

МИРОВАЯ ЭКОНОМИКА И МЕЖДУНАРОДНЫЕ ФИНАНСЫ

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Network board capital and performance of international companies*

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The paper estimates the influence of links between boards of directors on corporate performance at the world level in the framework of network analysis. The vast majority of empirical papers on the topic analyses the case of isolated countries. The current study estimates the effect of networking in large companies at the international level. It enables a more correct construction of the network between directors and eliminates the influence of national specificity. We construct an international network of boards and calculate three alternative centrality metrics: degree, closeness, and betweenness. Then the econometric analysis is applied to estimate the effect of centrality on performance. We consider two dependent variables which are responsible for the long-term and short-term effects (correspondingly, M/B ratio and ROE). The effect of boards' networking on firm outcomes is found to be positive on average for large global companies. This result is robust to used centrality metrics and financial indicators. The influence of networking is found to be similar in the short and long term. We found that closeness centrality is the most important aspect of network capital for firm outcomes; degree has a moderate impact; the effects of betweenness are the weakest and statistically close to insignificant. The study contributes considerably to existing literature summarizing particular empirical evidences. Obtained findings also raise new theoretical issues and provide some useful practical implications.

Keywords: board of directors, network analysis, relational capital, international companies.

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Introduction

Relationships of directors, managers and employees with the external environment including other firms, business associations, and government bodies configure a network that provides significant competitive advantages for companies. The developed network of relationships with a variety of stakeholders has positive multiple effects on sustainability and financial outcomes. It could provide access to a variety of unique valuable resources and opportunities outside the enterprise.

There are many positive effects from a network of relationships. Managerial capabilities together with external relations affect the speed of strategic changes within a company (Lo, Stepicheva and Peng, 2016). The collaborative networking behavior increases the adaptability and flexibility of creating system that enables a firm to adapt operatively to the environment (Romero and Molina, 2011). External sources of knowledge are an important factor of innovations together with internal activity (Arora and Gambardella, 1990; Cassiman and Veugelers, 2006; Hagedoorn and Wang, 2012; Love, Roper and Vahter, 2014). Participation in a business association, collaboration in research, informal ties with various partners are possible channels of spillovers that are useful for the production and exploitation of new knowledge. Strong ties with partners reduce the firm propensity to exit from a foreign market or increase the propensity to re-enter (Yayla et al., 2018). Both local and international networks are important drivers of internationalization (Andersson, Evers and Griot, 2013). Foreign ownership and investment are potential sources of spillovers from other markets that enhance productivity (Harris and Robinson, 2003).

Therefore, it is reasonable to consider a set of corporate relations as an important and valuable asset. This is realized within the concept of “Intellectual Capital” (IC) which became very popular in theoretical and empirical research in the last two decades (Shakina, Molodchik and Parshakov, 2020). This concept implies that a significant share of firm capital is intangible. Relational capital (RC) is reconized as important part of IC which comprises intangible assets that are outside the firm (Edvinsson, 1997). RC is quite heterogeneous and encompasses such aspects as relationships with various economics agents, brand, reputation etc. Thus, there is a question how to measure this capital correctly. Researchers usually apply a set of miscellaneous indicators (Shakina and Barajas, 2012; Shakina, Naidenova and Barajas, 2022) or construct an integral index (Shakina and Barajas, 2014; Yayla et al., 2018). Relational capital is often found to be an important factor of firm performance (Hormiga, Batista-Canino and Sánchez-Medina, 2011; Shakina and Barajas, 2012; Wang et al., 2021). However, empirical findings are ambiguous that could be connected, among other, with differences in methodology — which participants and types of inter-firm relations are considered and which variables are applied for analysis.

The board of directors (BDs) is at the highest level of organizational structure in large companies which is responsible for the development and implementation of strategy. Thus it influences on corporate behavior, the efficiency of business processes, and, consequently, financial outcomes. Empirical studies confirm the significant effects of directors on corporate performance. They indicate the importance of such aspects as board size (Gemmill and Thomas, 2006), board system (Kao, Hodgkinson and Jaafar, 2019), qualification (Shakina, Barajas and Molodchik, 2017), tenure (Pérez-Calero, Mar Villegas and Barroso, 2016), number of roles (Merendino and Melville, 2019), gender diversity (Adams and Ferreira, 2009), diversity in expertise (Wincent, Anokhin and Örtqvist, 2010), outside

directors (Kor and Sundaramurthy, 2009; Geletkanycz and Boyd, 2011), foreign directors (Masulis, Wang and Xie, 2012), politicians in the board (Hillman, 2005), etc. Generalising the results we could summarize these miscellaneous aspects into two important properties of the boards: internal quality (human capital of directors) and relationships with the external environment (relational or social capital of directors).

Theoretical concepts underline the role of the relational capital of the board. They consider the intellectual capital of BDs which is “intellectual resources such as knowledge, information, experience, relationships, routines, and procedures that a board can employ to create value” (Nicholson and Kiel, 2004). Thus social capital is viewed as an important part of the boards’ IC and discern three levels: intra-board links, board-management links, and extra-organizational relationships. I. Berezinets, T. Garanina, and Y. Ilina note that the board serves as a source of IC; at the same, it is also the key driver forcing other intellectual assets to work (Berezinets, Garanina and Ilina, 2016). They propose to distinguish two major assets of boards: human capital (knowledge, skills, education, experience, etc.), and social capital (ties with other organizations, social status, networking opportunities, membership in BDs in other companies, etc.). It is also possible to make a distinction between internal and external social capital (ties within and outside the organization) (Harris and Helfat, 2007). Some researchers note that boards connections are not always a source of IC because they generate benefits only when the resources provided are strategically useful and are established by directors who can use them effectively (Blanco-Alcántara, Díez-Esteban and Romero-Merino, 2019). All these points raise the question of how to measure and analyse the relational capital of the board.

The network analysis (Freeman, 1978) seems to be a well suitable approach for analysis of inter-board ties. D. A. Harris, and C. E. Helfat propose to view corporate directors as a social network and to apply an appropriate methodology for empirical research (Harris and Helfat, 2007). However, there are few papers that apply network analysis for measuring the board’s relational capital (or “network capital”). Moreover, their results are quite miscellaneous. If some researchers (Larcker, So and Wang, 2013; Omer, Shelley and Tice, 2014; Benson et al., 2018; Blanco-Alcántara, Díez-Esteban and Romero-Merino, 2019) reveal a positive influence of centrality metrics on firm results, other find a negative impact (Godigbe, Chui and Liu, 2018) or a nonlinear relationship (Lee, Choi and Kim, 2012). It should be noted that almost all these papers consider separate country-specific cases. The relationship between networks and firm results seems to be conditional on national-specific features. At the same time, it is quite difficult to summarize these isolated and scarce findings. Another limitation of current studies is that they usually deal with networks of interlocking directors only within concrete countries. Indeed, boards in large companies are typically multinational and their analysis should ignore the national boundaries. The more general research carried out at the international level should provide the most general knowledge about the economic effect of directors’ social capital.

The current paper fills this gap in the empirical literature on directors’ networks. It analyses the influence of network board capital on the performance of the world’s largest traded companies according to the Forbes Global 2000 ranking in 2018. This approach gives some advantages. The world economy becomes more global and the share of foreign directors in corporate boards increases. Therefore, considering only country-bounded relationships could lead to misevaluation of networks. Large companies are more internationally active and innovative, thus the role of networking and knowledge spillovers could

be more significant for them. Emphasis on traded companies provides transparency and higher data quality. The sample encompasses more than 60 % of world aggregate market capitalization¹, so the results could be generalized to large global firms as a whole.

In the study we apply three alternative network centrality metrics: degree, closeness and betweenness. Also, we use two indicators of firm performance, responsible for short-term (return on equity) and long-term effects (ratio of market-to-book value). Econometric analysis reveals a positive influence of board centrality variables on firm results in most models. Thus, the effect of directors networking on corporate performance is strongly positive on average for large global companies. While previous empirical papers on local economies report quite contradictory results, the current study generalize these cases and give a more common estimation of average economic effect stemming from inter-board relations. Comparative analysis of models also shows that the effect from networks is beneficial both in long-term and short-term perspective and that the most efficient strategy is to be in the center of inter-firm relationships. These findings seems be very interesting while they raise new theoretical issues and provide new perspectives for research. Also some useful practical implications follow from the empirical results.

The study is organized as follows. Firstly, we make a review of the theoretical and empirical literature on the topic. Secondly, data and methodology are described. Thirdly, we provide empirical results. Finally, discussion and practical implications are presented.

1. Literature review

There are three important strands in literature that should be analysed. They cover the topics of relational capital, corporate governance and network analysis.

The idea of relational capital is well elaborated in papers on intellectual capital. The widely accepted structure of IC consists of three components: human capital (HC), structural capital (SC) and relational or social capital (RC) (Edvinsson, 1997). Relational capital includes such elements as a network of formal and informal ties with various stakeholders (clients, suppliers, competitors, authorities), company's brand, reputation etc. It could also be subdivided into some large components. For example, the study (Molodchik, Shakina and Barajas, 2014) distinguishes two elements: customer loyalty and networking capabilities.

There is a broad empirical literature on the role of relational capital for firm behavior and results. One study (Shakina and Barajas, 2014) estimates the firm production function with intangible inputs. All inputs have a positive effect on output and the elasticity for RC is between values for HC and SC. Another paper (Shakina, Naidenova and Barajas, 2022) evaluates shadow prices of intellectual assets as their contributions to market value. It shows that a well-known corporate brand has the highest shadow price; membership in a business association also has significant positive effects. Some researchers (Naidenova and Parshakov, 2013) analyse the mutual influence between various intangible assets and performance. Their findings are very industry-specific, but, in general, there are no significant effects of RC on other firm indicators. E. Hormiga et al. (Hormiga, Batista-Canino and Sánchez-Medina, 2011) analyse crucial elements of relational capital for new business

¹ Calculated by authors using evaluation on the world market capitalization provided by Knoema on the website: <https://knoema.com/atlas/World/topics/Economy/Financial-Sector-Capital-markets/Market-capitalization>

start-ups. They found that support from informal networks, company's reputation, attendance at business-related events, and customer accessibility are significant drivers. Analysis of Chinese high-technology firms (Wang et al., 2021) shows that RC has the strongest total effect on both operational and financial performance; but, at the same time effect of RC is mediated by innovation quality. Many researchers (Peng, 2003; Batjargal et al., 2013; Yi et al., 2016) argue that the positive effect of relational capital is larger in the case of emerging markets when formal institutions are weak or inefficient; in this case, firms need to rely on alternative informal channels. The study (Totskaya, 2015) distinguishes two parts of the social capital of Russian SMEs: "bonding" (firm-internal) and "bridging" (external) ties. It found the positive impact of internal ties on sales growth and external ties on geographic expansion. The strength and density of only horizontal external relations are found to be important; vertical external ties are insignificant.

Empirical findings about the role of relational capital are ambiguous despite many evidences that it has positive effects (Hormiga, Batista-Canino and Sánchez-Medina, 2011; Shakina and Barajas, 2012; Wang et al., 2021). It could be explained by high heterogeneity of this kind of capital. Companies have a complex organizational structure and their environment includes many economics agents. Thus, their relationships are very diverse differing in such aspects as: who interact, with whom and how. It also raises the question how to evaluate RC. There are two popular approaches how to take into account a heterogeneous structure of relational capital: apply a set of different variables (Shakina and Barajas, 2012; Shakina, Naidenova and Barajas, 2022) or calculate an integral index (Shakina and Barajas, 2014; Yayla et al., 2018).

Inter-firm linkages at the top management level are possibly the most important for companies. Directors coordinate other employees, develop and realize corporate strategy, so their influence on performance appears to be highest. The empirical pieces of evidence on the economic effects of corporate governance are numerous. They relate to various aspects of directors' properties and boards' structure. Some results (Shakina, Barajas and Molodchik, 2017) indicate that directors' qualification influences efficiency. According to one paper (Gemmill and Thomas, 2006), the larger the board size, the better is the performance of closed-end funds. Another study (Kao, Hodgkinson and Jaafar, 2019) shows that independent directors, small board size, presence of two-tier board system and absence of CEO duality are positive factors for results. Researchers (Merendino and Melville, 2019) also find a nonlinear U-inverted relationship between board size and independent directors from one side and corporate results from another. The findings show a positive effects on innovations: boards' diversity in expertise and interlocking directors primarily impact on incremental innovation, while education level influences radical innovation (Wincent, Anokhin and Örtqvist, 2010). Contrariwise, the study (Marinova, Plantenga and Remery, 2016) indicates no link between board diversity and financial results. There is evidence that female directors strongly impact on board activity and corporate outcomes: but there are both positive and negative effects (Adams and Ferreira, 2009). As we suppose, despite the differences all these findings share some similarities — they mostly indicate an importance of directors' human capital: skills, education, experience, incentives, etc.

At the same time, there is possibly a large relational or social capital of directors embedded in their links with the external environment. A. J. Hillman reports that firms with politicians on the board have better market-based indicators (Hillman, 2005). R. W. Malsulis, C. Wang, and F. Xie examine the benefits and costs of foreign directorates and find

a negative effect on financial indicators in US corporations despite other advantages (Maulis, Wang and Xie, 2012). Many papers investigate the effect of outside members of the boards. Their results are contradictory. Some researchers (Geletkanycz and Boyd, 2011) find that CEO outside directors are positively related to the long-term performance. Other scholars (Gemmill and Thomas, 2006) show that insiders impact positively on the results of closed-end funds while outsiders have a negative influence. On the other hand, papers also don't reveal any effect of outside directors (Rosenstein and Wyatt, 1990) or report that a high number of roles held by directors in other companies reduces performance (Merendino and Melville, 2019).

Some studies consider together quality of directors (human capital) and their ties with the environment (relational or social capital). Three types of board capital are distinguished (Pérez-Calero, Mar Villegas and Barroso, 2016): human capital (average tenure), internal social capital (board intensity), and external social capital (director interlocks). All three types influence directly on firm performance; at the same time, internal social capital moderates positively the effect of other types. The paper (Kor and Sundaramurthy, 2009) investigates the effects of outside directors' human and social capital on firm growth. It reveals that membership on multiple boards, the number of managerial positions in the industry, and founder outside directors have a positive influence while the average tenure of outsiders has a negative impact. At the same time, some negative interaction effects are found.

The network analysis (Freeman, 1978) is a suitable approach for analysis of relations between firms. Its key idea is to consider a system of inter-firm links as a network of nodes; each node corresponds to concrete company; connection between nodes indicates a presence of relationship between two firms. In the context of BoD the relationship indicates a presence of one or some persons in the boards of both companies. The constructed network shows a position of each firms in respect to all other firms through the lens of inter-boards ties. It enables to construct various centrality metrics. They indicate the intensity and quality of firm relations with environment and could be perceived as network board capital — important aspect of relational capital of the boards. The seminal paper (Harris and Helfat, 2007) provides a well-developed theory for applying network analysis for the case of directors. It shows that this approach is convenient and promising for research on corporate governance. Since then, there is increasing empirical literature that uses this methodology for measuring boards' relational capital and estimation of its effects. However, there are still few studies on this topic. Moreover, their findings are quite miscellaneous.

Many papers confirm a positive influence of centrality on firm performance. D. F. Larcker, E. C. So, and C. C. Wang construct a boardroom network on the sample of 115,411 directors from US public companies and analyse their stock performance (Larcker, So and Wang, 2013). They found that firms with central or well-connected boards earn superior stock returns. These firms also have higher future growth in ROA which is not immediately reflected in stock prices. The centrality-return association is larger for some categories of firms (young, high growth opportunities, low ROA, low stock momentum). Authors suppose that board networks are more important for firms with large growth opportunities or working in adverse circumstances. T. C. Omer, M. K. Shelley, and F. M. Tice (Omer, Shelley and Tice, 2014) analyse 4255 firms from around the world in 2004–2010 and find a positive impact of the integral centrality index on corporate market

value. Calculating the index separately for insiders and outsiders there is also a higher effect of outsider directors. Analysis of US companies in 1999–2011 (Benson et al., 2018) reveals that larger board networks reduce the probability of default prediction and increase corporate credit ratings. This positive casual influence is higher in times of recession and increased financial uncertainty. The effect is robust for using different metrics (betweenness, closeness, degree, eigenvector) and controls for endogeneity. The next paper (Blanco-Alcántara, Díez-Esteban and Romero-Merino, 2019) finds no direct effect of degree centrality on performance of Spanish firms in 1999–2015. However, authors emphasize a difference between directors and propose that within-industry networks and contacts of outsider directors are more beneficial for the company. More detailed analysis confirmed a positive influence of intra-industry links, especially when they are among outsiders.

Some other studies based on network analysis report adverse effects of well-developed boards' relational capital. One of them (Lee, Choi and Kim, 2012) found a negative effect of outside director centrality (betweenness and closeness) on the performance and value of 125 large Korean public trading companies. However, a more detailed analysis shows a nonlinear (U-shape) effect for closeness: so, only a moderate level of centrality is negatively associated with firm performance (Godigbe, Chui and Liu, 2018) propose that networks of boards are channels for the diffusion of corporate practices, including undesirable ones. They analyse 1803 US firms from 1996 to 2013 and find that all five metrics of centrality (degree, betweenness, closeness, eigenvector, integral PCA index) negatively impact on quality of earnings reports (discretionary accruals). At the same time, firms with good financial results are less likely to adopt poor behavior.

Researchers usually apply a set of miscellaneous metrics of board centrality such as degree, betweenness, closeness, eigenvector, or composite index. The results seem to be quite robust to used centrality variables and financial indicators, but they vary significantly across studies. Most empirical papers are devoted to the analysis of networks at the national level (Lee, Choi and Kim, 2012; Larcker, So and Wang, 2013; Benson et al., 2018; Godigbe, Chui and Liu, 2018; Blanco-Alcántara, Díez-Esteban and Romero-Merino, 2019) while the studies on international networks are quite rare. As we suppose, the difference in findings could be explained to a great extent by country specificity. Therefore, there is a lack of empirical studies which need to be filled by conducting cross-country research that provides a more general knowledge. This study aims to answer the question about the average effect of network board capital (as important aspect of relational capital) on firm performance at the international level.

2. Research question

In this paper, we investigate the relationship between financial results and a specific dimension of a company's relational capital: the networks of the Board of Directors (BoD). The key research question is whether or not the boards' networking has a positive effect on firm performance. This question could be disentangled in some more concrete questions:

- What is the influence of networking in general?
- Does the board network capital have a different impact on short-term and long-term performance?

- Do the various aspects of inter-board relationships (evaluated by different metrics of centrality) have the same effect on firms?

Our study is positioned on the intersection of three fields. First, we rely on the studies on the link between the quality of corporate governance and firm performance. Second, we consider BoD as an important aspect of a company's relational capital, which influences on financial outcomes, according to the intellectual capital literature. Third, we use network analysis as an approach to measure the relational capital of BoD. More specifically, obtained indicators should be interpreted as proxies for network board capital. The Figure 1 illustrates the intersection of these three fields.

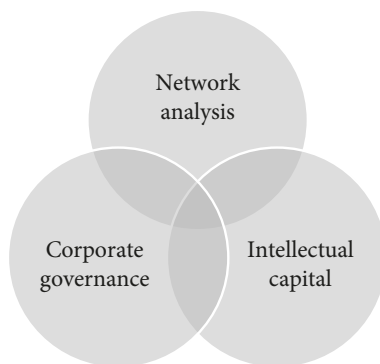


Fig. 1. The positioning of the paper

Therefore, we mainly contribute to the literature on the links between relational capital and a company's performance.

3. Methodology

To analyse the impact of networking relational capital on the company performance we estimate the following regression equations:

$$\ln(ROE_i) = \alpha_1 + RC_i \times \beta_1 + CV_i \times \theta_1 + \varepsilon_{1i}. \quad (1)$$

$$\ln\left(\frac{M_i}{B_i}\right) = \alpha_2 + RC_i \times \beta_2 + CV_i \times \theta_2 + \varepsilon_{2i}. \quad (2)$$

Here RC is a vector of relational capital characteristics, which are described below; CV is a vector of control variables; α_1 , α_2 are parameters (scalars); β_1 , β_2 , θ_1 , θ_2 are vectors of parameters; ε_{1i} and ε_{2i} are model errors; index i denotes a firm.

Two indicators of outcome are taken as dependent variables: return on equity (ROE) and market-to-book value ratio (M/B). They relate respectively to short-run and long-run performance for shareholders. It is reasonable to consider the results from the perspective of owners while the directors are immediately responsible to owners for achieving the ultimate business goals. We discern two indicators by two reasons. Firstly, corporate strategy is quite complex and has different levels of implementation; so, firm performance is multidimensional and hard to measure by a single variable. Secondly, inter-boards links could impact on a company in different ways. There is a high possibility that the effect

of networking is delayed rather than immediate. Therefore a joint analysis of regressions (1) and (2) allows to view the firm success from various perspectives.

Network relational capital RC_i includes three variables which are often used in studies: degree, betweenness and closeness. They are constructed by the following scheme. We analyse data on the links between members of the board of directors of companies as a weighted undirected network (graph). If there is a director, which is on the boards of both companies A and B, we consider these enterprises as interconnected. The number of common directors is considered as the weight of the connection. This network is used for calculating indicators. First, the degree centrality, is simply the number of its adjacent edges (Freeman, 1978). Its larger value implies more links with environment and higher overall network activity. The second metric is the betweenness centrality, which is defined by the number of shortest paths going through a vertex or an edge. We apply the Brandes' algorithm (Brandes, 2001) to evaluate it. High betweenness centrality suggests that a firm could be perceived as a middle-man or intermediary connecting other enterprises. It means that a company could derive larger benefit from its links due to unique location in the network. In the third place, we evaluate the closeness centrality, which measures how many steps are required to access every other vertex from a given vertex (Freeman, 1978). Formally, the closeness centrality of a vertex is defined by the inverse of the average length of the shortest paths to and from all the other vertices in the graph. By other word, the higher closeness centrality indicates that a company is in the center of links within this network. Therefore, a company could have easier access to other firms. It should be noted that both the metrics of betweenness and closeness are normalized variables so they are immediately comparable in models.

Control variables include: capital intensity (log) and number of employers (log) as traditional economics resources, debt-capital ratio as a proxy of risks, share of advertising costs in sales as a proxy of clients' relational capital, share of R&D in sales and share of intangibles in total assets as two proxies for innovativeness. Also we include two sets of country and sector dummy variables.

It should be noted that dependend variables, labour and capital intensity are included in both models in logarithms. It has some advandages. Firstly, it provides a better statistical properties of results. The distribution of original variables has large skewness and thus is very far from a normal. Thus, analysis of model in logs reduces problems of heterogeneity and of outliers. Secondly, there is a good theoretical background — models could be viewed as Cobb-Douglas production functions after equivalent transformation². The proxies of capital and labour are traditional firm inputs. But after transforming only labour remains to be absolute variable. Thus, it serves as a proxy of firm size and we could easily evaluate the scale effect in the model on the basis of relevant coefficient. Note that ROE and M/B ratio are not directly comparable. But analysis of these variables in log form enables to interpret marginal effects as semi-elasticities — thus we could compare short-run and long-run models.

² Consider a production function in the Cobb — Douglas form: $Y = AK^\alpha L^\beta e^{Z\gamma + \epsilon}$, where Y is an absolute indicator of performance (market value or profit), K is capital, L is labour (number of employess), Z is vector of other factors, A , α , β and γ are estimated parameters, ϵ is an error. After taking logarithms and transforming this model could be rewritten as $\ln Y = \ln A + [1 + (\alpha - 1)] \ln K + [(\alpha + \beta - 1) - (\alpha - 1)] \ln L + Z\gamma + \epsilon$ and finally as $\ln\left(\frac{Y}{K}\right) = \ln A + (\alpha - 1) \ln\left(\frac{K}{L}\right) + (\alpha + \beta - 1) \ln L + Z\gamma + \epsilon$.

There is a possible endogeneity issue because firm performance and factors are interdependent. Thus we estimate both models using two-stage least squares method (2SLS); two years lagged values are taken as instruments for the most control variables. The network of directors was already constructed with lag; so we consider the metrics of relational capital together with country and industrial dummies as exogenous variables.

4. Data

To analyse the effect of networking capital on company performance we collect data on the world's largest traded companies from the Forbes Global 2000 ranking in 2018. This ranking is based on sales, profit, assets, and market value and contains 2,000 companies from 60 countries. In 2018, the majority of companies are from the US (28.25 %), Japan (11.45 %), and China (10 %). The most widespread industries are banks and materials.

Forbes Global 2000 companies are chosen since they are highly international. Having global companies in the sample is important to study the influence of network relational capital. In the era of globalization, it is difficult to be on the list of the biggest while working only on the local market. The boards of large corporations are usually multinational and a construction of the network of directors and its consequent analysis should not be limited by national boundaries. These corporations are transparent that simplifies the data gathering and increases reliability of empirical results.

Network capital measures are based on the data obtained from Reuters website and refer to year 2017. We gathered all accessible information about members of the boards. For each director, we have information on name, age, years of experience in the firm, company name, position and short CV of the director. After that, we look for the missing values in the corporate annual reports and excluded firms with insufficient data. The total number of directors in final sample is 28,393 which present 915 enterprises. Having the data about positions overlapping in BoD of all these companies enables us to construct a network of directors and calculate three centrality metrics. Dataset and replicating script-sin R package are available by request. Besides the directors' indicators, we also collected information on financial statements in 2016–2018 and market capitalization of companies. The source is the Refinitiv Eikon database.

The descriptive statistics are available in Table 1. Note that key indicators are taken for one year — 2018 for dependent variables and 2017 for network metrics³. At the same time, the data on control variables has a panel structure. This structure has some advantages: it provides valid and relevant instruments and enables to insert some missing values.

Two ordinal variables — Country and Industry — captures unobserved properties of companies related to their location, macroeconomic conditions and specificity of business processes. We grouped firms by 5 large geographic regions (USA + Canada, Europe, China, East Asia, other countries) and 12 sectors (Mining, Food, Chemicals, Electromechanical products, Construction, Utilities, Trade, Transportation, IT, Services, Banking, Financial services). These variables are used for creation of relevant sets of dummies.

³ It is quite complicated task to gather information about the board of directors in dynamics. Open sources usually contains information about the current structure of BoD possibly with a slight delay. But data about older structure of the boards is often inaccessible. The data we gathered about the boards in 2018–2019 was actual only for 2017; later we matched this dataset with financial indicators.

Table 1. Descriptive statistics

Variable	Description	N	Mean	St. Dev.	Min	Max
Degree	Network board capital metrics; see detailed explanation above	915	0.007	0.012	0.001	0.022
Closeness		915	0.255	0.494	0.001	0.857
Betweenness		915	0.276	0.296	0.001	0.824
ROE	Profit to equity ratio, %	915	93.107	22.399	0.148	2648.565
Ln (ROE)	Natural logarithm of ROE	915	0.853	2.592	-1.908	7.882
M/B	Market capitalization to book value of equity ratio, \$/\$	915	12.537	4.133	0.032	310.961
Ln (M/B)	Natural logarithm of M/B	915	0.904	0.829	-3.447	5.740
Number of employees	Number of employees, proxy for firm size	2745	81 998	62 880	3	642 292
Ln (Number of employees)	Natural logarithm of number of employees	2745	1.257	10.394	1.099	13.373
Capital intensity	Total assets to employees ratio, mln \$ per worker	2745	0.506	0.021	0.000	18.024
Ln (Capital intensity)	Natural logarithm of capital intensity	2745	1.346	-7.406	-11.199	2.892
Debt	Share of debt in capital, \$/\$	2745	0.218	0.453	0.000	0.998
Advertising costs	Advertising costs to revenue ratio, \$/\$	2745	0.028	0.010	0.000	0.357
R&D expenses	R&D expenditure to revenue ratio, \$/\$	2745	0.052	0.021	0.000	1.000
Intangible assets	Share of intangible assets in total assets, \$/\$	2745	0.159	0.111	0.000	1.000
Country	Ordinal variable, takes a value 1–5 which indicates a region where firm is located	915	1.255	2.355	1.000	5.000
Industry	Ordinal variable, takes a value 1–12 which indicates to firm's economics sector	915	3.818	6.830	1.000	12.000

Compiled by the authors on the basis of collected database. The sources of original information are: Forbes Global 2000 ranking in 2018, Reuters website, Refinitiv Eikon database.

All the variables are measured in units that are more convenient for next econometric analysis. Specifically, among relative indicators only ROE is taken in percentage. We also divided three centrality metrics per 1,000 in order to provide more presentable results.

It should be noted that some indicators (ROE, M/B, Number of employees, Capital intensity) are highly skewed with significant outliers. But, after log transformation their distributions became much closer to normal and effect of outliers disappear. This fact in respect to dependent variables is also presented in the Figure 2. It is one empirical evidence that justifies taking logarithms in addition to above described reasons.

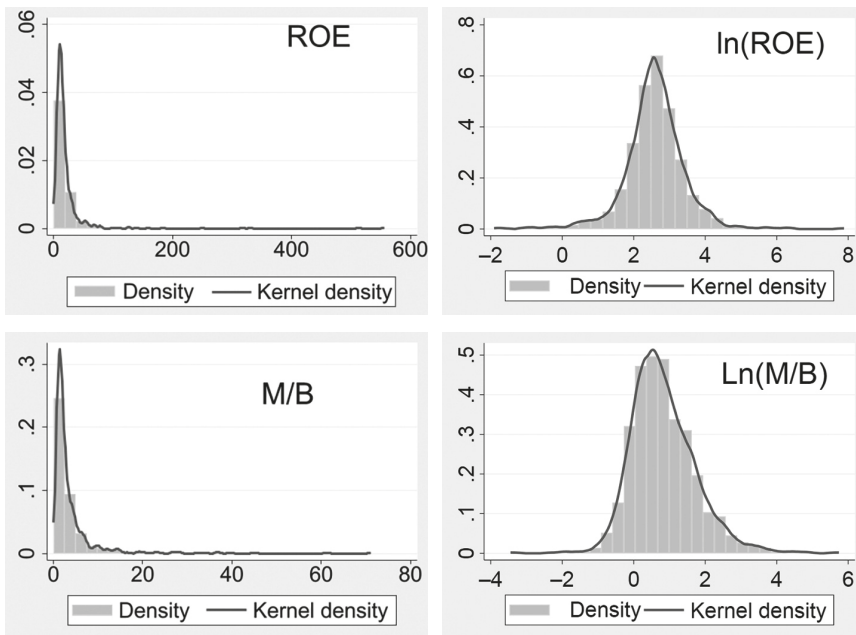


Fig. 2. Statistical distribution of key variables

Compiled by the authors on the basis of collected database.

Sources: Forbes Global 2000 ranking in 2018, Reuters website, RefinitivEikon database.

One disadvantage of logarithms is that we lose observations with zero or negative values of dependent variables that could lead to selection bias issue. However, this problem is not actual in the current study because the analysed sample consists of world's largest and most successful enterprises, all of which in the sample are traded companies and have positive capitalization and profit in 2018. There were few observations with negative values of equity; in these cases we replaced equity by its one year lagged values.

5. Empirical results

The results of regression analysis are shown in the Table 2. We estimated 8 models, 4 for each performance indicator. There is a separate regression for each network metric, as they correlate and their effects could overlap. However, we also estimate a specification with all three centrality metrics. Due to the possible non-normality of residuals, we make a robust correction of standard errors in all specifications. Since the dependent variables are in log form, the coefficients are elasticities (factors in logs — labour and capital intensity) or semi-elasticities (all other factors including network indicators).

First of all, it should be noted that the results are very robust to using different metrics of relational capital. Thus the interpretation relies on summarization of all 4 specifications within each performance indicator. The most of network centrality indicators are significant positive drivers for both financial outcomes. This result indicates that in general companies derive benefit from any inter-firm relationship through the boards. It underlines the high importance of directors' networking in addition to other corporate relationships.

Table 2. Regression analysis results

Model	Ln (ROE)				Ln (M/B)			
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(2.3)	(2.4)
Degree	7.473* (3.977)	6.532* (3.514)	–	–	5.848* (3.209)	4.745* (2.885)	–	–
Closeness	0.292*** (0.110)	–	0.197** (0.097)	–	0.230** (0.095)	–	0.159* (0.089)	–
Betweenness	0.137 (0.100)	–	–	0.177* (0.094)	0.084 (0.087)	–	–	0.115 (0.081)
Ln (Number of employees)	–0.317*** (0.045)	–0.302*** (0.044)	–0.299*** (0.044)	–0.306*** (0.044)	–0.343*** (0.039)	–0.332*** (0.038)	–0.330*** (0.038)	–0.334*** (0.039)
Ln (Capital intensity)	–0.376*** (0.040)	–0.368*** (0.040)	–0.367*** (0.040)	–0.372*** (0.040)	–0.425*** (0.036)	–0.419*** (0.036)	–0.418*** (0.036)	–0.421*** (0.036)
Debt	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	0.008*** (0.002)	0.008*** (0.002)	0.008*** (0.002)	0.008*** (0.002)
Advertising costs	0.001 (0.010)	0.002 (0.010)	0.001 (0.010)	0.003 (0.010)	0.027** (0.011)	0.028*** (0.011)	0.027** (0.011)	0.029*** (0.011)
R&D expenses	0.001 (0.008)	0.002 (0.008)	0.001 (0.008)	0.001 (0.008)	0.032*** (0.007)	0.033*** (0.007)	0.032*** (0.007)	0.033*** (0.007)
Intangible assets	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)
Observations	915	915	915	915	915	915	915	915
R2	0.259	0.252	0.252	0.252	0.502	0.498	0.499	0.498
Adjusted R2	0.239	0.234	0.233	0.234	0.488	0.486	0.486	0.486
F-test (country dummies)	0.027	0.029	0.022	0.029	0.000	0.000	0.000	0.000
F-test (sector dummies)	0.289	0.005	0.027	0.010	0.000	0.000	0.000	0.000

Notes: symbols *, ** and *** denote a statistical significance at the 1, 5 and 10 percent levels, correspondingly. All models also include a constant term, four country dummies and eleven sector dummies; not presented in the table.

Source: The results calculated by the authors.

The next remarkable finding is that the influence of centrality metrics on ROE is statistically close to the impact on M/B ratio. However, all appropriate coefficients are a bit higher in models of ROE⁴. Thus, impact of board's relational capital on companies in short and long run is similar. It is possible that long run effects are a little less that could be connected with a slow exhaustion of benefits over time. Thus companies could consider the boards' networking as important intangible asset that could provide both strategic and operating competitive advantage on the market.

A deeper analysis shows a difference in impact and statistical significance of centrality metrics⁵. Closeness is found to be statistically the most significant driver of firm results;

⁴ Note that we could directly compare semi-elasticities from different models.

⁵ Note that Betweenness and Closeness are directly comparable by coefficients because they are normalized in a similar way; at the same time Degree is measured in another way and could be compared with other metrics only in sense of statistical significance.

it also has much larger effects than betweenness for both financial outcome indicators. The larger effects of closeness in comparison to betweenness effects shows that the standing in the core of network provides more advantages than the being the intermediary between other firms. Highest level of significance also indicates that the central position in network is possibly more important than a general activity in relationships with other firms (that is proxied by Degree centrality). Degree centrality is a positive factor in all models at 10 % significance. Therefore, firms in average obtain advantages from an extensive increase of links with boards of other companies. This factor seems to be less important than central positioning but more important than the role of intermediary. The difference in effects could help in development of more detailed governance policy for companies.

The coefficients for the control variables in general are as one would expect. There is strong decreasing return to scale. Many empirical studies also confirm the evidence that large enterprises are less productive. The coefficients by log capital intensity in models are negative (about -0.4 for both ROE and M/B), but they correspond to positive elasticity to capital (about $+0.6$) in untransformed model (see footnote 3). Debt is positive driver in all regressions. Thus, it is efficient for owners to involve external capital and use effect of financial leverage despite the associated risks. Advertising costs have a strong positive influence only in models of M/B ratio. It possibly means that clients' relational capital is formed for a long period and firms need a time to get a benefit from investment. A very similar picture is observed in respect to R&D share — firms gain profits only in long-run perspective. Intangible assets are similarly important in all specifications — it is reasonable while they include the most observed part of intellectual resources that could give economic return. Sector and country dummies are not shown in the table directly. Instead we report the results of the Wald test (F-test) which checks a joint insignificance of these sets in each regression. Almost all the tests indicate that dummies are significant.

Some tests and robustness checks were made to validate our models. First of all, we checked whether the logarithmic form is correct. We considered alternative linear regressions where dependent variables are simple ROE and M/B ratio; all factors are the same without any changes. Then we realize two non-nested tests (Bera — McAleer and MacKinnon — White — Davidson) for each of 8 regressions⁶. Results of both tests do not allow to choose between logarithmic and linear forms; thus, the first one seems to be better taking into account the theoretical and statistical arguments described above. The second group of tests analyses a possible nonlinear influence of independent variables — first of all, the metrics of network capital. Some alternative regressions were estimated using logs and squares of centrality variables. Statistical significance of these variables is weak and appropriate models in general have less explanatory power. Finally, we performed Wu — Hausman test on endogeneity in all regressions. Its results indicate that regressors are in general exogenous; 2SLS estimates are consistent and unbiased, but, in principle, it is possible to apply the usual OLS estimator.

The results are in general in line with previous literature. However, the empirical papers based on data on particular countries often provided contradictory results about the pure economic effect of networking. This study generalizes these segmentary evidences and reports that this influence is definitely positive in average in the world. At the same

⁶ Models with different dependent variables (including the same variable in various forms) are not comparable directly. The common idea of non-nested tests is to check whether the prediction from one model can explain the residuals of the alternative model and vice versa.

time, our results shed light on heterogeneous influence of this influence in new directions — time aspect and type of interboard links. The papers on the topic usually experiment with specifications using various indicators of boards' centrality and firm performance simply as a kind of robustness check. But they do not analyse a difference between long-run and short-run effects and between different types of directors' networking. The current research raises a new question about heterogeneity in effects of boards' relationships. As we believe, the next empirical studies answer this issue.

Conclusions and implications

In this paper, we use data on the board of directors of the world's largest companies to analyse the links between directors' relational capital and firm performance. Most papers on the topic analyse the case of isolated countries that provides biased results. The current study estimates the effect of boards' networking in large companies at the international level. It enables the construction of the network between directors more correctly and eliminates the influence of national specificity.

We construct an international network of boards and calculate three centrality metrics: degree, closeness and betweenness. Then the econometric analysis is applied to estimate the effect of centrality on firm outcomes. We consider two models with dependent variables which are responsible for the long-term (ratio of market capitalization to book value) and short-term (return on equity) effects. For each model we estimate four specifications. The results obtained are quite robust. Some performed tests validate our models.

There are some useful practical implications stemming from our results. First of all, companies get benefits from any tie, so they should increase interconnectedness with other companies through BoD as much as possible. It is reasonable to appoint directors which have a position in other boards; the more efficient if new directors give access to new firms with which there is no interboard relationship yet. Secondly, the board networking provides very similar effects on long-term and short-term results. Thus, there is no conflict of interests between present and future for companies. It is possible to create a balanced structure of corporate governance which is effective both in long-run and short-run. Coherence in firm targets means that directors turnover should not be high and composition of the board should be more or less stable. Thirdly, the governance strategy "to be in the center of inter-firm network" is a much more efficient than the strategy "to be a convenient mediator between other companies". Moreover, the second strategy may have no effect at all. Therefore, when appointing new directors, the owners should make large accent on their participating in the boards of enterprises with high relational capital, and low accent on which unique relational opportunities their own firm could provide to other companies.

The main limitation of the paper is that its objective is quite general. It should be noted that these advices are relevant to governance policy of large international corporations while the purpose of this paper is to analyse the world level in general. But firms from concrete markets could need more detailed recommendations that would require additional knowledge of national and industry specificity. Another limitation is that the empirical part is based on incomplete panel data. Key factors (relational capital) are available only for one year and data on them is cross-sectional. At the same time, the analysis of more sophisticated panel data models could provide more reliable and efficient estimates

and take into account possible dynamic effects of networking. However, it would require significant efforts in gathering and processing of data about the boards. These notes outline promising directions for future investigations on the topic.

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Сетевой капитал совета директоров и результаты деятельности международных компаний*

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В статье изучается влияние взаимосвязей между советами директоров на результаты деятельности компаний в рамках методологии сетевого анализа. Подавляющее число эмпирических исследований по данной теме анализирует изолированные страны. В данном исследовании оценивается эффект сетевых взаимодействий между крупными корпорациями на международном уровне. Это позволяет более корректно сконструировать сеть взаимосвязей между директорами с целью устранения национальной специфики. Строится международная сеть советов директоров, и рассчитываются три альтернативные метрики центральности: по степени, близости и посредничеству. В центре последующего эконометрического анализа воздействие центральности на результаты компаний. При этом рассматриваются две зависимые переменные, отражающие как краткосрочные, так и долгосрочные эффекты (соответственно рентабельность собственного капитала и отношение рыночной и балансовой стоимости). Было выявлено, что сетевые эффекты в целом положительно и статистически значимо влияют на результаты международных корпораций. Этот вывод устойчив к выбору метрик центральности и зависимой переменной. При этом было обнаружено, что сетевые эффекты в долгосрочной и краткосрочной перспективе довольно близки. Влияние центральности по близости оказалось самым значимым аспектом сетевого капитала для компаний; центральность по степени имеет умеренное влияние; центральность по по-

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средничеству — самые слабые эффекты, которые статистически близки к незначимым. Данное исследование вносит заметный вклад, обобщая разрозненные эмпирические результаты, а также поднимает новые теоретические вопросы и дает некоторые полезные практические рекомендации.

Ключевые слова: совет директоров, сетевой анализ, отношенческий капитал, международные компании.

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