo proposto, confirmou-se a hipótese da existência de pelo menos um ponto de equilíbrio. Desse modo, conseguiu-se satisfazer o objetivo da pesquisa de que é possível atender tanto aos aspectos econômicos quanto aos aspectos sociais das empresas quando se tomam como informações básicas os indicadores.

PALAVRAS-CHAVE: Teoria dos Jogos. Ponto de Equilíbrio de Nash. Jogos Bimatriciais. Desempenho econômico. Desempenho Social.

1. INTRODUCTION

Over the last decade there has been an increase in the pressure placed on companies to expand their focus on sustainability and on the social responsibility of the businesses beyond the financial performance (Lee & Saen, 2012). The concept of sustainable development has become popular in the 1980s, due to the definition established in 1987 by the *World Commission on Environment and Development* (WCED, 1987) of the United Nations (UN), document also known as the Brundtland Report. The definition presented involves an ethical concept in relation to the fight against poverty and the environment protection, comprising the macro level (Baumgartner & Ebner, 2010; Clarke-Sather, Hutchins, Zhang, Gershenson & Sutherland, 2011).

According to Claro, Claro and Amâncio (2008), after the Brundtland Commission definition it has arisen a number of further definitions and many others will exist in the future; however, the common ground is in the analysis of the dimensions that make up the sustainability.

Ebner and Baumgartner (2006) state that over the last decades sustainability has become a very popular term in the economy. Lee and Saen (2012) confirm that the adoption of sustainability practices ensures a competitive advantage and also it ensures the enactment of the companies' efficiency in a turbulent business landscape. Similarly, Ioannou and Serafeim (2012) point out that the adoption of sustainable practices by companies, besides bringing about a competitive advantage and enhance the financial long-term performance, it can also provide them an improvement in the generated economic value.

Science has been reinforcing the corporate sustainability focus, mainly with regard to the expressions differentiation: sustainability (specifically the social dimension) and social responsibility. Ebner and Baumgartner (2006) carried out a literature survey and identified as common the discussion of this expressions differentiation, and that, in the view of many authors, both concepts present different approaches. In this sense, Baumgartner and Ebner (2010) confirm that the approach of

sustainable development undertaken by an organization is called corporate sustainability, having three pillars: economic, environmental and social.

Corporate sustainability is defined as from the meeting of the company *stakeholders*' current needs, direct and indirect, as well as the meeting of the future *stakeholders* needs (Dyllick & Hockerts, 2002). Therefore to meet this goal, companies need to maintain their economic, social and environmental growth. In this sense, the concept of the *triple bottom line* appears, in which prevails the perspective of integration of the economic, social and environmental aspects.

According to Krajnc and Glavic (2005), in order to monitor their activities results, companies were using only financial indicators. However, to meet the demands of their agents (suppliers, employees, banks, insurance companies, shareholders, society in general), companies have begun to adopt more sustainable practices. According to Callado (2010) and Callado and Fensterseifer (2010), the motivation for the adoption of sustainable practices consists in the continuity of the companies that is no longer guaranteed only by profitability. Influenced by sustainability initiatives, the company can extend its activities for a longer period, generating an increase in its shares market value.

In his study Lo (2010) sought to analyze the efficiency of the sustainable US companies compared to the non-sustainable companies by evaluating the profitability using the Data Envelopment Analysis model (DEA). The author concluded that sustainable enterprises had a superior performance in the profitability models. The study includes environmental sustainability and the existence of such balance between the actions of economic nature towards the actions of social and environmental nature.

Given the various approaches directed towards the corporate sustainability concept, the present study adopts the traditional triple bottom line, comprised of the economic, social and environmental dimensions. The adoption of this tripod is justified as it is the most consolidated classification in the literature up to now. The exclusion of the environmental dimension in the corporate sustainability context was executed, because the economic sustainability is the first analysis criterion (because its focus is centered in the company's results maximization). In addition, the social dimension

represents the highest criterion of social responsibility so as to contribute to the society welfare, including the group of stakeholders (Aupperle, Carroll & Hatfield, 1985; Carroll, 1991).

Considering the above, it is presented the following question: What is the Nash equilibrium point in the bi-matrix game of economic and social indicators of companies of Public Utilities sector listed on the BM & FBovespa? In order to respond that issue, in this research, the goal is to identify the Nash equilibrium point in the bi-matrix game of economic and social indicators of companies of Public Utilities sector listed on the BM & FBovespa.

According to Bontempo (1997), the Game Theory is a mathematical tool, but it has been studied intensively also in the economic theory applications as well as in other areas of knowledge such as accounting. With respect to its application, there is the study of Brandt, Fischer, Harrenstein and Shoham (2009), which used of the Game Theory to determine the Nash equilibrium point between the economic and the social performance of companies.

The point of equilibrium analysis verifies the strategies that companies should take in order to achieve the maximum gains with the minimization of their losses, not only in the economic performance but also in the social performance simultaneously. The delimitation of a point of equilibrium enables companies to achieve, at any given time, both maximum gains in economic performance and social performance, so as not to cause losses to any of the players (Nash, 1950, 1951, Simonsen, 1994; Fiani, 2004; Lins & Calôba, 2006).

Within the framework of the social performance analysis, it is still verified a large number of inconclusive studies on this relationship (Arlow & Gannon, 1982; Preston & O'Bannon, 1997). Aupperle et al. (1985), Ullmann (1985) and Arlow and Gannon (1992) have made important findings, but the discussion about the relationship between the economic-financial performance and the social performance is not yet fully consolidated. There has been a decrease in the studies that show a negative relationship between the economic and the social performance. With the results presented by Ullmann (1985) and Griffin and Mahon (1997), it is confirmed

the statement previously issued by Cochran and Wood (1984), according to such authors, researchers have not reached a consensus on the relationship between these variables, or there is still no clear relationship between the economic and social performance, which is an important discussion for the business management.

2. THE GAMES THEORY

The game theory principle, considering its direct untying of the probability theory, took place in the mid-twentieth century, when the mathematician John Von Neumann introduced the resolution of interests' conflict perspective through mathematics (Souza, 2003). But it took off as from 1944, when Von Neumann and Oskar Morgenstern (1953) launched the book *Theory of games and economic behavior*. According to Fiani (2004), the game theory consists of a method applied to the decision-making process when two or more agents interact among themselves. Considering the way of interaction among players, there are different approaches within the game theory, such as non-cooperative games and cooperative games. For the resolution of a non-cooperative game, which presumes the existence of a dispute amongst the players not making possible agreements among them, it is necessary, first, a matrix containing the players' profits and losses. Thus Player A chooses his strategies as arranged in rows (m), while Player B carries out his choices based on the earnings shown in columns (n) (Lins & Calôba, 2006).

The zero sum games consider that the gains and losses matrix of Player A is opposed to the gains and losses matrix of Player B. However, customarily the gains and losses between the players are not symmetrical. Thus, realizing that the model used will generate non opposing matrices, in other words, the model employed is of sum different from zero, it will be necessary to evaluate the results by bi-matrix game, returning thus to the analysis of the Nash equilibrium point . In the game matrix for the Nash equilibrium model, players are identified as social indicators (Player A) and economic indicators (Player B). In this case, it is considered a matrix of

ordered pairs reflected in gains of A (a_{ij}) and gains of B(b_{ji}), as shown in the matrix of Table 1.

Table 1: The Game Matrix

		Player B (Economic Indicators)			
		Indicator 1	Indicator 2	⋯	Indicator n
Player A (Social Indicators)	Indicator 1	$(a_{11}; b_{11})$	$(a_{12};\ b_{21})$	⋯	$(a_n; b_n)$
	Indicator 2	$(a_{21}; b_{12})$	$(a_{22};\ b_{22})$	⋯	$(a_n; b_n)$
	⋮	⋮	⋮	⋱	⋮
	Indicator m	$(a_m; b_m)$	$(a_m; b_m)$	⋯	$(a_{mn}; b_{mn})$

Source: Prepared by the author

The game solution consists of identifying the ordered pair whose gain is the maximum among the alternatives and the loss is the minimal among the opponent' strategies (Simonsen, 1994). The values to identify the equilibrium point were determined through the Multiple Linear Regression. As from this method, the values of Standardized *Beta* Coefficients (*Beta Standardized*) are used.

The use of the Standardized *Beta* Coefficients values is approached by Maroco (2003, p. 391) when he inferred that "[...] the simple comparison of the regression coefficients to evaluate the importance of each independent variable in the model is not valid". The use of these values of Standardized *Beta* Coefficient is justified because the dependent variables present different magnitudes. Thus, "so that the importance of each variable in the model can be compared, it is necessary to use the standardized variables (for example, $Z_{ij} = (X_{ij} - \bar{X}_i)/S'_{X_i}$) in the model adjustment or otherwise to standardize the regression coefficients" (Maroco, 2003, p. 391).

Thus, to meet the objectives of this study, it is considered only the values of *Beta Standard*, without considering the model effectiveness and the variables significance, since the objective is just to find out what the relationship between the indicators is and not the significance levels.

Accordingly, the constructed model is presented in the format described below.

Being X_i dependent variable representing the i-hundredths social indicators, Y_i independent variable representative of the j-hundredths economic indicators, there is the formation of the following equation:

$$X_i = a_{0i} + a_{1i}Y_1 + a_{2i}Y_2 + \cdots + a_{ni}Y_n + \varepsilon_i$$

with $i = 1, \cdots, m$.

Thus, the equation Standardized Coefficients are established $\alpha_{1i}, \alpha_{i2}, \cdots, \alpha_{ni}$ in the following way:

$$\alpha_{ij} = a_{ij}\left(\frac{s_{Y_j}}{s_{X_i}}\right)$$

These coefficients α_{ij}represent the gains of the social indicators X_i (strategies) on the part of Player A, having in view the Y_j strategies of player B.

Similarly, for the economic indicators, it was considered the variables Y_j as the variables dependent on the model that represents the j-hundredths economic indicators, as well as X_i the independent variable, representing the i-hundredths social indicators of the analyzed companies. Thus the following equation is obtained:

$$Y_j = b_{0j} + b_{1j}X_1 + b_{2j}X_2 + \cdots + b_{mj}X_m + \varepsilon_j$$

with $j = 1, \cdots, n$.

It is possible to obtain the Standardized Coefficients of the equation $\beta_{1j}, \beta_{2j}, \cdots, \beta_{nj}$, calculated as:

$$\beta_{ij} = b_{ij}\left(\frac{s_{X_i}}{s_{Y_j}}\right)$$

Similarly to what was considered to the strategies of X_i, the regressions identify the payment amount for Y_j if the player B chooses it as strategy (Economic Indicators) for all the options (Social Indicators) of the player A.

The comparison matrix was adapted from Table 1, and is constructed as shown in Table 2.

Table 2: Comparison Matrix

		Player B (Economic Indicators)			
		Y_1	Y_2	⋯	Y_n
Player A (Social Indicators)	X_1	$(\alpha_{11};\beta_{11})$	$(\alpha_{12};\beta_{21})$	⋯	$(\alpha_n;\beta_n)$
	X_2	$(\alpha_{21};\beta_{12})$	$(\alpha_{22};\beta_{22})$	⋯	$(\alpha_n;\beta_n)$
	⋮	⋮	⋮	⋱	⋮
	X_m	$(\alpha_m;\beta_m)$	$(\alpha_m;\beta_m)$	⋯	$(\alpha_{mn};\beta_{mn})$

Source: Prepared by the author

For determining the Nash equilibrium point in a bi-matrix game, Simonsen (1994, p. 414) points out that one must identify "[...] a house where the gain of A is maximum in the column and the gain of B is maximum in the row".

It is noteworthy that for the equilibrium points' identification it was observed the signs (negative or positive) of the Beta Coefficients obtained by the linear regressions.

Thus, it is sought to highlight what strategies (indicators) that companies should take on to achieve a balance between economic and social performance. Nash (1950; 1951) described that, like the zero-sum games, any bi-matrix game should consider the possibility of pure strategies, when there is a Nash equilibrium point, or of mixed strategies, when there is not a specific point so that the condition is met. Considering this determination, the systems were admitted and it is only observed the presence or absence of Nash equilibrium for pure strategies.

Based on this statement, it is formulated the hypothesis of this study, linked to the problem to be investigated and is therefore exposed:

H_0: There is not a Nash equilibrium point in the bi-matrix game of economic and social indicators of the companies of the Public Utilities sector.

If the null hypothesis H_{0b} is not confirmed, it will be admitted the hypothesis H_1, which is given in the following expression:

H_1: There is at least one Nash equilibrium point in the bi-matrix game of economic and social indicators of the companies of Public Utilities sector.

In this conception, Simonsen (1994) corroborates the moments where there may occur the presence of one more equilibrium point, then being able to admit mixed strategies in this case in order to obtain the best equilibrium point.

3. METHODOLOGY

In this research, the goal is to analyze the relationship between economic and social performance indicators of companies listed in the Public Utility sector of the BM & FBovespa through the application of the game theory for bi-matrix games.

As population, it was considered all companies belonging to the Public Utilities sector - which comprises 30% of non-financial companies that hold negotiations at BM&FBovespa - making a total of 75 organizations. This population delimitation encompasses the most representative sector of January 2014, according to the BM & FBovespa sectorial classification.

Therefore it is verified that not all companies made available the consolidated accounting statements as well as the information necessary for calculating the performance indicators for the periods concerned (2009-2011). Thus it was carried out the exclusion of these companies and the final sample was comprised of 26 companies in the Public Utilities sector.

The use of data for carrying out the analysis consists of a set of the most relevant indicators for the measurement of the companies' economic and social performance. To characterize the companies' economic situation, the following indicators were used: Asset Return (ROA) Net Equity Return (ROE) Net Margin (NM) Earnings per Share (EPS) and the Price-to-Earnings Ratio (P/E ratio). The use of such indicators is focused on Brigham and Houston (1999), Schrickel (1999), Brigham, Gapenski and Ehrhardt (2001), Salazar and Benedicto (2004), Savytzky (2005), Brigham and Ehrhardt (2006), Assaf Neto (2009), Hoji (2012) and Silva (2012).

The companies' social performance was characterized from the viewpoint of the Value Added Statement, due to the great social usefulness of this statement. The indicators used were: Personnel Expenses (PE), Tax Expenditures (TE) Ratio of Value Added (RVA) Gross VA Rate of Change

(gvarc) Rate of Change Total VA Gross (RCTVAG) and the Asset Potential to Generate Wealth (APGW). These indicators present theoretical support in the works of Bao and Bao (1998), Haller and Stolowy (1998), Santos (1999), Cosenza (2003), Aswegen, Steyn and Hamman (2005), Santos (2007), Nandi (2011).

The use of game theory is justified having in view the objective proposed in this research, precluding the application of other techniques such as panel data, for example, as the analysis to be performed is the cross-cut one.

The results for the equilibrium point identification will be determined through linear regressions in order to establish the values of Standardized Betas, performed using the *SPSS* software. Linear regressions will be made as follows: first it is carried out a regression between a social indicator (dependent variable) with all the economic indicators (independent variables). Thus, the found Beta Standardized Coefficients will be arranged in lines. Next, it is performed the same procedures, in turn, for the economic indicators that will be considered the dependent variables and the social indicators, the independent variables. Thus, the found coefficients will be arranged in the columns. In this context, to determine the Nash equilibrium point in a bi-matrix game, Simonsen (1994, p. 414) points out that one should identify "[...] where the gain of A is maximum in the column and the gain of B is maximum in the line". Thus, the game equilibrium point is identified; companies must position their strategies for these indicators in order to achieve balance between economic and social performance.

4. DATA ANALYSIS

This section seeks to describe the identification of the Nash equilibrium points of a bi-matrix game between economic and social indicators.

In order to determine the equilibrium point, it was defined the values based on the Simple Linear Regression, considering only the values of the *Beta* Standardized Coefficients, since they indicate the relationship between

the independent variables and the dependent variable. Table 3 presents the results of the regressions for the period 2009-2011, taking as dependent variables the economic indicators and as independent variables the social indicators. In other words, first, the regression with ROA in the dependent variable, and next all the social indicators in the independent variable, and so on.

Table 03: Results of the linear regressions

2009										
	ROA		ROE		ML		LPA		PL	
	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.
Const		,246		,766		,295		,967		,000
GP	-,201	,424	,050	,856	-,247	,379	,100	,699	,134	,195
GT	,281	,381	-,198	,575	,313	,379	-,113	,731	,921	,000
QVA	-,311	,168	-,135	,581	-,050	,837	-,207	,365	,233	,016
TVAB	-,041	,871	,013	,962	-,057	,838	-,094	,718	,203	,059
TVT	-,001	,996	,077	,800	-,103	,735	,074	,795	,056	,617
PAGR	,062	,843	,275	,433	-,217	,537	,394	,233	-,109	,396
R^2		,239		,067		,063		,194		,875
2010										
	ROA		ROE		ML		LPA		PL	
	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.
Constant		,190		,687		,319		,165		,000
GP	,153	,593	-,306	,346	-,222	,495	,329	,276	-,383	,088
GT	-,875	,035	,139	,753	-,083	,852	-,582	,164	,735	,021
QVA	-,651	,019	-,249	,398	-,211	,475	-,223	,413	,275	,172
TVAB	,015	,948	-,053	,842	,358	,186	-,315	,205	-,426	,024
TVT	-,020	,935	,277	,323	,207	,460	-,121	,637	-,479	,017
PAGR	,726	,081	-,182	,687	-,199	,662	,790	,070	-,656	,041
R^2		,337		,154		,143		,275		,618

2011										
	ROA		ROE		ML		LPA		PL	
	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.	Beta Pad.	Sig.
Constant		,298		,391		,799		,638		,895
GP	-,117	,784	-,067	,866	-,455	,326	,154	,736	,444	,312
GT	-,379	,398	-,211	,616	,373	,441	-,364	,450	-,448	,330
QVA	-,350	,226	-,537	,055	,075	,806	-,261	,397	-,138	,635
TVAB	-,071	,793	-,108	,673	-,065	,823	-,062	,831	,034	,901
TVT	,138	,664	,111	,709	,111	,746	,067	,843	-,142	,662
PAGR	,065	,888	,169	,696	-,403	,421	,147	,766	,779	,109
R^2		,193		,285		,059		,066		,157

Source: Research Data

At first, as it was sought to analyze the possible existence of influence between the independent variables and the dependent variable, it was not taken into account the significance coefficient of the Standardized Beta coefficients. For confirmation and robustness proof, this coefficient should be taken into consideration; however in this paper it is given greater emphasis in describing the equilibrium model for management purposes and not for the results statistical inference.

Table 4 presents the regressions results for the period 2009-2011, assuming the social indicators as dependent variables and the economic indicators as independent variables. In other words, in the first regression, it is assumed GP as dependent variable and all the indicators as independent variables, and so forth.

Table 04: Results of the linear regressions

2009

	GP		GT		QVA		TVAB		TVT		PAGR	
	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.
Const		,008		,000		,005		,000		,000		,000
ROE	-,348	,266	,105	,519	-,628	,049	-,238	,472	,039	,902	,148	,620
ROA	,108	,744	-,290	,108	,446	,183	,354	,324	,028	,935	-,206	,520
ML	-,035	,869	,041	,714	,059	,776	-,053	,814	-,098	,653	-,040	,845
LPA	,055	,844	,262	,084	-,270	,329	-,301	,315	,089	,755	,374	,171
PL	,485	,034	,813	,000	,274	,208	,274	,244	,371	,107	,338	,116
R^2	,221		,785		,244		,115		,180		,282	

2010

	GP		GT		QVA		TVAB		TVT		PAGR	
	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.
Const		,005		,000		,005		,000		,000		,000
ROA	-,204	,609	-,434	,273	-,156	,669	,298	,319	-,476	,119	-,328	,382
ROE	-,089	,791	,403	,228	-,463	,142	-,588	,026	,338	,185	,379	,234
ML	-,093	,694	,151	,513	-,029	,894	,179	,310	,177	,319	,126	,568
LPA	,103	,826	,430	,355	-,286	,509	-,903	,016	,486	,174	,517	,246
PL	-,202	,368	-,155	,478	-,183	,373	-,453	,011	-,633	,001	-,327	,125
R^2	,082		,120		,231		,496		,492		,203	

2011

	GP		GT		QVA		TVAB		TVT		PAGR	
	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.	Beta Pad	Sig.
Const		,005		,000		,000		,000		,000		,000
ROE	-,585	,203	-,785	,089	,566	,166	,216	,653	-,538	,243	-,147	,745
ROA	,112	,728	,480	,140	-,786	,011	-,159	,643	,515	,122	,249	,440
ML	-,015	,945	,154	,485	-,111	,574	-,085	,718	,128	,569	,055	,803

LPA	,386	,356	,527	,206	-,672	,078	-,201	,649	,516	,223	,102	,805
PL	-,144	,503	,046	,828	,005	,980	-,050	,825	,079	,713	,334	,130
R^2	,133		,155		,322		,018		,124		,134	

Source: Research Data

Carried out the linear regressions, it is determined next, the maximum gain arranged in the column for Player A (economic indicators) and the maximum gain arranged in the row for Player B (social indicators) as listed by Simonsen (1994). Thus, it is found the Nash equilibrium point for a bi-matrix game, so that the companies position their strategies to such indicators in order to achieve a balance between economic and social performance.

It is set forth in Table 5 the results for the Nash equilibrium point for the period 2009-2011.

Table 5: Nash equilibrium point of the Public Utilities sector

2009

	ROA	ROE	ML	LPA	P/L	**Max**
GP	(-0,348; -0,201)	(0,108; 0,050)	(-0,035; -0,247)	(0,055; 0,100)	(0,485; **0,134**)	**0,134**
GT	(0,105; 0,281)	(-0,290; -0,198)	(0,041; 0,313)	(0,262; -0,113)	**(0,813; 0,921)**	**0,921**
QVA	(-0,628; -0,311)	(**0,446**; -0,135)	(**0,059**; -0,050)	(-0,270; -0,207)	(0,274; **0,233**)	**0,233**
TVAB	(-0,238; -0,041)	(0,354; 0,013)	(-0,053; -0,057)	(-0,301; -0,094)	(0,274; **0,203**)	**0,203**
TVT	(0,039; -0,001)	(0,028; **0,077**)	(-0,098; -0,103)	(0,089; 0,074)	(0,371; 0,056)	**0,077**
PAGR	(**0,148**; 0,062)	(-0,206; 0,275)	(-0,040; -0,217)	**(0,374; 0,394)**	(0,338; -0,109)	**0,394**
Max a_{ij}	**0,148**	**0,446**	**0,059**	**0,374**	**0,813**	

2010

	ROA	ROE	ML	LPA	P/L	**Max b_{ij}**
GP	(-0,204; 0,153)	(-0,089; -0,306)	(-0,093; -0,222)	(0,103; **0,329**)	(-0,202; -0,383)	**0,329**
GT	(-0,434; -0,875)	(**0,403**; 0,139)	(0,151; -0,083)	(0,430; -0,582)	**(-0,155; 0,735)**	**0,735**
QVA	(-0,156; -0,651)	(-0,463; -0,249)	(-0,029; -0,211)	(-0,286; -0,223)	(-0,183; **0,275**)	**0,275**
TVAB	(**0,298**; 0,015)	(-0,588; -0,053)	**(0,179; 0,358)**	(-0,903; -0,315)	(-0,453; -0,426)	**0,358**

To Be Continued

Continuation

TVT	(-0,476; -0,020)	(0,338; **0,277**)	(0,177; 0,207)	(0,486; -0,121)	(-0,633; -0,479)	**0,277**
PAGR	(-0,328; 0,726)	(0,379; -0,182)	(0,126; -0,199)	**(0,517; 0,790)**	(-0,327; -0,656)	**0,790**
Max a_{ij}	**0,298**	**0,403**	**0,179**	**0,517**	**-0,155**	

2011

	ROA	ROE	ML	LPA	P/L	**Max b_{ij}**
GP	(-0,585; -0,117)	(0,112; -0,067)	(-0,015; -0,455)	(0,386; 0,154)	(-0,144; **0,444**)	**0,444**
GT	(-0,785; -0,379)	(0,480; -0,211)	**(0,154; 0,373)**	(**0,527**; -0,364)	(0,046; -0,448)	**0,373**
QVA	(**0,566**; -0,350)	(-0,786; -0,537)	(-0,111; **0,075**)	(-0,672; -0,261)	(0,005; -0,138)	**0,075**
TVAB	(0,216; -0,071)	(-0,159; -0,108)	(-0,085; -0,065)	(-0,201; -0,062)	(-0,050; **0,034**)	**0,034**
TVT	(-0,538; **0,138**)	(**0,515**; 0,111)	(0,128; 0,111)	(0,516; 0,067)	(0,079; -0,142)	**0,138**
PAGR	(-0,147; 0,065)	(0,249; 0,169)	(0,055; -0,403)	(0,102; 0,147)	**(0,334; 0,779)**	**0,779**
Max □□□	**0,566**	**0,515**	**0,154**	**0,527**	**0,334**	

Source: Research Data

According to data presented in Table 5, the first found combination which induces to gains in the economic performance and in the social performance in a jointly way is between the indicator Profit per Share with the Asset Potential to Generate Wealth. Other strategy that generates gains, common to economic and social indicators adopted by the companies in 2009, is given by the combination of Price/Earnings Profit index with the Expenditure on Taxes.

In the period of 2010 it was identified three strategies that brought about a balance for the two ways of performance evaluation analyzed in the research. It is inferred that the companies adopted, as strategy, the combination of the Net Margin with the Rate of Change of the Gross Added Value, the Earnings per Share with the Asset Potential to Generate Wealth and also the Price / Earnings index in combination with the Expenditure on Taxes.

For the year 2011, companies in the Public Utilities sector adopted two strategic combinations that combined generated gains for both groups of indicators: Net Margin with Expenditure on Taxes and also the Price / Earnings index with the Asset Potential to Generate Wealth.

It is observed that companies of the Public Utilities sector that use as focus the Quotient of the Added Value and the Quotient of the Total Rate of the Value Added Change tend to impair all their economic indicators, as well as the Return on Assets and the Return on Equity tend to impair the social indicators. This finding is carried out, because these indicators are not in any of the strategies adopted by companies and identified in the Nash equilibrium point.

These are the Nash equilibrium points identified in the games, for which companies can position their strategies in order to achieve a balance between economic performance and social performance, in which it is not possible to obtain gains to satisfy either the first set of indicators or the second set without placing a burden on either of the two information categories.

According to the data presented, it is possible to perceive that, for all periods analyzed, it was found at least a point of equilibrium. It is for these indicators that companies can position their strategies to achieve a balance between economic and social performance, without causing discomfort to any of the players.

This finding implies the rejection of the null hypothesis (H_{0b}) and the acceptance of the hypothesis (H_{1b}), assuming that there is at least one Nash equilibrium point in the bi-matrix game of economic and social indicators. It is corroborated thus the premise established by Nash (1950; 1951) that defined that any game ruled in mixed strategies presents one equilibrium point. Simonsen (1994) alert for the moments when it might occur the identification of more than one equilibrium point in the game. Thus, the strategies combination of economic indicators with the social indicators brings about a balance of the companies' economic and social performance.

5. CONCLUSION

Over long periods of time, the companies' great concern was their economic and financial performance, however, a new perspective emerged where the emphasis, for the performance analysis, was no longer in the profit. Thus, it is inserted the discussion around the corporate sustainability, which is focused on an economic, social and environmental balance for businesses.

In face of this discussion, in this research the aim is to identify the Nash equilibrium point in the bi-matrix game of economic and social indicators of the companies of Public Utilities sector listed on the BM & F Bovespa. The research was carried out with a sample of 26 companies. The choice of indicators for assessing the economic performance is focused on profitability and market indicators; for assessing the social performance, it was used the indicators derived from the VAD (Value Added Statement).

In the described model, there was great difficulty in estimating the values for the games matrices. Estimating the gains among the indicators was the great difficulty faced during the work execution. Therefore it was used to estimate the game matrix parameters, the standardized parameters of the multiple linear regression. The use of the standardized coefficients takes into account that the estimated coefficients of a regression are directly influenced by the variable's magnitude or size. On the other hand, the standardized coefficients are free of such involvement. It was possible thus the comparison and therefore its use in estimating the weights of the games matrix.

In the obtained results, it stood out the existence of at least one equilibrium point for the analyzed years and especially, it was proposed two equilibrium points for 2009 and 2011 and three for 2010. This higher number of equilibrium points favors a possible decision making process by the users of this information.

It is highlighted that the proposed model confirmed the hypothesis of the existence of at least one equilibrium point, and so the research is able to meet its objective namely it is possible to meet both the economic and the social aspects of companies when taking the indicators as basic information. Questionings that can be dealt with in greater depth refer to the importance of the regressions coefficient significance for the model,

besides taking into account some obtaining criterion of the Nash equilibrium point for mixed strategies.

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