

Interorganizational networks and corporate value creation in Brazil

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Abstract

Objective: In this study we evaluated the association between interorganizational networking and corporate value creation in 218 non-financial firms traded on B3.

Method: Using descriptive, inferential and multivariate statistical techniques, we analyzed information regarding 2,080 board members (15,611 observations) for the year 2016, retrieved from reference forms and the Economatica® database.

Results: Our results show that firms are more likely to create value if they limit the sharing of directors with other firms to 8 interlockings and keep at least 2 and at most 4 independent directors on the board.

Contributions: We conclude that the corporate value creation was greater for firms practicing board interlocking than otherwise, making it possible, in the light of Resource Dependence Theory, to demonstrate a positive association between interorganizational networking indicators and measures of corporate value creation.

Key words: Interorganizational networks. Board interlocking. Top management. Value creation. Resource Dependence Theory.

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1. Introduction

Based on the establishment of interorganizational networks, constituted through relationship channels among organizations, also known under other names as strategic alliances, corporate partnerships, organizational network, corporate social networks, corporate strategies can take form with interorganizational support. In this study, the term “interorganizational networks” is adopted for these relationships.

The interorganizational partnerships can derive from corporate interests linked to the reduction of the costs related to processes, information gaining and learning (Larentis, Antonello, Milan & De Toni, 2014), which represent possible sources of competitive advantages. According to Ribeiro and Colauto (2016), companies are more inclined to adopt common organizational practices when sharing board members and directors with other strategically aligned companies, tending towards a collective relationship and a uniform decision process.

In that context, one of the ways for the company to establish and strengthen strategic partnerships is the intertwining and development of relationship networks among top management members and other companies, including board members and directors, with a view to expanding the network. This practice is called board interlocking and is considered a facilitator of the access to external resources (Hillman, Cannella & Paetzold, 2000). Board interlocking represents social relationships between two or more companies through the sharing of a management professional (Fich & White, 2005; Ribeiro & Colauto, 2016).

The establishment of interorganizational networks can be explained based on different theories, such as the Agency, Transaction Costs, Agency Costs or Resource Dependence theories. The choice of what theory to explain the interorganizational networks depends on the goals for which the networks are constituted. For the sake of this study, the establishment of the networks rests on the Resource Dependence theory, which helps to explain the reasons for the networking links among companies (Hillman *et al.*, 2000), when the top management members serve as links between the firms, facilitating the access to external resources in favor of shared objectives (Zald, 1969).

Ribeiro e Colauto (2016) explain that the Resource Dependence theory helps to explain the board of administrators as a mechanism that facilitates the organization's access to external resources, which are essential for the firm's medium and long-term development. In addition, the corporate relationships grant the companies access to commercial partners, favoring the gaining of specific and strategic knowledge.

Concerning the effects of the interorganizational networks on the corporate value, Almeida and Machado (2013) appoint that companies that work in a single market face difficulties to expand but, through alliances, they encounter a competitive form of value creation. Santos and Silveira (2007) noted the opposite effect, indicating that high levels of interlocking negatively affect the company value. Aranha, Rossoni and Mendes-da-Silva (2016), then, found a positive link between board interlocking and corporate performance.

In view of the above and considering conflicting and inconclusive results in the literature, the interest in answering the following problem question emerges: **What is the relationship between the establishment of interorganizational networks and value creation in Brazilian publicly traded companies?** Thus, the primary objective of this study is to investigate the relationships between the establishment of interorganizational networks through board interlocking and value creation in Brazilian publicly traded companies. In addition, the goal is to describe the characteristics of the networks in the Brazilian corporate environment, besides comparing the companies that participate in networks with other companies in terms of value creation.

Hence, considering that companies close alliances with other companies to find a competitive form of value creation (Almeida & Machado, 2013), that there are signs of optimal centrality levels (which maximize the company value and performance) of the company in the corporate relationship network (Mendes-da-Silva, 2011), and that the controlled practice, without excesses, of interlocking can contribute to value creation (Santos & Silveira, 2007), this study, based on the Resource Dependence theory, raises the hypothesis that networking through board interlocking contributes to value creation in publicly-traded companies.

In that sense, the companies that participate in corporate social networks are expected to maximize their potential access to external resources and strategic knowledge, resulting in the maximization of their value, superior to that of the companies that do not relate in interorganizational networks through board interlocking.

It is highlighted that, each day, the themes interorganizational networks and corporate value creation arouse the stakeholders' attention and interest. Thus, the goal is to contribute to the systematic evolution of research on the themes, considering that the studies present performance measures instead of value creation, as well as inconclusive results (Camargos & Barbosa, 2009; Lamb, 2017; Larentis *et al.*, 2014; Marchi, Cassanego & Wittmann, 2012; Kaczmarek, Kimino & Pye, 2014; Santos & Silveira, 2007; Vedel, 2016). Another goal is to contribute to the expansion of the literature on corporate social networks, using a relationship approach of their constituent elements, which originates in the board interlocking, also considering the limited exploration of the combination between both themes in Brazil (Balestrin, Verschoore & Reyes, 2010).

2. Literature Review

2.1 Resource Dependence Theory and interorganizational networks

In the Resource Dependence theory, the board of directors and the directors, serving as connection channels among companies in the corporate environment, act as management mechanisms of external resources, reducing uncertainties and, in addition, decreasing the transaction costs (Pfeffer & Salancik, 1978). According to Hillman *et al.* (2000), the Resource Dependence theory helps to understand the board of directors as a mechanism that facilitates the company's access to external resources.

The access to external resources is facilitated when the companies establish mutual links through their top management members, because these tend to work towards common objectives (Zald, 1969). In that context, companies should be considered in their interdependence with the environment (Pfeffer & Salancik, 1978).

The sharing of top management members among companies is one of the mechanisms used to facilitate the access to those resources, a practice known as board interlocking. According to Cunha and Piccoli (2017), this phenomenon contributes to the dissemination of management and governance practices, based on the sharing of knowledge and experiences of the board members on other boards, including corporate strategies.

In the increasingly competitive corporate context, the challenge for the companies is to align the business strategy with the shareholder interests, in an environment in which the shareholders intend to gain greater corporate value. In that sense, board interlocking can influence the company's performance (Aranha *et al.*, 2016).

Therefore, the establishment of interorganizational networks through board interlocking, based on the Resource Dependence theory, helps to explain the reasons for the companies' network connections. Gobibi, Cunha, Brito and Senger (2005) argue that mechanisms like the perceived dependence among the stakeholders, the development of cooperation and the establishment of trust help to guarantee joint action among the companies.

According to Ribeiro, Colauto and Clemente (2016), the Resource Dependence theory tries to explain the occurrence of board interlocking in the organizational environment as a link among companies to capture essential resources for their progress, coming from external sources. Thus, the Resource Dependence theory contributes to enrich studies that help to understand the board of directors as a mechanism that facilitates the company's access to external resources (Ribeiro & Colauto, 2016).

Balestrin *et al.* (2010) explain that these relationships result from organizations that adopt some kind of cooperative or interorganizational strategy to reach individual and collective objectives while remaining autonomous and independent.

Nevertheless, these interests are not always harmonious and converging. According to Gobibi *et al.* (2005), the network is a plural space where different agents coexist with different capitals and interests, which can generate situations of conflicts and disputes, to the detriment of the consensus and harmony that predominate in research in this organizational field.

For the sake of this study, the interorganizational networks are analyzed based on the sharing of board members and directors between two or more companies at the same time, equivalent to board interlocking. These are links established through the same professional's participation in the management of both (Fich & White, 2005; Ribeiro & Colauto, 2016). According to Pfeffer & Salancik (1978), when an organization indicates a professional to sit on its board of directors, that person is expected to favor resources that help to enhance the company's financial structure and its development over time.

In this study, the indicators of network formation are in line with Ribeiro and Colauto (2016): degree centrality, power degree; betweenness; board size, in addition to the number of directors; and independence of the board. Other studies have used similar proxies to analyze networks through board interlocking (Cunha & Piccoli, 2017; Mendes-da-Silva, Rossoni, Martin & Martelanc, 2008).

2.2 Value creation in interorganizational networks and hypothesis development

Bonds among companies, in which the clusters provide for an intense relationship and are encouraged by governance entities, can appoint factors that generate competitive advantage (Deboçã & Martins, 2015). Nevertheless, there is a gap in the Brazilian scientific research when considering the controversial and inconclusive aspects in studies on the effect of the establishment of interorganizational networks through board interlocking on the company value and performance (Santos & Silveira, 2007; Kaczmarek *et al.*, 2014).

Santos and Silveira (2007) have found that the influence of board interlocking on corporate value and performance is negative, indicating that the existence of an executive director or chairman of the board who serves in other companies tends to reduce the company value. In the study by Lamb (2017), it is also appointed that the number of links does not influence a company's financial performance.

Another aspect to be taken into account in the networks is the value creation and exchange through the exchange of learning. Marchi *et al.* (2012) found that, in the corporate networks, value creation is as significant as value exchange, demonstrating the existence of an intense level of learning that permeates the corporate network sphere.

According to Vedel (2016), the network structure is relevant for the creation of corporate value, as confirmed in empirical studies. In that sense, and based on the Resource Dependence theory, the organizations constitute interorganizational relationships to exert power or control over other organizations holding the scarce resources, aligning their own interests with those of the stakeholders and reducing the environmental uncertainties, thus seeking to absorb as much knowledge as possible, enhancing the organizational competences and adding value for themselves and their stakeholders (Larentis *et al.*, 2014, Pfeffer & Salancik, 1978).

For the sake of this research, the value creation indicators are in line with the variables adopted by Camargos and Barbosa (2009): Tobin's Q, Market to Book and Firm value.

Hence, based on the interorganizational network indicators and the value creation measures, and on the premises of the Resource Dependence theory, which departs from the external environment, external resources are needed for the organizational development and the access to these resources is possible when the corporations establish mutual links through their top management members, reducing uncertainties and decreasing transaction costs (Pfeffer & Salancik, 1978). Thus, the companies linked up in networks through their board members and directors are expected to gain more resources to create greater value than the isolated, unconnected companies. Therefore, the following hypotheses are raised: **H1**: The indicators of interorganizational networks are positively related to the value creation measures; and **H2**: The companies that participate in interorganizational networks create more value than other companies.

3. Methodological Procedures

The research population includes all 289 non-financial companies publicly traded on B3 on August 30th 2017. The non-inclusion of companies from the financial sectors (banks, insurance companies and other financial institutions) derives from the peculiar nature of their operations and, consequently, from their financial reports, differing from the other companies (Medeiros & Mol, 2017). To define the sample, 71 companies were excluded, whose data were not available to calculate the research variables, resulting in 218 companies. In total, 15,611 observations were collected from the companies in the sample and from the 2,080 board members and directors linked to those, referring to the year 2016.

Figure 1 displays the measures adopted for the interorganizational network analysis.

Variable	Definition	Measuring	Theoretical background
Degree centrality	Number of neighboring bonds of an actor with other participants in the same network (direct link)	Proportion of actors (companies) in the network, minus one	Wasserman and Faust (1994)
Power centrality	Number of links between a company and others through top management members	Sum of top management members' participation in (an)other company(ies)	Bonacich (1987)
Betweenness	Interactions between two non-neighboring actors (indirect link)	Number of geodesics (smallest distance between two points) between the pairs of companies, divided by the number of geodesics between the companies that share a member	Freeman (1979); Mendes-da-Silva (2011)
Size of Board of Directors and Executive Board (Size BD and EB)	Design of corporate governance structure	Natural logarithm of number of board members and directors in a company	Silveira, Barros and Famá (2003)
Independence of Board of Directors (Independ)	Measure of board of directors' independence level	Number of independent members on the Board of Directors in relation to total number of members	Freitas and Mol (2017)

Figure 1. Interorganizational network variables.

Source: elaborated based on Ribeiro and Colauto (2016).

In addition to the Degree centrality analyses, the company's ability to maintain connections with other companies was taken into account, which is called the Power Degree, a measure of the number of connections a company maintains with others at the same time, within the network, through board interlocking, sharing the top management members.

The information on the operational variables of interorganizational networks were taken from the companies' reference forms for 2016 which are available on the B3 website. To analyze the establishment of networks, based on the sharing of board members and directors, Ucinet 6.644 and NetDraw 2.161 software.

Figure 2 displays daa on the operational variables considered for the analysis of the corporate value creation, collected in Economática®.

Variable	Definition	Measure	Theoretical background
Tobin's Q (QT)	Estimate of company's intangible assets (market, administration quality and investment opportunity)	$QT = \frac{MVOS + MVPS + BVTD}{A}$	Camargos and Barbosa (2009); Fauver, Hung, Li and Taboada (2017)
Market to Book (MB)	Measure used to indicate the detachment between the market value and the book value	$MB = \frac{MVOS + MVPS}{NE}$	Camargos and Barbosa (2009); Carvalho, Maia, Louzada and Gonçalves (2017)
Firm Value (FV)	Measure of own capital (stocks), capital from third parties (debts) and capital from business activities in relation to company investments	$FV = \frac{\text{Firm Value}}{AT}$	Camargos and Barbosa (2009); Silveira, Barros and Famá (2003)

Obs: QT – The formula is based on the comparative tests of the explanatory power of the estimation method, which explains at least 96.6% of the values of the original QT; MVOS = Market Value Ordinary Stocks; MVPS = Market Value Preferential Stocks; BVTD = Book Value of Total Debt, defined by: Current Liabilities + Long-Term Liabilities + Inventories – Current Assets; A = Assets; NE = Net Equity; Firm Value = BVOS + BVPS + STDb + LTDb + STFin + LTFin + CEAP – STCI. Where: STDb and LTDb = Short and Long Term Debentures; STFin and LTFin = Short and Long Term Financing; CEAP = Currency Exchange Advance Payments; STCI = Short Term Cash and Investments.

Figure 2. Operational values as proxies of corporate value creation

Source: elaborated based on Camargos and Barbosa (2009).

Other variables are considered to strengthen the analyses and permit the characterization of companies that take part in networks, such as: economic sector, listing segment, total number of board of administrators and executive board members, gender of top management member (board members and directors), average age of the board members and directors and duality of board members and directors.

The main study objective, linked to hypothesis H1, is verified using correlation analysis. The additional objective of analyzing the interorganizational network characteristics is achieved using descriptive statistics with central trend, dispersion and frequency distribution measures and the specific social network indicators. For the additional objective of comparing the value creation among the companies that participate in interorganizational networks and that do not (hypothesis H2), the comparison of means test is used, separating the companies in two groups (network participants and non-participants). In addition, the regression tree technique is used, adopting the chi-square automation interaction detection method (chaid) to identify the characteristics of the network participants with a higher probability of corporate value creation.

4. Presentation and Analysis of Results

4.1 Analysis of interorganizational networks

The analysis of 218 companies and their 2,080 board members and directors shows that 148 companies (67.9%) participate in interorganizational networks through board interlocking, while 70 (32.1%) do not do so, and were therefore excluded for this initial part of the analyses, focused on the network indicators. Santos and Silveira (2007) found a similar scenario, in which 74% of the companies have at least one board member from another company, that is, they practiced interlocking.

Figure 3 displays the graph resulting from the links among the companies after organizing the data in a squared matrix in Ucinet (inputs) and Netdraw (outputs).

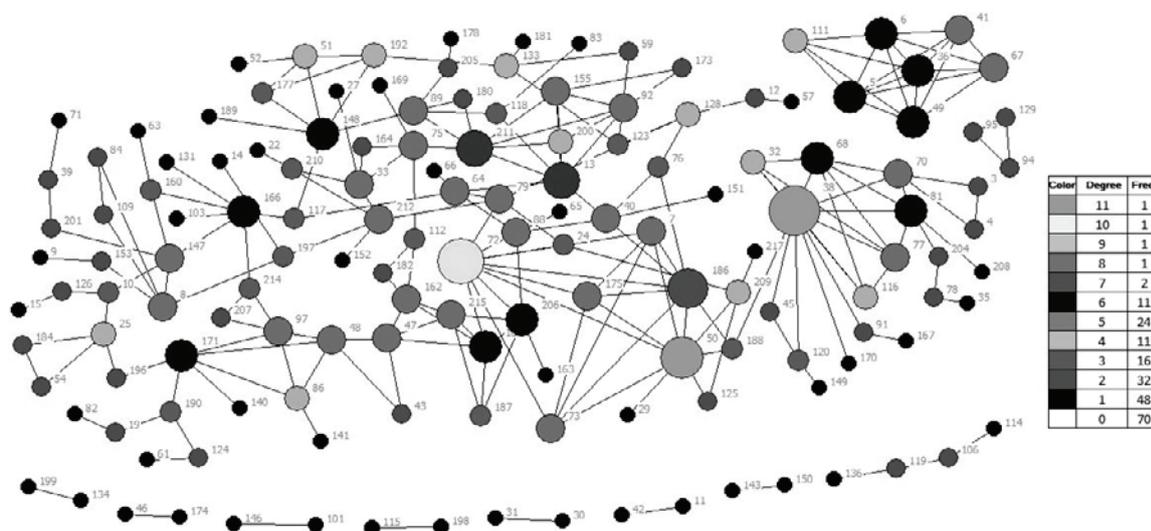


Figure 3. Graph of interorganizational networks among companies listed on B3

Figure 3 displays a web of lines linking the companies, represented using knots, in different numbers of connections. The knots - shaped as circles - represent the companies that are connected inside the network. The sizes and colors of the knots vary according to the number of interconnections in the network, representing the degree centrality; the more they relate with other companies, the larger the knots. The colors are defined by each company's degree centrality in the network. Furthermore, besides a large corporate network, other smaller sub-networks exist, including pairs, triplets and another network with seven companies. This phenomenon may be due to agreements and partnerships between companies in the same sector, aiming to facilitate the communication among them. In other cases, the companies are affiliated or represent links between controlled and controlling companies.

The degree centrality is equivalent to the number of actors one actor directly links up with, divided between the entry degree (sum of interactions between the other knots and the actor) and the exit degree (sum of the actors' interactions with the others), depending on the sense of the flows (Bloodgood, Hornsby, Rutherford & McFarland, 2017). For the sake of the network under analysis, the degree centrality of a company is equivalent to its number of links with others through board interlocking, that is, it refers to how many members of the board of administrators and executive board participate in two or more companies at the same time, independently of the sense of the connection.

In addition to the centrality, an actor's ability to link up with other actors can be analyzed, as measured by the power degree. In this study, that is equivalence to a company's number of connections with other companies at the same time through board interlocking.

In social group relationships, the probability that information will disseminate in a network is proportional to the strength of its bonds (Homans, 1950), which can be estimated by the connection frequency. In Table 1, the distribution of the degree and power degree are shown.

Table 1

Distribution of degree centrality and degree power in the network.

Degree centrality					Power degree				
Degree	Freq.	Proportion (%)	Accumulated	Accumulated (%)	Power degree	Freq.	Proportion (%)	Accumulated	Accumulated (%)
11	1	0.5	1	0.5	28	2	0.9	2	0.9
10	1	0.5	2	0.9	26	1	0.5	3	1.4
9	1	0.5	3	1.4	23	1	0.5	4	1.8
8	1	0.5	4	1.8	20	1	0.5	5	2.3
7	2	0.9	6	2.8	16	2	0.9	7	3.2
6	11	5.0	17	7.8	14	2	0.9	9	4.1
5	24	11.0	41	18.8	13	4	1.8	13	6.0
4	11	5.0	52	23.9	12	2	0.9	15	6.9
3	16	7.3	68	31.2	11	3	1.4	18	8.3
2	32	14.7	100	45.9	10	2	0.9	20	9.2
1	48	22.0	148	67.9	9	2	0.9	22	10.1
0	70	32.1	218	100.0	8	4	1.8	26	11.9
					7	11	5.0	37	17.0
					6	7	3.2	44	20.2
					5	13	6.0	57	26.1
					4	18	8.3	75	34.4
					3	17	7.8	92	42.2
					2	27	12.4	119	54.6
					1	29	13.3	148	67.9
					0	70	32.1	218	100.0

Among the companies that participate in networks, Cemig presented the highest degree in the sample, with 11 connections of board members and directors through board interlocking. Next are Embraer (10), Coteminas (9), Springs (8), Arezzo (7) and Valid (7). The 70 companies with zero degree do not link up with any other company.

As verified, in the network, Afluente and Afluente-T obtained the highest power degree, both with 28, followed by Celpe (26), Cosern (23), Coelba (20), Cemig (16), Coteminas (16), Springs (14) and AES Tietê-E (14).

For the network under analysis, the betweenness is equivalent to the number of times a company intermediates the link between two other companies and can serve as a communication bridge between pairs of companies. In Table 2, the frequency distribution of this measure is shown per class of betweenness in the network.

Table 2

Distribution of betweenness in the network

Betweenness class			Freq.	Proportion (%)	Accumulated frequency	Accumulated proportion (%)
1734	---	2022	3	1.4	3	1.4
1445	---	1733	3	1.4	6	2.8
1156	---	1444	5	2.3	11	5.0
867	---	1155	5	2.3	16	7.3
578	---	866	6	2.8	22	10.1
289	---	577	11	5.0	33	15.1
1	---	288	34	15.6	67	30.7
0	---	0	151	69.3	218	100.0

Embraer shows the highest betweenness and the greatest ability to serve as a communication channel between pairs of companies, with a betweenness score of 2,015, that is, serving as a bridge between pairs of companies on 2,015 occasions (combinations). Next, in decreasing order of betweenness, Cemig (1,908), Taesa (1,900), Klabin (1,505), Raiadrogasil (1,490), Estácio Part (1,460) and Springs (1,444) stand out. Among the 218 companies in the sample, 151 did not play any intermediary role, including the 70 companies that do not present any centrality, as observed in Table 1.

This measure shows the betweenness of all companies studied, demonstrating that Embraer is the company that plays this role most efficiency within the network under investigation.

A relevant measure to analyze the relationship among companies in a network is the number of top management members and the independence of the board members. According to and Colauto (2016) and Santos and Silveira (2007), the size of the board and outsiders tend to positively influence the social network practices, with a positive correlation between indirect bonds (betweenness) and board size.

As for the independence of the board of directors, equivalent to the number of independent members on the board, Freitas and Mol (2017) highlight the relevance of this degree to study corporate subordinations and relationships. For the sake of this study, it is highlighted that the analysis considers the sum of full members on the board of directors and the executive board. In Table 3, the frequency classes of the number of top management members are shown, as well as the number of independent board members in the companies' administrative structures.

Table 3

Frequency distribution in classes of board of directors and executive board size and independence of board of directors

Size of the Board of Directors and Executive Board							Number of Independent Members on the Board of Directors						
Class	Freq.	Proportion (%)	Accumulated frequency	Accumulated proportion (%)	Class	Freq.	Proportion (%)	Accumulated frequency	Accumulated proportion (%)				
20	---	23	7	3.2	7	3.2	8	---	9	1	0.5	1	0.5
16	---	19	24	11.0	31	14.2	6	---	7	9	4.1	10	4.6
12	---	15	58	26.6	89	40.8	4	---	5	33	15.1	43	19.7
8	---	11	75	34.4	164	75.2	2	---	3	75	34.4	118	54.1
4	---	7	51	23.4	215	98.6	0	---	1	100	45.9	218	100.0
0	---	3	3	1.4	218	100.0							

As regards to size of the top management, Cemig showed the largest number of members (23), followed by Ambev (21), Braskem (21), Coelce (21), Weg (21), Alliar (20), Celesc (20), Ceg (19) and Klabin (19).

Concerning the independence of the board of directors, Estácio Par is highlighted with 9 independent members, followed by Embraer, Lojas Renner and Eternit with 7 each. Among the 218 sample companies, 75 (34.4%) do not have any independent board member.

The network density corresponded to 0.93%, that is, of all 47,534 possible links between the 218 companies, 442 actually took place. This density measure can influence the speed of information diffusion or the extent of threats and opportunities the network can offer to the connected companies. The network density is considered low (Bloodgood *et al.*, 2017). According to Watts and Strogatz (1998), the greater the local network density, ranging from 0 to 1, the greater the density. Hence, when the companies are better nested, they present greater benefits resulting from the network cohesion; when the density is low, the network is described as sparse or not-dense (Obstfeld, 2005).

It is highlighted that, in the sample, the highest degree centrality of a company in the network was 4.17%, which is considered low, as this indicator can range from 0% to 100%. According to Provan, Fish and Sydow (2007), the degree centrality in the network shows a centralizing agent's network integration difficulty, as the existence of a large number of links does not guarantee that the network is centralized.

4.2 Descriptive analysis

Table 4 shows the descriptive statistics of the main research variables.

Table 4

Descriptive statistics of research variables

Variable	No. of companies	Minimum	Maximum	Mean	Standard deviation
Network (Board Interlocking)	218	0	1	0.679	0.468
Duality (CEO and Chairman)	218	0	1	0.119	0.325
Number of members on board of directors	218	0	14	6.794	2.472
Number of members on executive board	218	1	14	4.734	2.397
Number of members on board of directors and executive board	218	0	23	10.784	4.215
Degree centrality	218	0	11	2.028	2.210
Betweenness	218	0	2.015	159.729	372.208
Tobin's Q	218	-583.262	1.358.662	20.844	158.781
Market To Book	218	0.000	76.267	2.053	5.606
Firm Value	218	-1,608.121	503.974	2.764	123.201

The network proxy is dichotomous, equal to 1 if the company participates in the network and zero if not, demonstrating that, out of 218 companies, 148 (67.9%) interrelate through board interlocking. The Duality variable is also dichotomous, corresponding to 1 if the same professional acting as CEO serves as the Chairman, and zero if not. This practice was found in 27 companies (12.4%). Furthermore, on average, the boards of directors consist of 7 persons, while the executive boards have 5 members.

In this study, the degree variable represents the number of connections between a company and others through board interlocking. As verified, the maximum in the network was one company linked to 11 others. On average, the degree centrality in the network is about two connections.

As for the Power Degree, the maximum was 28 shared board members and directors between one company and others, against an average of 3 shared members in the network.

The Betweenness variable shows the links between two companies through another company, with a maximum of 2,015 bridges between company pairs, while the network average was about 160 points.

Among the three corporate value creation measures, the Market to Book presents the lowest dispersion and greater data homogeneity. These variables are fundamental to test the research hypotheses and analyze their results.

4.3 Tests of research hypotheses

Initially, to verify H1, correlation analysis was used between the interorganizational network indicators and the value creation measures. Those variables were first tested for data normality, using the Kolmogorov-Smirnov and Shapiro-Wilk tests. In both tests, all variables presented a non-normal data distribution, with $p = 0.000$. Thus, in view of the non-normality of the data, Spearman's non-parametric correlation test was applied to check the associations (Table 5).

Table 5

Spearman's non-parametric correlation test

Variables	Degree	Betweenness	Board Intelocking	Tobin's Q	Market To Book	Firm Value
Degree	1	.619(**)	.825(**)	.181(**)	.228(**)	.224(**)
Betweenness		1	.466(**)	.179(**)	.248(**)	.195(**)
Board Interlocking			1	.135(*)	.241(**)	.232(**)
Tobin's Q				1	.245(**)	.691(**)
Market to Book					1	.341(**)
Firm Value						1

Obs.: (*) Significant correlation at 0.05; (**) Significant correlation at 0.01.

The test revealed a correlation between the three interorganizational network measures, as well as between the three value creation measures, demonstrating that the measures to represent the respective variables are mutually associated, confirming the same trend in the representation of the variables. Cross-correlations were also verified between the network variables and the value creation variables, all at 1%, except for the correlation between Board Interlocking and Tobin's Q, at 5%. This shows support not to reject H1, revealing a correlation between the establishment of interorganizational networks and value creation in Brazilian publicly traded companies?

This result is in line with the findings by Mendes-da-Silva (2011), which indicated a significant correlation between the degree centrality and Tobin's Q and that the normalized Degree was significant and positively related with the company value. The empirical results suggest that there are signs of an association between company value and performance and the company's position in the corporate relationship network.

To compare the value creation among the companies that participate in interorganizational networks and that do not (hypothesis H2), the comparison of means test was applied after separating the companies in two groups: i) 148 companies that participate in networks through board interlocking; and ii) 70 companies that do not participate in networks.

Table 6 shows the descriptive statistics of the value creation measures.

Table 6

Descriptive statistics of value creation measures among the company groups

Value Creation	Network	N	Mean	Standard Deviation	Variation Coefficient
Tobin's Q	Total	218	20.844	158.781	7.618
	Participant	148	31.033	178.593	5.755
	Non Participant	70	-0.699	103.168	-147.594
Market To Book	Total	218	2.053	5.606	2.730
	Participant	148	2.392	6.503	2.719
	Non Participant	70	1.337	2.821	2.110
Firm Value	Total	218	2.764	123.201	44.575
	Participant	148	13.946	67.579	4.846
	Non Participant	70	-20.878	192.795	-9.234

In Table 6, it can be observed that, among the three value creation measures that were considered, the Market to Book presents a more homogeneous distribution.

As the Kolmogorov-Smirnov and Shapiro-Wilk tests applied to all variables presented a non-normal distribution, Mann-Whitney's non-parametric comparison of means test was applied (Table 7).

Table 7

Mann-Whitney's non-parametric comparison of means test

	Tests - Null hypothesis	Test	Sig.	Result
1)	The distribution of Tobin's Q is the same between companies that participate in interorganizational networks and the other companies	Mann-Whitney's U-test for independent samples	.047	Rejects the null hypothesis for the three tests
2)	The distribution of the Market to Book ratio is the same between companies that participate in interorganizational networks and the other companies		0.000	
3)	The distribution of the Firm Value is the same between companies that participate in interorganizational networks and the other companies		0.001	

In view of the information in Table 7 and the descriptive measures in Table 6, there is support not to reject the hypothesis H2 as, in the three value creation measures, a higher average was found for the companies that participate in interorganizational networks when compared to non-participants.

This result is in line with Mendes-da-Silva (2011), who appoints that, based on the correlation between the degree centrality and Tobin's Q, there are values that maximize the company's centrality in the network.

The findings demonstrate that, based on the Resource Dependence theory, the companies constitute networks as a way to execute their corporate strategies, getting access to external resources and creating corporate value for themselves and their stakeholders in the increasingly competitive environment.

Nevertheless, it is highlighted that these results go against the findings by Santos and Silveira (2007), according to which board interlocking is harmful to the company value, as measured by Tobin's Q and the market capitalization.

4.4 Multivariate analysis (regression tree)

In addition, for the sake of a more solid analysis of the correlation between the establishment of interorganizational networks and value creation, a regression tree analysis method is applied, using the variable selection algorithm by means of the chi-square automatic interaction detection (chaid) method. Among the three value creation indicators considered, the Market to Book was defined as the measure that represents the value creation for this analysis, due to the fact that, its comparison with Tobin's Q and the Firm Value, it is more homogeneous (Table 6).

Hence, the Market to Book was the measure chosen as the dependent variable in the tree, while the explanatory variables were: degree, power degree, betweenness, size of the board of directors and executive board and independence of the board of directors. In Figure 4, the regression tree (chaid method) of the network is displayed.

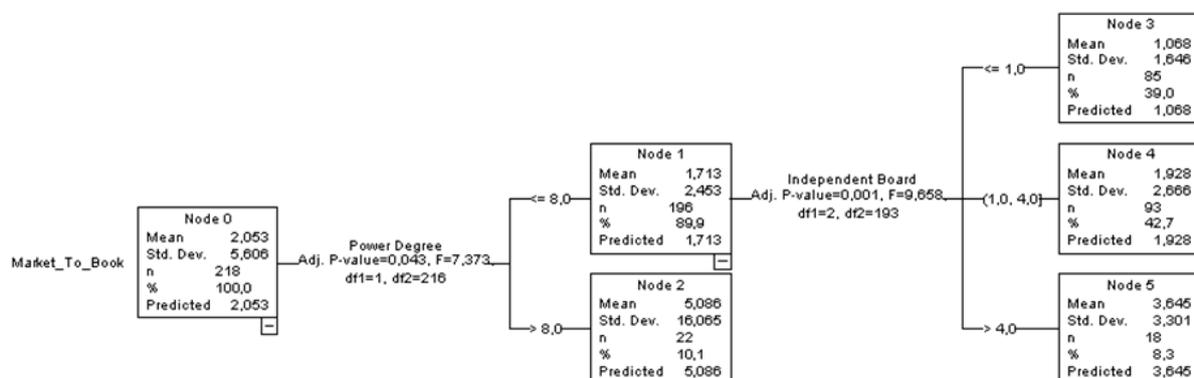


Figure 4. Regression tree (chaid method) of the network with impact on the Market to Book ratio.

The independent variables tested (degree, betweenness, size of the board of directors and executive board) presented no significant probability in the regression tree, to the point of characterizing the value-creating companies measured using the Market to Book.

Departing from the analysis of the Market to Book ratios of the 218 companies (knot 0), the tree results in five regression knots. In the first subdivision, based on the power degree, the companies were divided in two knots, the first including companies with a power degree up to 8 (knot 1), and the second with less than 8 (knot 2), with $p = 0.043$. In knot 1, the tree regressed in three other knots, based on the number of independent members on the board, with $p = 0.001$. This subdivision contained companies with up to one (knot 3), 2 to 4 (knot 4) and more than 4 (knot 5) independent board members.

Thus, based on the structure resulting from the regressed tree, the probable variables and measures that contribute to the company's value creation can be inferred, in this case those network participants whose boards of directors include between 2 and 4 independent members, with a 42.7% probability (knot 4); and with a maximum power degree of 8 with an 89.9% probability (knot 1).

These findings are similar to Santos and Silveira (2007), according to whom high levels of interlocking can negatively affect the company value, like in companies where half or more of the board members serve on three or more boards, identifying that the ideal interlocking point is up to 5 links per company.

In view of the above, based on the Resource Dependence theory, it was verified that the companies that practice board interlocking - the way for companies to participate in interorganizational networks - have, on average, higher value creation measures than the other companies. In addition, a positive association was found between the indicators of interorganizational networks and the corporate value creation measures.

5. Final Considerations

The relations were investigated between the establishment of interorganizational networks and corporate value creation in 218 companies listed on B3. The predominance of links between the companies was evidenced, with 148 (67.9%) companies that participated in networks, confirming that, in Brazil, board interlocking is a recurring practice among publicly-traded companies.

Among the characteristics of the networks and of the participating companies, degree, betweenness, density and centralization measures could be evidenced, like in the studies by Cunha e Piccoli (2017) and Mendes-da-Silva *et al.* (2008), which evidenced companies that concentrate most of the connections between the established networks, influencing the indicators and measures in the networks.

The larger the number of members on the board of directors and the executive board, the greater the practice of board interlocking among the companies. Similarly, the independence of the board can grant the members freedom to sit on the boards of directors and executive boards of other companies, influencing the establishment of corporate social networks and, consequently, the exchange of resources and the creation of corporate value, in line with Fich and White (2005) and Santos and Silveira (2007).

Both research hypotheses were confirmed, as a correlation could be verified between all interorganizational network variables and all value creation variables considered in the study. As found in the companies that constitute interorganizational networks through board interlocking, the value creation measures are higher than those of the other companies.

The research results entail implications for the understanding of the interorganizational networks' positive contribution, through board interlocking, to corporate value creation. The findings show that the relation is positive, but becomes harmful in case of an excessive number of independent board members (more than 4) and sharing of the professionals (more than 8) with other companies.

According to Santos and Silveira (2007), the ideal interlocking point for the performance variables is up to 5 links per company while, in this study, the limit was 8 per company, to contribute to the value creation. This suggests that the time factor, the sample and the measures considered in the study may have contributed to these differences, thus motivating future studies to compare the results.

Based on the Resource Dependence theory, it was thus verified that the companies linked in networks through board interlocking can contribute to improve each other's economic activities through the exchange of resources and the reduction of uncertainties (Ribeiro *et al.* 2016). Similarly, the existence and efficiency of corporate bonds support the creation of corporate value (Mendes-da-Silva, 2011).

In view of the above, it can be concluded that the companies link up to get access to external resources, guarantee the execution of their corporate strategies and create a higher corporate value for themselves and their stakeholders. Therefore, the research achieved the intended goals, presenting a specific view on the relationships between the two constructs analyzed.

The research also provides support for the definition of corporate governance practices and for regulators' supervisory policies of board interlocking limits, which influence the quality of the professional managers' services.

The study does not explore qualitative analyses of the social networks constituted by the Brazilian publicly-traded companies in depth, nor does it consider the influence of the financial segments in the established networks. Therefore, for the sake of future research, interrelations between financial companies and companies from other sectors as well as the same sector should be considered, with a view to analyzing the effect of these relationships on the creation of company value as well as on the economic-financial performance inside the network, besides considering a longitudinal analysis to verify the evolution of the effects over time.

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