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Does the capital of social capital matter? Relational resources of the board and the performance of Brazilian companies

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Abstract Based on theories of social capital, in this study, we seek to assess the impact of a board's social capital on the market value of companies listed on the Brazilian stock exchange. As our indicator of social capital, we use the relational resources identified in the direct, indirect and heterogeneous ties of the board. Employing panel data from 508 observations, our results indicate that heterogeneous relational resources have a stronger and more significant influence than the resources available from board members' direct relationships. Additionally, as the effects of board interlock are endogenously determined by several factors related to the firm level, we seek to mitigate the endogeneity problem using models of instrumental variables and simultaneous equations. Our hypotheses were consistent after controlling for endogeneity. We also check whether the board's social capital could present a U-inverted effect on the market value. This relationship was only plausible in social capital by indirect ties. Finally, we isolate the effect of relational resources within and between industries on Tobin's Q. There was no significant effect through interlocks within the same industry. However, ties with companies in several other industries were significant.

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1 Introduction

The board of directors has been gaining in prominence because it plays such a crucial role in the management of listed companies (Johnson et al. 2013). The main characteristic of company boards is that they are the shareholders' representatives in companies that define the strategies and objectives of these companies and aim to maximize returns and to perform ratifying and monitoring functions (Brookfield et al. 2012). Therefore, it should be expected that each director, in particular, and the board in general, would be held responsible for monitoring, deciding and advising executives and shareholders in the quest to increase the value of firm assets.

Although it is strongly believed that boards have a significant and direct influence on the financial performance of companies, the empirical proof in support of such beliefs remains obscure (He and Huang 2011). As noted by He and Huang (2011), Johnson et al. (2013) and Stevenson and Radin (2009), research that examines the relationship between the board and performance has concentrated on the formal and structural characteristics of the board, on intellectual capital, on the demographic profile of the directors and on the degree of independence of the board but has not arrived at any consistent results. As the broad review undertaken by Johnson et al. (2013) shows, in addition to such elements, the most recent studies apparently focus more attention on the relationships that board directors establish outside of the firm.

When directors sit on the boards of two or more companies, they create a link known as board interlocking (Bohman 2012; Mizruchi 1996; Saavedra et al. 2014). When many companies are combined, interlocking networks emerge as the result of many interconnected boards (Sánchez and Barroso-Castro 2015). However, what is the importance of these relationships between the boards of publicly listed companies, or what might be the benefit of having directors who have multiple board relationships?

Davis (1996) and Mizruchi (1996) note that good directors tend to be involved with more organizations and in different groups. Indeed, the centrality and positions of these directors in these networks is an indicator of their prestige (Chahine et al. 2011; Chen et al. 2008). Moreover, when they are more strongly embedded in a web of relationships, these directors are bound by social pressure to act in a responsible manner (Connelly and Van Slyke 2012; Davis 1996; Zona et al. 2015).

Studies also indicate that directors who are better positioned in the network tend to have a greater capacity for acquiring information (Horton et al. 2012; Saavedra et al. 2014), resources (Sánchez and Barroso-Castro 2015; Zona et al. 2015) and knowledge (McDonald et al. 2008; Westphal 1999) because of their privileged access to different and separate groups (Connelly and Van Slyke 2012; Davis 1996). In other words, they have greater social capital (Burt 1992; Kim 2007).

Although such arguments in favor of greater centrality and the privileged position of the board in the network are convincing, there are also debates as to whether these relationships positively or negatively affect the performance of firms (Fracassi and Tate 2012; Horton et al. 2012; Johnson et al. 2013; Kim and Cannella 2008; Pombo and Gutiérrez 2011). There is evidence of positive results in some studies (Filatotchev et al. 2016; Mendes-da-Silva et al. 2008; Mizruchi et al. 2006; Pombo and Gutiérrez 2011; Rossoni and Machado-da-Silva 2013) and negative results in other studies (Fracassi and Tate 2012; Santos et al. 2012), although these latter studies were restricted to identifying only the effects of the privileged position of the boards and their directors by using various social network analysis indicators (such as degree centrality, Bonacich's power, and structural holes). According to the extensive review of Johnson et al. (2013), these latter studies omitted the quantity, type, and availability of relational resources these directors hypothetically bring to organizations.

It is common knowledge that information and material and symbolic resources embedded in boards' relations are essential to firm performance (Connelly and Van Slyke 2012; Davis 1996; Johnson et al. 2011; Mizruchi et al. 2006; Sánchez and Barroso-Castro 2015; Stevenson and Radin 2009). However, the empirical evaluation of the effect of relational resources that emerge from interlocking boards, regardless of the type, is more of an exception than a general rule (an exception is Zona et al. 2015).

Given this gap in research on interlocking boards, we are interested in investigating the influence that the resources embedded in the network have on market performance, which we refer to as relational resources. Based on the theories of Social Capital (Burt 1992; Lin 1982, 2001; Lin et al. 2001), we define relational resources as those symbolic and material resources that do not belong to a company but that can potentially be mobilized through network relationships and by means of the board interlock. With this, we seek to demonstrate how unequally distributed resources in the companies' structure of social relations can be used to generate expected returns. This idea is central to theories of social capital and is based on the assumption that social relations allow instrumental gains for players in better positions (Lin 1982, 2001; Burt 1992; Mizruchi and Stearns 2001; Nahapiet 2008). Moreover, since we believe that interlocks with higher valued companies can generate greater material and symbolic gains, we doubly seek to fill an empirical gap in board social capital research and bring social capital theories closer to resource-based-view perspectives (Helfat and Peteraf 2003).

In this study, we take the market value of the companies that are part of the ego network of a particular company as a proxy for board relational resources. We use this measure because one of the most important indicators of firm wealth, prestige, and status in the capital markets is market value (Johnson et al. 2011). As a result, we consider the sum of relational resources present in a firm's ego network as a proxy for boards social capital. In light of the foregoing, our objective in this study was to assess the effect of the board's social capital on the market value of companies listed on the Brazilian stock exchange in 2010 and 2011.

The main contribution of this study involves a more comprehensive and consistent empirical evaluation of a board's social capital by including relational

resources. Unlike past studies that analyze the effects of board interlocks on performance (Johnson et al. 2011, 2013)—and which only evaluate the board's position in the network—we simultaneously consider the board's relations and relational resources, i.e., the capital of social capital. The importance of considering some measure of value in the board interlock is that most of the studies conducted so far presuppose that any tie has the same value, which is not true in the corporate world. Having ties with more valuable companies can potentially be linked to the privileged access to information, greater exchange of experiences and most prestigious board (Chen et al. 2008; Connelly and Van Slyke 2012). Therefore, we advocate that only when we have some measure of each interlock that can capture their real value. The point is not only important for the literature board interlock and corporate networks (Afuah 2013; Johnson et al. 2013), but it is also relevant to the literature of social capital (Andriessen and Gubbins 2009).

In this manner, we aim to resolve some of the inconsistencies in the literature regarding the effects of board interlock on performance, which sometimes yield positive results, sometimes negative results, and sometimes indeterminate results. We argue that some of these contradictory results manifest themselves because previous studies typically consider a number of these ties to the detriment of their quality. Additionally, as the effects of board interlock are endogenously determined by several factors related to the firm level, we seek to mitigate the endogeneity problem using models of instrumental variables and simultaneous equations. We also checked whether the social capital had a quadratic effect (U-inverted). Finally, we isolate the effect of relational resources within and between industries on Tobin's Q.

2 Theory and hypotheses

Generally speaking, social capital is understood as a social asset because of the relationships between the players in which social capital is captured and the exchanges that occur in social relationships (Lin 2001). In particular, social capital for Lin (2001) refers to the notion that an investment in social relationships can lead to greater access to a wide variety of resources. In other words, a connection with different networks or groups increases the chances of acquiring advantages (Burt 1992; Nahapiet and Ghoshal 1998).

As Nahapiet (2008, p. 580) argues, "those who do best do it by way of their connections and relationships […] they are more capable of accessing and benefiting from a range of opportunities and resources that affect their performance". In objective terms, Portes (1998, p. 7) notes that "economic capital is in the bank accounts of people, human/cultural capital is in their heads and social capital is in the structure of their relationships".

The social mechanisms that support the advantages of social capital involve greater facility in the flow of information, the influence that social ties exercise over the agents who make decisions, the accreditation and social support provided by the relationships, and reinforced identity and recognition (Lin 2001). However, their dimensions involve the volume of social capital as a function of the size of the

network and the volume of capital (economic, cultural and symbolic) possessed by the individual connected to the network (Lin 2001).

When referring to the social capital of a board and its relationships, Mizruchi (1996) found that studies addressing interlocking and firm performance yield a variety of results; some authors found positive associations and others negative (although to a lesser degree). This finding was corroborated in a recent review by Johnson et al. (2013), which highlights the complexity and contingent nature of the phenomenon. These companies all share the ways in which their social capital tends to be operationalized. For example, Davis and Mizruchi (1999) sought to understand how industrial restructuring in the United States affected the position of banks in the network.

To corroborate their hypotheses, these authors used Freeman and Bonacich's centrality concepts to determine the position of these companies. However, Weber et al. (2009) investigated the reasons why stock exchanges in developing countries adopted certain policies and employed the centrality indicator of the country in the world economic system as a factor to explain stock exchange policy making. Mendes-da-Silva et al. (2008) found a significant relationship between having a privileged position (in terms of centrality, density, and cohesion) on the boards of companies on *Bovespa's* New Market and market value and on listed firms' indebtedness. Mendes-da-Silva (2011) subsequently investigated the association between a firm's position in the network of relationships and company value using the concept of centrality (normalized degree, normalized betweenness, and normalized *eigenvector*) and found evidence that there are optimal levels of centrality in terms of firm value.

With a somewhat different and special object in mind, Pusser et al. (2006) analyzed the sponsors of higher education institutions in the United States and described the interlock between the governing boards of the universities and the boards of American companies. One indicator used to determine the position of the boards was degree centrality, from which the authors concluded that board members of private universities are more inclined to align themselves with the technoscience of the new economy, whereas members of the boards of public universities are more inclined to align themselves with financial corporations. Finally, in a recent review, Johnson et al. (2013) summarized the results regarding the social capital of boards as being erroneous and proposed that this type of capital does not function independently of other conditions.

In the US, boards of directors comprise both insiders and outsiders, and the share of insider participation is typically lower (Core et al. 1999). In Brazil, despite recommendations from the Brazilian stock exchange to make provisions for the independence of board members (i.e., encouraging the participation of outsiders), many board members also accumulate executive functions (insiders). Mendes-da-Silva (2011) analyzed the structure of the boards of Brazilian listed companies between 1997 and 2007 and found that outsiders constituted approximately 75% of board membership.

The literature suggests that board composition is associated with firm performance and executive compensation. Alves et al. (2016) examined listed companies in Portugal and concluded that CEO characteristics, the board structure, and

shareholder characteristics are associated with CEO compensation. However, most of the variation in CEO compensation seems to be related to firm-specific factors and seems to be less dependent on firm performance. This would be a poor governance signal, i.e., it is expected that executive compensation and turnover be based on firm performance.

Volpin (2002) argues that executive turnover in companies in which outsiders predominate tend to be more sensitive to firm performance, which accords with good corporate governance practices. In the case of emerging economies, González et al. (2015), examined 523 Colombian companies and found data showing that CEO turnover/performance sensitivity is reduced. These authors also found counterintuitive results from closely held companies that showed higher CEO turnover sensitivity/performance.

Despite these contradictory results, we still argue that relationships among boards can help explain the effectiveness of publicly listed companies, particularly because the subject is far from exhausted, notwithstanding a large number of studies. In particular, we believe that these studies did not pay sufficient attention to one of the elements of social capital: the resources existing in board members' social relationships.

Thus, following Lin (2001), social capital is present in the exchanges that arise in the relationships between players by way of the resources mobilized and available in these relationships. In other words, if social capital comprises both resources and relationships, it makes no sense to pay attention to only one dimension and ignore the other. Therefore, we propose that access to and use of the resources found in social networks may lead to better socio-economic conditions for social players, particularly for publicly listed companies (Mizruchi and Stearns 2001). Thus, the more capital there is that is potentially present in social relationships, the greater are the chances of making good decisions and of being judged more reliable and legitimate.

Rather than following the current logic that equates increased social capital with the most central boards (Johnson et al. 2013; Kim 2007; Pombo and Gutiérrez 2011), we advocate that interconnected directors on the boards of firms with higher market value generate more value for the company (Zona et al. 2015). We make this argument because there is a general sense in the market—and in the empirical evidence (Haunschild and Beckman 1998)—that the most valuable and biggest firms tend to have their status (Chandler et al. 2013; Johnson et al. 2011) and reputation differentiated (Connelly and Van Slyke 2012; Pombo and Gutiérrez 2011).

These elements are considered by investors when making investment decisions, and boards with members from most the valuable companies thus signal good company conduct (Chahine et al. 2011; Chen et al. 2008; Connelly and Van Slyke 2012; Sánchez and Barroso-Castro 2015). If it matters to investors, then it is likely that such relational resources have a positive association with market value. In addition, knowing that some of these resources (such as information and influence) are abstract and fluid, we believe that indirect relationships may also be potential catalysts and may have implications for the value of publicly listed companies. Therefore, based on these arguments we posit the following hypotheses:

Hypothesis 1a The greater is the amount of relational resources available in direct relationships, the greater is the market value of the company.

Hypothesis 1b The greater is the amount of relational resources available in indirect relationships, the greater is the market value of the company.

However, do board relationships have an impact in this manner? Might it not be that not only the volume, but also the heterogeneity of the relational resources matter? Burt (1992, 2001) argues that structural holes, or non-redundant ties, are opportunities for brokering the flow of information between players who are on opposite sides, i.e., where the weak links between these players in the network are holes that can be better worked upon to obtain greater resources. Because these resources are fragmented in the network of relationships, they are more likely to have different and heterogeneous information.

According to some authors (Rossoni and Machado-da-Silva 2013; Uzzi and Spiro 2005), this sum of characteristics begets a greater possibility for obtaining a greater competitive advantage. It is notable that the holes do not mean that the players are not connected but that they are focused on other objectives of their group and that these players are more likely not to have redundant information as a result, which is thus an opportunity for obtaining advantages.

Burt's (1992) concept of information redundancy consists of two forms of redundancy: the first is the redundancy of direct contacts (cohesion), in which two contacts are considered redundant to the extent that they have strong and cohesive relationships; the second redundancy involves indirect contacts (structural equivalence), in which two contacts are considered to be structurally equivalent insofar as they have the same relationships, even if they are not directly linked. Thus, for resources to be considered heterogeneous they must not be redundant in any of these ways.

As for boards, some studies have tended to approach this logic. Kim (2007) analyzes both the effects of the proportion of external directors and their social capital on the value of the company and concludes that the board can extract valuable resources from the environment and that this is a function of directors' social capital. The results of this study also suggest that an effective board has an effective external network of (interlocking) board members. Rossoni and Machado-da-Silva (2013) assess how the different origins of organizational legitimacy affect the performance of companies listed on the *BM&F Bovespa* based on their market value and use the concept of structural holes to test the hypothesis that the greater the proportion of structural holes in the board the greater the firm's market value.

The results of this study corroborated the hypothesis that boards with more heterogeneous ties have greater market value. Uzzi and Spiro (2005) analyzed the structure of small world networks of artists who were involved in musicals on Broadway from 1945 to 1989. Using the concept of weak ties (Granovetter 1973) and structural holes (Burt 1992, 2001), these authors found a significant relationship between such ties and the capacity of the productions to be successful with both critics and the general public. In the light of such results, in this study, we predicted that the relationship between the heterogeneity of ties would condition the effects of

the relational resources of the board on market value, which leads us to the following hypothesis:

Hypothesis 2 The larger is the heterogeneity of the relational resources available in direct relationships, the greater is the market value of the company.

3 Research method

Data and sample This study's sample population comprises companies listed on the *BM&F Bovespa* (the Brazilian stock exchange) in 2010 and 2011. We selected those companies whose share liquidity was greater than 0.01%, as some indicators of the study can only be evaluated in firms that are actually being traded on the stock exchange. After we had identified the firms on the register of active issuers of the *CVM* (*Brazil's SEC*), we crosschecked the data with financial information from the Economatica® database, from which we obtained 334 cases in 2010 and 350 in 2011.

According to Jlassi et al. (2014) and Shefrin and Statman (2011), in good years, share prices and market values might be inflated by optimistic investors, and the opposite might occur in bad years. In this research, there is an important matter to address, i.e., stock prices can be affected by speculation, and therefore, the influence of social capital can vary. Nonetheless, considering the Brazilian experience, extreme optimism period was observed around the year 2007 when there was a high number of IPOs, i.e., 64 IPOs that raised approximately US$ 27 billion. Recently, after 2015, one of the worst financial crises in Brazil's history has occurred. In short, the years 2010 and 2011 do not seem to be characterized by moments of excessive optimism or pessimism. So we chose this period for the study.

Furthermore, as the market value was determined considering $t + 1$ years, we managed to collect information about 310 companies in 2011 and 307 companies in 2012. Finally, consolidating the financial data obtained from the Economatica® database with other sources of register data (the *CVM's* ITR, DFP, IAN, IEP, FC, and FR external disclosure system; information from the *BM&F Bovespa*; and reference forms from companies), our sample resulted in 508 valid cases, derived from 280 firms, and organized into an unbalanced panel.

Board and cross-ownership networks We assembled the network of company boards based on information available in the reference forms of the listed companies identified in the *CVM* system. First, we listed all the firms and their respective directors individually during 2010 and 2011, which allowed us to generate an incidence network in the 2-mode format (companies vs. directors) for each year. We then used PAJEK software to create the relationship networks between boards (1-mode format), in which two firms were directly linked if they shared at least one director, i.e., board interlocking. These data regarding board networks were exported to UCINET software, which was used to generate relational indicators at the firm level, which were subsequently incorporated into the panel. To create cross-ownership company networks, the same sequence of steps as that described above was used, but we considered that two companies to be inter-related if they have the

same owners in the list of shareholders available on the *CVM* system or if one of the companies holds shares in the other.

3.1 Dependent variable

Organizational performance In line with the previous literature (Bhagat and Bolton 2008; Black et al. 2012; Black and Kim 2012; Carvalhal-da-Silva and Leal 2005; Kim 2007; Mendes-da-Silva et al. 2008; Rossoni and Machado-da-Silva 2013; Silveira et al. 2010), we defined market value as the performance indicator of companies listed on the stock exchange. Market value was assessed using Tobin's *Q*, which is the sum of the market value of a firm's shares and debts, with the latter value being divided by the book value of the assets (Bozec et al. 2010; Chung and Pruitt 1994). This measure was operationalized for 2011 and 2012, following the adaptation of Chung and Pruitt (1994, p. 72), formally defined as:

$$Tobin's\ Q = \frac{VMaO + VMaP + VCDclP}{VCAT}$$

where $VMaO$ = market value of ordinary shares, $VMaP$ = market value of preferred shares, $VCDclP$ = book value of the company's short and long-term debt, and $VCAT$ = book value of the organization's total assets. (Chung and Pruitt 1994). Table 1 lists the descriptive statistics and correlations of Tobin's Q and other variables.

3.2 Independent variables

Board social capital Social capital was calculated from the sum of the relational resources present in three types of relationship: direct, indirect and heterogeneous. To arrive at the *social capital of the direct relationships*, we first identified for each year the direct ties that each firm had with the others by means of board networks, which are known as '*ego* networks' in the vocabulary of social network analysis. We then identified the market value (the total value of the shares traded on the stock exchange) of each of the firm's relationships, which is what we call relational resources. Finally, we added the value of these relational resources for all the board's ties, which generated our social capital indicator of the company's direct relationships. The logic of this measure assumes that a board that has a director of a higher market value company on its own board is symbolically and economically more valuable than a director from a lower value company. Thus, we seek to capture the relational resources (the capital of social capital) of the board interlock (Lin 1982, 2001). A similar procedure was undertaken by Zona et al. (2015), but these authors considered the net income from affiliated companies as a relational resource. As one of the objectives of this study was to evaluate the asymmetry of resources, the authors used a weighted measure.

In addition, the *social capital of each firm's indirect relationships* as the term itself implies was obtained by way of the sum of the relational resources (market value) of the first-degree indirect relationships. Although it was similar to the previous procedure, to arrive at the indirect relationships, we had to implement the

Table 1 Descriptive statistics

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Tobin's Q	1.51	7.26	1												
2. Social capital of the board: direct relationships[a]	21.96	50.98	−.037	1											
3. Social capital of the board: indirect relationships[a]	73.24	121.93	−.049	.301**	1										
4. Social capital of the board: heterogeneous relationships[a]	14.42	35.25	−.036	.935**	.323**	1									
5. Social capital: cross-ownership[a]	42.63	102.81	−.046	.404**	.285**	.401**	1								
6. Degree centrality	2.97	3.58	−.055	.513**	.583**	.505**	.357**	1							
7. Eigenvector	0.01	0.04	−.022	.212**	.114**	.142**	.306**	.413**	1						
8. Structural holes	1.93	2.53	−.051	.515**	.560**	.565**	.376**	.924**	.243**	1					
9. Board size	8.23	4.21	−.088*	.253**	.383**	.305**	.272**	.458**	.111**	.501**	1				
10. Outsiders	0.85	0.19	−.070	.125**	.227**	.144**	.143**	.230**	.062	.229**	.377**	1			
11. Company age (ln)	2.44	1.14	.035	−.029	−.052	−.021	.068	−.097*	−.050	−.078*	−.009	−.171**	1		
12. Size (ln of assets)	14.43	2.27	−.299**	.182**	.314**	.212**	.227**	.377**	.153**	.386**	.445**	.260**	−.048	1	
13. Leverage	63.35	601.47	.919**	−.027	−.036	−.025	−.026	−.054	−.018	−.048	−.066	−.067	.054	−.190**	1

** Correlation is significant at the 0.01 level (1-tailed); * correlation is significant at the 0.05 level (1-tailed). N = 508

[a] Amounts in billions (R$)

following procedure: based on the networks of direct relationships, we calculated the geodesic distance between firms and saved it in a distance matrix. We then recodified this network in such a way that the first-degree indirect relationships (value two in the network) were identified by way of a binary code with the value 1, whereas all the other distances were codified as zero. As a result, it was possible to identify the first-degree indirect relationships for each node (firm).

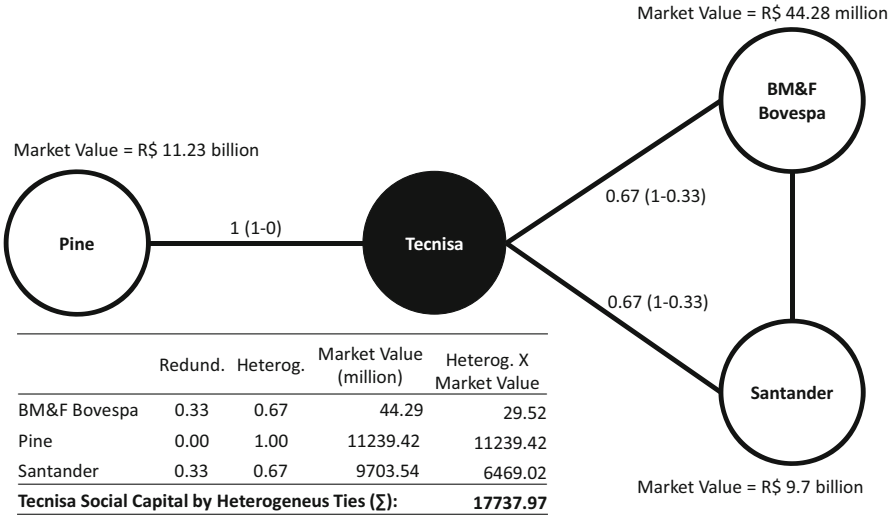
Finally, we generated the *social capital of heterogeneous relationships* as follows: first, we ran the structural holes procedure in UCINET and saved the DR (dyadic redundancy) matrix, which yields the degree of redundancy of each *alter* (direct relationship) in relation to each of the *egos* (firms) in the network. In short, redundancy indicates the percentage of ties that the *ego* and *alter* share in an *ego* network; the greater is the value, the more redundant is the tie (for details, see Burt 1992). Second, we subtracted one from the redundancy score of each valid *alter*, thus obtaining a heterogeneity score for the *alters*, which was tabulated in new matrixes. Third, we multiplied the market value of each existing relationship (*alter*) by its respective heterogeneity score. Finally, we added the product of the relationships of each firm to arrive at the *social capital of the heterogeneous relationships* of the firm. To make clearer the composition of capital through heterogeneous ties, we use a real case of our databank to illustrate this in Fig. 1.

As an additional analysis, we also evaluated the effect of the position of the board in relation to the boards of other companies. To perform this assessment, we used the following three indicators that have been considered in previous studies (Fracassi and Tate 2012; Johnson et al. 2013; Kim 2005; Mendes-da-Silva et al. 2008; Mendes-da-Silva 2011; Rossoni and Machado-da-Silva 2013): (1) *Degree centrality*. One of the position indicators we used was degree centrality, which reflects the number of a player's adjacent ties in the network (Freeman 1979; Freeman et al. 1991), which in our study refers to the number of companies linked by the directors that firm shares with others. (2) *Eigenvector*. This is closeness centrality, which evaluates the degree of a node's centralization (in this case, a company), considering also the centrality of neighboring ties; in other words, this measure takes into account the degree of hierarchization of the relationships to compose the indicator (Mendes-da-Silva 2011). (3) *Structural holes*. To operationalize the structural holes, we used the effectiveness measure of the ties (Burt 1992, p. 53), which measures the number of non-redundant *EffSize* contacts in relation to the total number of contacts, n, of player i. As we work with binary data, we use the simplified form of the equation developed by Borgatti (1997). Formally, considering that player i has n contacts, we can evaluate the number of redundant contacts by way of the equation $D\ alters = 2l/n$, in which "l" is the number of ties between *n (alters)*. Because *D alters* indicates the total number of redundant ties, we consider non-redundant *EffSize* ties as *n–D alters*. As the directors of these organizations vary on an annual basis, we calculated this measure for each year the company was listed on the exchange.

3.3 Control variables

Social capital of cross-ownership In aiming to generate a hypothesis that is concurrent with that of the social capital of the board, we created a control that considers the social capital deriving from the interlock between owners. Two firms have cross-ownership when at least one has a shareholding in the other (Kim 2003). To arrive at the social capital of ownership relationships, we identified those companies that had owners in common or that shared cross-ownership, i.e., when one was a shareholder of the other. We then identified the market value (total value of the shares traded on the stock exchange) for each of these companies. Finally, we added the market value of each company with cross-ownership, thus forming a social capital indicator of the ownership relations. We included the social capital of cross-ownership as a control variable because of the suspicion that some board interlocks between Brazilian companies is actually related to the participation of business groups in different companies (Brookfield et al. 2012) or is caused by property pyramidal structures (Rabelo and Vasconcelos 2002; Silveira and Dias 2010).

Board Size Studies show that there is a relationship between board size and market value (Filatotchev et al. 2016; Santos et al. 2012; Vesco and Beuren 2016) or at least many of them note that it is an important characteristic of the Board's



	Redund.	Heterog.	Market Value (million)	Heterog. X Market Value
BM&F Bovespa	0.33	0.67	44.29	29.52
Pine	0.00	1.00	11239.42	11239.42
Santander	0.33	0.67	9703.54	6469.02
Tecnisa Social Capital by Heterogeneous Ties (∑):				**17737.97**

Fig. 1 Composition of social capital by heterogeneous ties (Tecnisa ego network in 2010). *Note* Tecnisa, one of the analyzed companies, had board interlock with three other companies (alters) in 2010: Pine, Bovespa, and Santander. Except for these alters, Pine had no relationship with any others. Therefore, the redundancy of alter's ties was zero (1/0 = 0) and its heterogeneity equal to 1 (1 − 0). However, for the board interlock with Bovespa and Santander, it can be seen that these two companies have links between them, so the relationship is potentially redundant, since there is one tie linking two of the three alters (1/3 = 0.33). Thus, the heterogeneity of Tecnisa's ties with Bovespa and Santander is 0.67 (1 − 0.33). If added the ratio between the market value of alters (relational resources proxy) with the heterogeneity of each tie, we have the value of Social Capital by heterogeneous ties to Tecnisa company in 2010: 17.737 billion

structure (Fich and Shivdasani 2006; Fracassi and Tate 2012). In addition, bigger boards tend to be more likely to have a higher number of interlocks. For these reasons, we include the number of board members as a control variable.

Outsiders We also control the effect of the proportion of outside directors in relation to the total of board members. This control is important because the information, knowledge, and status can be apprehended by means of external directors who do not necessarily constitute interlock between companies (Haunschild and Beckman 1998; Johnson et al. 2013; Santos et al. 2012).

Age As with previous studies (Haniffa and Cooke 2002; Mendes-da-Silva and Onusic 2014), we operationalized the age of the company using the natural logarithm of the length of time it has been listed on the Brazilian exchange, i.e., on the *BM&F Bovespa*.

Company size We used the book value of total assets as a proxy for the size of the firm, and such information was collected from the Economatica® database. Moreover, with the aim of mitigating problems related to symmetry and kurtosis, the size of the company was 'logarithmized', following the previous literature (Mendes-da-Silva et al. 2008; Rossoni and Machado-da-Silva 2013; Silveira et al. 2010).

Financial leverage This is the amount of the total financial debt of the company, divided by its total asset value (Carvalhal-da-Silva and Leal 2005; Silveira et al. 2010). We operationalized this measure in accordance with Aivazian et al. (2005) due to the strong evidence that financial leverage is related to the market value.

Year To avoid problems related to seasonality, such as temporary trends, we controlled the time effect with dummy variables, which is common practice with panel data (see, for example, Carvalhal-da-Silva and Leal 2005; Procianoy and Verdi 2009; Silveira et al. 2010). Thus, 2010 was considered as the reference category, and 2011 was identified in the model with a dummy variable.

Industry We controlled for the Industry effect, as there is evidence that it precedes market value (Black et al. 2012; Procianoy and Verdi 2009; Silveira et al. 2010). To this end, we created $s - 1$ dummy variables, in which s is the number of sectors identified in Economatica®, and the 'others' sector is considered a reference category because the former has more observations.

Notably, we excluded some control variables, such as listings on special markets, for example, due to problems of collinearity, and due to the fact that the panels were run with fixed effects, in particular.

3.4 Econometric models

We analyzed the influence of board social capital on market value, based on an analysis of panel data, the variables of which were hierarchically incorporated into seven different models. We chose the econometric panel model because we had various cases (N) with a number of observations in time (T), yielding $N \times T$ observations. We tested three alternatives to assess which was the most suitable: (1) grouping the cut point data based on ordinary least squares (pooled OLS); (2) fixed effects (FE); and (3) random effects (RE). According to Greene (2000), the choice of the most adjusted model depends on confronting three test hypotheses: (a) the

existence (or non-existence) of a single intercept of the transversal cut units (evaluated using the Chow test); (b) whether the variance of the intercept is equal to zero (Lagrange multiplier test modified by Breusch and Pagan's proposition); and (c) whether the estimators are consistent, based on an estimation of the generalized least squares (Hausman test). Based on our evaluation of these hypotheses, we chose the best model for each of the relationships between variables.

Next, we looked for greater robustness in the results in nine different ways. First, we assessed whether the dependent variable had serious distribution problems. Second, we assessed whether the independent variables had a linear functional form relative to the dependent variable. Third, we assessed whether the models had heteroscedasticity problems using the White test; if so, we would address this problem using robust standard errors. Fourth, we checked for collinearity problems between the independent variables. As the model with all the variables (Model 7) had multi-collinearity problems (tolerance less than 0.2 and VIF greater than 5), we analyzed the hypotheses using the models that presented each independent variable individually. Fifth, we observed whether the results remained consistent when we regressed the models without the insignificant control variables, and we also checked whether they had the same tendency without the outliers. Sixth, we checked whether the coefficients remained consistent when analyzed separately for each of the investigated years. Seventh, we checked whether there was a quadratic effect of capital market value, as there is evidence of such an effect on ROA (Santos et al. 2012). Eighth, we checked whether the effect of social capital by relational resources was consistent by replacing the market value of the alters by the volume of the assets. The results were consistent despite the effect size being lesser with the market value proxy. Nine, we isolated the effect of relational resources within and between industries on Tobin's Q. Therefore, we considered the industry classification used by the Brazilian stock exchange and the Brazilian monetary authority (CVM). Thus, instead of using the social capital that originated from all the company relations as a proxy, we considered only companies' ties with each one of the industries individually.

Finally, because of how the literature on governance addresses such a problem involving the indicators related to corporate governance (Black and Kim 2012; Silveira et al. 2010; Wintoki et al. 2012) and because these elements have both characteristics of self-selection and reverse causality (Li and Prabhala 2007), we used instrumental variables by Robust Two Stage Least Square Models (H2SLS) and simultaneous equations by Robust Three-Stage Least Square Models (H3SLS). Two-stage models have been used in several studies (Black and Kim 2012; Filatotchev et al. 2016; Fracassi and Tate 2012; Pombo and Gutiérrez 2011; Santos et al. 2012; Vesco and Beuren 2016), particularly because they are taken as base models. Simultaneous equations models are less common facing complexity (exceptions are Johnson et al. 2011; Santos et al. 2012; Vesco and Beuren 2016), but they are more robust. We also have opted for robust models in the two types of models, due to White Tests showing heteroscedasticity problems.

Thus, as identification strategy in the models of instrumental variables (H2SLS), we consider the proxies of social capital as endogenous, and as instruments, we included ROA, board size and proportion of outsiders. The first instrumental

variable served to mitigate the simultaneity, since it is highly correlated with Tobin's Q, and due to a performance measure. The other instruments were included because they are usually correlated with the board interlocking (Johnson et al. 2011; Santos et al. 2012). In addition to these variables, we incorporate degree (number of interlocks) as an instrument of social capital by direct ties, Structural Holes as an instrument of Social capital by heterogeneous ties and both degree and structural holes for social capital by indirect ties. We chose these variables because they constitute our measures of social capital, as they pondered the value of relational resources of each company (alters' market value).

In relation to the models of three stages, we consider as exogenous variables in both equations the variables age(ln), size(ln), leverage and the governance levels of BM&F Bovespa. In the first equation, we define as endogenous variable social capital proxies, which, in turn, are also affected recursively by Tobin's Q, beyond board size, outsiders and degree, for social capital by direct and indirect ties, and structural holes, for social capital by direct and heterogenous ties. As defined for the two-stage model, the first variable has been added to mitigate the effect of reverse causality and the other variables because they are correlated with the proxies of social capital. In the second equation, we consider Tobin's Q as an endogenous variable, including the model social capital by cross-ownership.

4 Results

Table 2 shows the effects of the variables on market value (Tobin's Q). Thus, after the panel data adjustment tests (Chow, Breush-Pagan and Hausman), the fixed model was the most suitable for all the models. The use of robust standard errors also proved to be necessary, as the White Test highlighted heteroscedasticity problems in all the models ($p < 0.001$). In Model 1, we only have the effect of the control variables on Tobin's Q, from which we omitted the year and sector coefficients. Thus, Company Age was significant ($p < 0.01$), where every one year extra on the stock exchange is associated with an increase of 0.033 points [ln(1.034)] in Tobin's Q, which demonstrates that those companies that have been listed longer tend to be more valuable. Financial Leverage was also significant, not only for the base model, as in all other models and tests.

In Model 2, as part of an additional analysis, we added three indicators for the position of the board in the network (degree centrality, *eigenvector*, and structural holes). Even with collinearity problems, there were no distortions in the sign or in the significance of the effect of each variable individually in comparison with the models in which these variables were isolated. There was no evidence that a greater number of ties with other companies (degree centrality) by way of interlocking directors were associated with a greater market value; we also did not observe that the percentage of weak board ties (structural holes) had any significant influence. However, *eigenvector* centrality, which considers not only the centrality of the firm, but also the centrality of its adjacent relationships, proved to be negatively associated with a market value ($p < 0.1$). Thus, these results suggest that those

companies with lower market values tend to be related to companies with more centralized boards.

In Model 3, we added another control variable, the social capital of cross-ownership. The results indicate that there is a significant relationship between having a group of companies and having greater market value with Tobin's Q ($p < 0.1$). As a marginal effect of the social capital from ownership relationships on the market value of the company, we note that for every 100 billion added to the company's social capital there is a 0.51 point increase in Tobin's Q. Although this may seem to be a high value and highly unlikely to be achieved as social capital, it is worth noting that the average value of the social capital of direct relationships is 16 billion, and there are cases, such as Embraer for instance, in which its social capital was worth 290 billion in 2011.

Hypothesis 1a was analyzed in Model 4, in which indicates that there is not a relationship between the social capital available in the relationships directly established by the board and market value. This variable is not significant in Model 7 as well. However, there is a high correlation between one of the control variables, size board and the proxy of social capital through direct ties. When we remove board size, the variable becomes significant, which shows that it can be endogenous, requiring tests on models that control endogeneity. Anyway, we consider refuting the hypothesis. Hypothesis 1b, which was analyzed in Model 5, had to also be rejected because we were unable to identify a significant relationship between social capital from indirect relationships and market value.

Finally, Hypothesis 2 was tested in Model 6, in which the data indicate that the social capital of the heterogeneous relationships of the board had a significant and positive impact on Tobin's Q ($p < 0.05$), which corroborates the hypothesis. This model demonstrates that for every 100 billion of social capital weighted by the heterogeneity of board ties, there is an increase of 1.297 points in Tobin's Q. Evidence of the greater explanatory power of heterogeneous relationships over direct relationships is also shown in Model 7, which shows all the variables jointly.

Thus, when all the independent variables compete with one another, only the effect of the social capital of the direct board relationships on market values was not significant. The biggest difference with the other models is the social capital of indirect ties becomes significant at the 90% confidence level. In terms of the magnitude of the marginal effect, the heterogeneous social capital ratio is distorted due to collinearity with the social capital of direct ties, which complicates the interpretation of the effect.

4.1 Further analysis

Our fixed data models panel does not address endogeneity issues such as simultaneity, and mistakenly also assumes that the independent variables are purely exogenous. For these reasons, we reproduce the analysis using robust instrumental variables models (H2SLS) and robust simultaneous equations models (H3SLS) for mitigating the endogeneity problem.

The results are described in Table 3. First, we test whether the variables were endogenous, which was supported by both Wooldridge's Endogeneity Test and

Table 2 Fixed model panel data on the influence of social capital on market value (Tobin's *Q*)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Board social capital:				0.519			−4.546
Direct relationships[a]				(0.541)			(3.094)
Board social capital:					0.394		0.469*
Indirect relationships[a]					(0.281)		(0.276)
Board social capital:						1.297**	6.858*
Heterogeneous relationships[a]						(0.641)	(4.043)
Social capital:			0.515*				0.758**
Cross-ownership[a]			(0.314)				(0.356)
Degree centrality		0.101					
		(0.101)					
Eigenvector		−7.907*					
		(5.704)					
Structural holes		−0.172					
		(0.180)					
Control variables							
Board size	−0.055	−0.065	−0.057	−0.055	−0.055	−0.055	−0.061
	(0.056)	(0.066)	(0.056)	(0.056)	(0.056)	(0.056)	(0.059)
Outsiders	−0.100	−0.081	−0.077	−0.100	−0.099	−0.109	−0.113
	(0.463)	(0.456)	(0.4627)	(0.463)	(0.461)	(0.467)	(0.487)
Company age (ln)	1.034***	0.903***	1.035***	1.026***	1.002***	1.017***	0.981***
	(0.248)	(0.278)	(0.249)	(0.249)	(0.252)	(0.250)	(0.253)
Size (ln of assets)	0.011	0.012	0.010	0.011	0.010	0.012	0.011
	(0.052)	(0.051)	(0.052)	(0.052)	(0.051)	(0.051)	(0.052)

Table 2 continued

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Leverage	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	−0.124	0.368	−0.144	−0.119	−0.063	−0.098	0.016
	(1.340)	(1.475)	(1.337)	(1.340)	(1.347)	(1.344)	(1.374)
White's Test	432.8***	505.0***	412.1***	407.5***	427.5***	400.2***	504.5***
F de Chow Test	8.73***	8.52***	8.76***	8.76***	8.75***	8.76***	8.63***
Breusch–Pagan Test	35.47***	31.85***	36.90***	37.16***	36.31***	37.01***	36.04***
Hausman's Test	588.8***	602.1***	582.4***	581.7***	581.9***	582.3***	584.3**
Akaike's criterion	1678.69	1681.01	1680.44	1680.61	1680.39	1680.35	1684.90
F	78.74***	77.43***	78.14***	78.12***	78.15***	78.16***	76.52***
R^2 Overall	0.804	0.805	0.804	0.805	0.807	0.806	0.808

Standard error in parentheses. Dummies of Industry and Years omitted. N = 508, Companies = 280

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

[a] Amounts in billions (R$)

Robust Regression Test. Furthermore, Wooldridge Overidentifying's Test showed that there were no overidentifying instruments. Starting by the interpretation of the coefficients in the first three models, we found that all social capital variables were significant, which corroborates all our hypotheses, particularly because the results of these instrumental variable models tend to be more robust than the fixed models. However, as noted by the Shea's Partial Test R^2, the instruments are not strong enough to ensure there is no bias in the endogenous variable coefficients. Therefore, in models 4–6, we present the coefficients in the three-stage model. As in the two-stage models, all social capital variables were significant. What, again, would it take us to confirm all the hypotheses of the study.

In addition to incorporating the issue of endogeneity in the regression models, we also evaluated whether the social capital could have a curvilinear relationship to market value. As can be seen in Table 4, only the social capital by indirect ties presents a significant quadratic effect (U-inverted). The coefficients of this variable indicate that there is an optimal level of social capital by indirect relationships, whose implications we will explore in the discussion.

Finally, we sought to assess whether having boards interlocked with companies within the same industry could have some impact on market value (Model 1 of Table 5). This is because previous studies have shown that companies with ties to similar industries tend to perform better in the IPO process than companies without such ties (Filatotchev et al. 2016). In addition, we analyzed whether interlocks with companies from other industries would have any effect on market value (Model 2 of Table 5), since there is evidence of the influence of ties with the financial industry on better lending rates (Mizruchi and Stearns 2001), as well as on the performance of IPOs (Filatotchev et al. 2016). The results indicate that there is no significant relationship between the number of interlocks in the same industry and Tobin's Q. In relation to the ties with companies of different industries, the relationship was significant only for the agribusiness industry ($\beta = 0.514$, $p < 0.1$). When we consider the relational resources of the board originated from ties within the same industry, we also did not find a significant influence on Tobin's Q (Model 3 of Table 5). Regarding relational resources embedded in interlocking with companies from other industries, the effect was significant for ties with agribusiness companies ($\beta = 7.81$, $p < 0.01$), with companies whose industry was not clearly defined by the Brazilian stock exchange ($\beta = 1.31$, $p < 0.05$) and with transport and service industry companies ($\beta = 2.07$, $p < 0.05$).

5 Discussion

Before discussing the empirical results obtained in this study—and with the intention to contribute to the generalization of the findings (at least with respect to emerging economies)—we understand relevance by keeping in mind the characteristics of the Brazilian institutional environment with respect to corporate governance practices generally adopted by the companies. In this regard, reviewing the recent work of Black et al. (2014), Leal et al. (2015) and Martins et al. (2017) is instructive. Corporate governance practices adopted by Brazilian companies were

Table 3 H2SLS and H3SLS estimations (dependent variable: Tobin's *Q*)

	Model 1 H2SLS	Model 2 H2SLS	Model 3 H2SLS	Model 4 H3SLS	Model 5 H3SLS	Model 6 H3SLS
Board social capital	2.901***			1.253**		
Direct relationships[a]	(1.041)			(0.595)		
Board social capital		0.876*			0.557***	
Indirect relationships[a]		(0.476)			(0.204)	
Board social capital			4561***			1.704**
Heterogeneous relationships[a]			(1772)			(0.760)
Social capital	−2.031***	−0.828	−2.422***	0.063	−0.047	−0.064
Cross-ownership[a]	(0.727)	(0.887)	(0.904)	(1.701)	(0.135)	(0.159)
Control variables						
Company age (ln)	0.001	0.001	0.001	−0.106	−0.098	−0.110
	(0.001)	(0.584)	(0.001)	(0.107)	(0.106)	(0.106)
Size (ln of assets)	0.060***	0.001	0.071***	−0.468***	−0.483***	−0.471***
	(0.052)	(0.162)	(0.012)	(0.056)	(0.061)	(0.056)
Leverage	0.011***	0.011***	0.011***	−0.011***	−0.011***	−0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant				7.565***	7.662***	7.648***
				(0.851)	(0.881)	(0.854)
Wooldridge's Endogeneity Test	8.467**	7.824**	8.476**			
Robust Regression Test	11.855***	16.885***	7.968***			
Shea's Partial R^2	0.026	0.022	0.017			
Wooldridge's Overidentifying Test	0.290	0.479	0.206			

Table 3 continued

	Model 1 H2SLS	Model 2 H2SLS	Model 3 H2SLS	Model 4 H3SLS	Model 5 H3SLS	Model 6 H3SLS
Wald Chi^2	1.0e+09***	6.0e+06***	9.5e+08***	3013.44***	3086.80***	3048.81***
R^2	0.774	0.816	0.746	0.855	0.857	0.856
RMSE	3.450	3.114	3.653	2.760	2.737	2.747

Standard error in parentheses. Dummies of industry, years and governance level omitted

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. N = 508, Companies = 280

[a] Amounts in billions (R$)

recently studied in a comparative approach by Núñez and Oneto (2015) and Martins et al. (2017).

According to Black et al. (2014), corporate governance practices adopted by listed companies in Brazil have improved substantially over the most recent decade, as investors' prefer. However, these authors' results do not seem to show robust associations between corporative governance practices and firm value. In analyzing the evolution of corporate governance practices in Brazil from 2004 to 2013, Leal et al. (2015) argue that this possible improvement of governance practices was primarily due to the voluntary membership of companies in special listing segments of the BM&F Bovespa. In other words, based on the choice of some companies, the Brazilian market has witnessed a notable growth in the quality of listed company governance when considered in the aggregate of listed companies.

In terms of corporate governance practices, it has become particularly relevant to consider the role played by the executives and board members of listed companies. In this regard, Mendes-da-Silva (2011) analyzes the formation of boards of directors

Table 4 Test of curvilinear effects of social capital (dependent variable: Tobin's *Q*)

Independent variable	Model 1 Direct relationships[a]	Model 2 Indirect relationships[a]	Model 3 Heterogeneous relationships[a]	Model 4 Cross-ownership[a]
Social capital	0.644	1671**	1.603	0.943
	(1.171)	0654	(1.542)	(0.973)
Social capital^2	−0.492	−2733**	−1574	−0.863
	(5.222)	(1094)	(7210)	(1604)
Control variables				
Board size	−0.054	−0.059	−0.055	−0.057
	(0.056)	(0.058)	(0.057)	(0.057)
Outsiders	−0.103	−0.074	−0.108	−0.078
	(0.478)	(0.462)	(0.471)	(0.468)
Company age (ln)	1.024***	0.939***	1.014***	1.038***
	(0.255)	(0.259)	(0.255)	(0.249)
Size (ln of assets)	0.011	0.011	0.012	0.011
	(0.052)	(0.052)	(0.052)	(0.052)
Leverage	−0.008***	−0.008***	−0.008***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	−0.115	0.058	−0.095	−0.156
	(1.370)	(1.379)	(1.358)	(1.341)
F	76.43***	77,43***	78.14***	78.12***
R^2 Overall	0.805	0.811	0.806	0.804

Standard error in parentheses. Dummies of Industry and Years omitted. N = 508, Companies = 280

Fixed Models: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

[a] Amounts in billions (R$). Social Capital^2 = exp 10^{-9}

of companies listed in Brazil vis-à-vis their area of expertise and the universities from which they graduated (i.e., the pedigree effect). Based on over a decade of data, the authors obtained results that suggest that the likelihood that individuals will occupy seats on boards is associated with their profession and the university he/she attended. In addition, the type of ownership control seems to be relevant not only for the profile of the board, but also for its role.

In this regard, it is notable in Brazil that there is a significant presence of government officials occupying seats on the boards of companies in which the government has invested. Lazzarini et al. (2015) studied the impact of the presence of the main Brazilian state-owned investment bank on the performance of these investee firms and found an absence of any consistent effect at the firm level.

In this study, we began from such points and tried to evaluate the impact of the board's social capital on the market value of companies listed on the Brazilian stock exchange. To do so, we used the relational resources inherent in the direct, indirect and heterogeneous relationships of the board as an indicator of social capital.

First, examining the effects of the board's network position on market value, although there was evidence of positive results in the literature, including in Brazil, the results reinforce the mistakes and lack of consistency noted in the review by Johnson et al. (2013). For example, whereas Mendes-da-Silva (2011) and Rossoni and Machado-da-Silva (2013) found positive results with data running until 2008, in our study with data from 2010 to 2012, the evidence is different; so much so that one of the indicators we examined has a negative effect. One possible explanation for the negative effect of the *eigenvector* centrality on market value is revealed in Black et al. (2012). According to these authors, in emerging markets such as the BRIK (Brazil, Russia, India and South Korea) countries, companies that are experiencing difficulties and whose valuation is low may seek to strengthen or justify changes by arranging ties with companies with greater market value simply by hiring directors from these companies.

Second, regarding the cross-ownership network, this study corroborates Brookfield et al. (2012), which suggests that—despite the restructuring that occurred in Brazil between 1995 and 2003 (i.e., privatization and the entry of foreign capital)—the ownership structure in Brazil has retained the same characteristics it had previous to that time: the main shareholders are state and federal government pension funds and state-owned companies. Perhaps we find no significant relationship between social capital deriving from ownership relationships and market value precisely because of these characteristics.

Third, about the board social capital of the board, our study indicates that the relational resources present particularly in heterogeneous ties positively and significantly affect the market value of companies listed on the Brazilian stock exchange. Moreover, as there was evidence that our proxy of social capital was endogenously affected by other variables and recursively influenced by the performance of companies, we analyzed the results by using models that seek mitigate the effect of endogeneity. As result, after controlling for endogeneity, all our proxies of social capital have proved significant, whose explanatory power remained higher when the relational resources are originated through heterogeneous ties. Given these results, our research showing that the greater is the social capital of

Table 5 Effects of interlocks and social capital with firms in specific industries on Tobin's *Q*

Independent variable	Model 1 Number of Interlocks	Model 2 Number of Interlocks	Model 3 Social Capital[a]	Model 4 Social Capital[a]
Ties Agribusiness		0.514*		7.810***
		(0.273)		(2.400)
Ties Food and Beverage Industry		0.121		0.037
		(0.144)		(0.064)
Ties Retail		0.233		2.640
		(0.304)		(2.380)
Ties Construction		0.100		−3.920
		(0.204)		(6.590)
Ties Electricity		0.312		4.360
		(0.275)		(2.820)
Ties Finance and insurance		0.003		0.200
		(0.161)		(0.205)
Ties Industrial Machines		0.149		−5.040
		(0.469)		(42.600)
Ties Mining industry		−0.010		7.850
		(0.259)		(7.490)
Ties Another Industries		−0.039		1.310**
		(0.103)		(0.571)
Ties Paper and Cellulose		0.168		32.500
		(0.211)		25.200
Ties Oil and Gas		0.176		0.634
		(0.177)		(8600)
Ties Chemical Industry		−0.230		−0.717
		(0.259)		(0.695)
Ties Steel and Metallurgy		0.088		5.600
		(0.135)		(4.010)
Ties Telecommunications and Software		0.160		0.672
		(0.209)		(0.860)
Ties Textile Industry		−0.123		−0.110
		(0.242)		(0.121)
Ties Transport and Services		0.039		2.070**
		(0.171)		(0.934)
Ties Vehicles and Parts		−0.877		−6.150
		(0.923)		(9.100)
Ties Same Industry	−0.082	−0.118	−0.020	−0.019
	(0.083)	(0.129)	(0.386)	(0.446)
Board size	−0.057	−0.061	−0.055	−0.059
	(0.058)	(0.061)	(0.056)	(0.058)
Outsiders	−0.064	−0.137	−0.104	−0.135

Table 5 continued

Independent variable	Model 1 Number of Interlocks	Model 2 Number of Interlocks	Model 3 Social Capital[a]	Model 4 Social Capital[a]
	(0.459)	(0.519)	(0.491)	(0.541)
Company age (ln)	1.021***	0.972**	1.033***	1.000***
	(0.249)	(0.305)	(0.252)	(0.282)
Size (ln of assets)	0.011	0.011	0.012	0.011
	(0.052)	(0.053)	(0.052)	(0.053)
Leverage	−0.008***	−0.008***	−0.008***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	−0.745	0.114	−0.116	−0.053
	(1.362)	(1.525)	(1.375)	(1.470)
F	122.89***	32.10***	122.14***	32.32***
R^2 Overall	0.804	0.802	0.804	0.805

Standard error in parentheses. Dummies of Industry and Years omitted. N = 508, Companies = 280

Fixed Models: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

[a] Amounts in billions (R$)

the board, the greater is the maximization of these firms' value. Thus, in line with Flap and DeGraaf (1986), we show that the capital of social capital really does matter; the resources supplied by the *alters* are potential resources that can be used to benefit individual firms. Examining the heterogeneity of relationships reveals that structural holes are the means of obtaining information and different resources, enabling firms to have bigger competitive advantages among themselves, including higher market value. Notably, in our study, the resources that are available in structural holes have the greatest impact on market value.

Fourth, we also analyzed that the social capital had a quadratic effect on the market value. Our results showed that only the variable social capital by indirect ties has a curvilinear effect (U-inverted), whose relational resources effect by indirect ties, after reaching an optimized stage, begin to decline. One of the possible reasons for this occur is probably due to the fact that the interlock with companies that, in turn, have many other interlocks with other companies, has its importance and cohesion decayed due to various relationship options that it holds. Thus, the effective mobilization of relational resources is compromised. Another reason that adds to this probably involves some type of power asymmetry in board interlock (Zona et al. 2015). Since a company has board interlock with another company that has many other board interlocks with the highest market value companies, its appeal for the attention of interlock directors is reduced.

Finally, we sought to assess whether having boards interlocked with companies within the same industry could have some impact on Tobin's Q. Although there is evidence that ties in the same industry may be advantageous in the context of IPOs (Filatotchev et al. 2016), we did not find significant influence in Brazil when we

analyzed Tobin's Q. When we considered the board's relational resources, the results were equally not significant. This may have occurred in our analysis because their relevance is not the same for already consolidated companies, contrary to initial public offering situations, whose companies do not yet have a reputation history. When we look at the ties with companies of other industries, the results were more significant when we take into account the relational resources, in which three apparently different industries were more valuable to have board ties: agribusiness, transportation and services and the category "others", whose business concentration involves education, electronic retail and virtual services. Looking at these industries in detail, we see that they were exactly the ones that had above average growth in the period studied. In addition, companies in industries such as electronic retail and virtual services, transport and services in Brazil traditionally present directors with a great knowledge of the complexity of the retail infrastructure in Brazil, which is essential for any gain in efficiency of operations. It is also added that such industries are usually financed with public investments, among them educational, whose relationship of the directors is essential for obtaining good investment options. It is worth highlighting that, unlike in the US and English markets, where financial and technology institutions are central (Filatotchev et al. 2016; Mizruchi and Stearns 2001), in Brazil, institutional conditions highlight the salience of ties with industries that at first glance would not be relevant. Such differences in institutional arrangements may be analyzed in more detail in the future.

Contributions Our study makes some important contributions to the board interlock literature. First, we seek a new way to assess a board's social capital. As noted by Johnson et al. (2013), almost all the studies on the social capital of the board consider the presence of directors' ties with other companies (Brookfield et al. 2012; Fracassi and Tate 2012; Hillman et al. 2011; Horton et al. 2012; Sánchez and Barroso-Castro 2015; Stevenson and Radin 2009; Santos et al. 2012) or the number of outsiders (Kim 2007; Knockaert and Ucbasaran 2013; Peng 2004; Pombo and Gutiérrez 2011). When these studies do not do this, they assume that greater centrality and a more privileged position in the network indicates greater social capital (Mahmood et al. 2011; Mendes-da-Silva 2011; Rossoni and Machado-da-Silva 2013; Westphal and Khanna 2003). Thus, in some cases, the social capital in the relationship with political parties can be taken as a proxy (Fan et al. 2007; Lester et al. 2008) or affiliations with universities and elite groups (Bond et al. 2010; Johnson et al. 2011; Kim 2005; Mendes-da-Silva et al. 2008; Wurthmann 2014).

However, as is strongly emphasized by Afuah (2013), it may be faulty reasoning to assume that increasing the network size leads to greater value. The key element of the board's social capital is not only network ties and reciprocity, but also whether the interlock provides valuable information and resources (Connelly and Van Slyke 2012). Perhaps this is the reason that studies about interlocking boards have yielded contradictory results.

On this point, we make our second contribution. We have included access to relational resources through the market value of companies connected to the board as a proxy for social capital. With our measure, we focus on the capital of social capital, which, despite being cited in studies of board interlock (Connelly and Van

Slyke 2012; Finegold et al. 2007; Sánchez and Barroso-Castro 2015; Stevenson and Radin 2009), has only recently been evaluated empirically (Zona et al. 2015). Our study shows that greater centrality in the network is not the only value but that companies with more valuable ties—relations with high market-value firms—tend to have a higher value of Tobin's Q.

Third, as the information content and access to resources may pervade board members' direct relations (Burt 1992, 2001; Connelly and Van Slyke 2012), our study contributes to the board interlock literature by analyzing the effect of relational resources that are present both in indirect relations and in heterogeneous relations—and not only in direct relations. Our results show that embedded resources in the most heterogeneous relations—those relationships with a higher proportion of structural holes (Burt 1992, 2001)—have a greater influence on market value than even direct relations. This result suggests that those boards that are bound to the higher value out of the inner circle of companies can benefit from what Granovetter (1973) called the strength of weak ties. In the capital markets, having less cohesive relations might improve access to information, such as by signaling the greater independence of board members, particularly when the relationship is with high-value companies.

Fourth, following a new line of studies (Black and Kim 2012; Filatotchev et al. 2016; Fracassi and Tate 2012; Johnson et al. 2011; Pombo and Gutiérrez 2011; Santos et al. 2012; Vesco and Beuren 2016), our study investigates the effect of board interlock on the market performance of companies trying to mitigate the effect of endogeneity sources such as simultaneous and contemporaneous correlation with the errors from the use of instrumental variables and simultaneous equations. As is seen, our hypotheses were robustly consistent particularly after our efforts to analyze the effects through more robust methods. Even for the endogeneity, which is now a buzzword, it is essential for the use of more robust models to investigate endogenously limited processes such as the relationship between board characteristics and firm performance.

Fifth, the study results indicate that the relational resources by indirect ties, after reaching an optimized stage, begin to decline. These results are surprising and open a wide avenue of research, as the effect of indirect ties is rarely analyzed in the board interlock literature. In the special case of indirect ties of interlock between companies, the literature of social networks and social capital still has much to contribute (Afuah 2013; Andriessen and Gubbins 2009; Johnson et al. 2013).

Finally, our study also contributes to the study of social capital, particularly because it analyzes a specific aspect of this field of study that addresses the use of social relations as a means of mobilizing resources that are not in possession of an individual actor (Lin 2001), a person or a company. As noted by Andriessen and Gubbins (2009) and Nahapiet and Ghoshal (1998), there are several meanings of the concept of social capital explored in the organizational literature, which sometimes makes it difficult to compare results. However, as We note, the analysis of the effects of potentially mobilized resources in networks of relationships is a relatively unexplored field, which this study seeks to investigate.

The practical contributions of this research are illuminating for investment fund managers, managers of companies listed on the Brazilian stock exchange, and

autonomous investors. By analyzing both the components of a company's board and the performance indicators of its market value, fund managers can evaluate strategies and look for a better composition for their share portfolio to increase the profitability of the funds they manage. Moreover, managers of companies listed on the stock exchange can improve the composition of their boards by finding interlocks with directors of high market value companies. Autonomous investors can consider boards when assessing the business environment before deciding where to invest their capital.

Limitations and recommendations for future studies Our study has some limitations. First, knowing that studies of ties between different boards are appropriate from the perspective of social capital (Connelly and Van Slyke 2012; Stevenson and Radin 2009), the data did not allow an identification of the types and nature of existing relationships between members of different boards. Second, although our measure of social capital considered that relations with companies with more resources (i.e., a high market value) are instrumentally and socially valuable (Lin 1982, 2001; Lin et al. 2001; Connelly and Van Slyke 2012), we do not empirically evaluate the norms of reciprocity and trust that emerge from relations between directors as a proxy for social capital. Future studies may evaluate these matters more deeply, such as by assessing how a company mobilizes and takes advantage of the knowledge, prestige, and resources associated with a board member of a more valuable company compared with how it treats a member connected to a less valuable company. To this end, a perspective that considers status and prestige differentiation between board members would be fruitful (e.g., Flickinger et al. 2016; Shipilov and Li 2008).

Third, there are methodological limitations. We evaluated the effects of the board's social capital on market value only directly. Future studies might analyze whether the effect of a board's social capital is moderated by the concentration of shares and/or by the support of the majority shareholder or whether the effect on the market value varies according to the independence of the directors and the CEO. Moreover, the period evaluated was restricted to only two years lagging by only one year. We suggest evaluating how the effect of the board's social capital can be temporally contingent (Mizruchi et al. 2006). For this, panel data over longer periods would be required, enabling the use of different econometric models to control the effects of endogeneity. Another compelling alternative would be to compare these analyses between different markets, such as those of the BRICS countries (Black et al. 2012). In addition, our data on board interlock was restricted to listed companies. Future studies could incorporate as relational resources originated by interlocks outside the stock market affect the performance of companies, such as investment relationships with public investment banks (Inoue et al. 2013; Lazzarini et al. 2015) or institutional investors (Fischer and Pollock 2004). Moreover, we suggested that the effect of the board's social capital might be analyzed by competing for alternative explanations at the firm level, such as companies' competitive advantages, company culture, leadership style, level of internationalization, or of variables at the level board, i.e., board composition/tenure, intellectual capital and executive experience. Finally, in addition to assessing the social capital originated from the relationship with companies of

different industries, one could analyze which industries are more salient for each one of the industries individually and in different periods.

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