Winning virtuous strategy creation by interlocking interconnecting directors in boards of directors in firms in information century

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Abstract – The article presents an original research on 1) the information theory of the board of directors and 2) the strategy creation by the interlocking interconnecting directors in the boards of directors in the firms in an information century. We review the possible structures of the board of directors, and show that there are the interlocking directors networks in the boards of directors in a big number of firms. Researching the strategic governance of firms, we highlight a fact that the director makes the information sensing, filtering, processing, resonant absorption, analysis, decision making, hence it can be empirically represented as a digital signal processor with the Harvard or von Neumann director’s mindset architectures. We think that the board of directors can be theoretically represented as the electronically-scanned electronically-steered phased array radar with a certain number of active antenna elements, filters banks, digital signal processors, memory chipsets in agreement with the digital signal processing and business administration sciences. Using the theoretical assumptions, we formulate the Ledenyov theory on the winning virtuous strategies creation by the interlocking interconnecting directors in the boards of directors in the firms. We suggest that 1) the transmitted information data-stream measurements, 2) the information bit error rate measurements have to be used to accurately characterize the interlocking interlinking interconnecting directors networks in addition to the well known parameters such as the director’s boards seats accumulation number, centrality, Freeman degree, Betweenness. We believe that the positive and negative feedback loops can quite possibly lead to the destructive coordination among the directors by eliminating the randomness element and by introducing the greater uniformity in the pursuing business strategies. We developed the MicroID software program to compute the probability number of the additional directorship mandates issues.

JEL code: C0, G21, G24, G30, G34, L1, L4, M2.

PACS numbers: 89.65.Gh, 89.65.-s, 89.75.Fb.

Keywords: theory of firm, firm valuation, firm strategy creation, board of directors composition, interlocking directors networks, boards seats accumulation number, centrality, Freeman degree, Betweenness, information flows measurements, destructive coordination, microeconomics, Harvard/von Neumann director’s mindset architectures, digital signal processing, electromagnetic signals absorption, chemical elements absorption, information absorption.
Introduction

Review on the structures of board of directors and the interlocking directors networks configurations in boards of directors in firms

The authors believe that a group of elected appointed directors (institutional agents), who control all the business activities by the management team (corporate agents) toward the firm’s business development, constitute a board of directors. The standard board of directors in the firm can be represented as a matrix in Drago, Polo (November 11 2007), Cai, Garner, Walkling (2009), Whitehead (December 2014), hence the authors can write the following empirical expression

\[
\text{Board of Directors} = \begin{vmatrix}
  d_{1,1} & d_{1,2} & d_{1,j} \\
  d_{2,1} & d_{2,2} & d_{2,j} \\
  d_{i,1} & d_{i,2} & d_{i,j}
\end{vmatrix}
\]

where \( d_{ij} \) is the position of a director’s seat in the matrix, which describes the standard board of directors in the firm.

The composition of the board of directors changes over the time. The board of directors composition dynamics over the time can be described by the generalized formula as in Santella, Drago, Polo (November 11 2007)

\[
\text{board}_{c,t} = \text{board}_{c,t-1} + \int_{t}^{t+1} (en - ex)\,dt,
\]

where

\[
en(t) = \frac{d}{dt}en \cdot t = en,
\]

\[
ex(t) = \frac{d}{dt}ex \cdot t = ex,
\]

\( en(t) \) is the number of directors entrants at time \( t \),

\( ex(t) \) is the number of directors exits at time \( t \),

\( \text{board}_{c,t} \) is the board of directors size at time \( t \),

\( c \) is the company,

\( i \) is the director.

In general, the three main functional tasks by the board of directors are

1. Corporate governance;
2. Human capital management;
3. Accounting standards compliance revision.
The **broad functional tasks by the boards of directors** may also include in *Wikipedia* (2015)

1. “Governing the organization by establishing broad policies and objectives;
2. Selecting, appointing, supporting and reviewing the performance of the chief executive;
3. Ensuring the availability of adequate financial resources;
4. Approving annual budgets;
5. Accounting to the stakeholders for the organization's performance;
6. Setting the salaries and compensation of company management.”

There are a **one-tier board type** and a **two-tier board type**, depending on the *board internal structure*, in *Postma, van Ees* (2001): “In corporate governance systems, boards perform three functions: the interlocking function (from a resource-dependency and network perspective), a monitoring function (from an agency perspective), and a strategic function (from a strategic choice perspective). In a one-tier board the board of directors incorporates **non-executive directors** (outsiders, they sometimes represent the interests of key-stakeholders) and **executive directors** (top management) of the firm. In a two-tier board there is a clear distinction between the directors as members of a supervisory board and the top management team. The board serves in this respect as a supervisory board vis-à-vis the management board.”
Fig. 1 shows the one-tier board and two-tier board schematic representation in Postma, van Ees (2001).

![Fig. 1. One-tier board and two-tier board schematic representations (after Postma, van Ees (2001)).](image)

Fig. 2 presents some information on the operationalization of board functions in Postma, van Ees (2001).

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<tr>
<th>Board Functions: theoretical perspectives</th>
<th>Relevant aspects</th>
<th>Indicators</th>
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<td>Interlocking function:</td>
<td>Interlocking</td>
<td>Size of board Insiders/outsiders</td>
</tr>
<tr>
<td>- Resource dependency</td>
<td>Trust</td>
<td>Background directors Reputation</td>
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<tr>
<td>- Social networking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring function:</td>
<td>Monitoring</td>
<td>Board compensation Board committees</td>
</tr>
<tr>
<td>- Agency theory</td>
<td></td>
<td>Insiders/outsiders CEO-duality</td>
</tr>
<tr>
<td>Strategic Function:</td>
<td>Strategic discretion</td>
<td>Initiation of strategic dec. Evaluation/ratification</td>
</tr>
<tr>
<td>- Strategic choice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2. Operationalization of board functions (after Postma, van Ees (2001)).**

The board of directors performs the governance of firm by formulating the business strategy to create, capture, deliver, sustain the value to the customers by designing the optimal business model and by linking the firm’s business resources and capabilities to the competitive environment in agreement with the research findings in Andrews (1971), Johnson, Scholes,

The directors can be elected or appointed to a number of the boards of directors in the firms, creating the \textit{interlocking interconnecting directors networks in the boards of directors in the firms}, which can be classified as a type of social networks in Malloy (2007), Ibara (2007), Ledenyov (2009), Gargiulo (2009).

Fig. 3 illustrates the \textit{historical and contemporaneous directors interlocks in the boards of directors in the firms} in Rousseau, Stroup (2011).

![Fig. 3. Historical and contemporaneous directors interlocks in boards of directors in firms](after Rousseau, Stroup (2011)).

Let us review the exact definitions of the interlocking interconnecting directors’ networks in the boards of directors in the firms as in the academic literature.

Postma, van Ees (2001) state: “The interlocking function of the supervisory board refers to the institutional function of board structure, indicating that by increasing size and diversity of boards, links to the external environment can be established and critical resources be secured, including prestige and legitimacy (Goodstein et al., 1994). Also from a transaction cost
economics point of view the board is reserved for those stakeholders who supply or finance firm specific assets (Williamson, 1996).”

Non, Franses (2007) state: “A director can hold several directorships in different firms. Such a director constitutes a link between the firms. Firms that are linked in this way are interlocked.”

Rommens, Cuyvers, Deloof (November 2007) explain: “The resource dependence model sees interlocks as an organizational mechanism to co-opt other companies in an uncertain environment, so that each company depends on the other for resources. Information asymmetries and other uncertainties make corporate environments highly unpredictable, and interlocks may facilitate information flows between companies (e.g. Schoorman et al., 1981; Haunschild and Beckman, 1998, Gulati and Westphal, 1999). This information may include collusive information about competitors: interlocking directorates between competitors could therefore provide a means to distort competition, as competing firms may have common directors in order to strengthen collusive deals (e.g. Dooley, 1969; Schoorman et al., 1981; Gulati and Westphal, 1999). Interlocks may also be facilitators of information flows between companies and financial institutions and monitoring by financial institutions. Interlocks could thereby improve access to finance and lower the cost of finance (e.g. Richardson, 1987; Mizruchi and Stearns, 1994; Kroszner and Strahan, 2001; Santos and Rumble, 2006). However, financial institutions could abuse the control they exercise through interlocks by subordinating the interests of the company to their own interests (e.g. Richardson, 1987; Kroszner and Strahan, 2001).”

Santella, Drago, Polo, Gagliardi (2009) write: “There are several theories on the function of interlocking directorships. Mizruchi’s (1997) comprehensive review on the topic illustrates three main reasons for the formation of interlocks: collusion, cooptation and monitoring, and legitimacy, career advancement, and social cohesion.”

Pawlak M 2012 write: “Many executive (inside) directors and non-executive (outside) directors hold only one directorship, but others, particularly outside directors, hold more than one directorship. The situation in which one inside or outside director serves at the same time in two corporations is called an ‘interlocking directorship’, and this director is called an ‘interlocking director’. Interlocking directorships (directorates) are more common in groups of outside directors, as they include a number of public and political figures who are recruited from other companies, and especially from the banking, insurance, and investment sectors (Scott John, 1991).”

Uddin (2012) writes: “Interlocking directorate is a loosely coupled inter-firm relationship. A direct interlock occurs when an executive or director of one firm sits on the
board of another firm, and an indirect interlock occurs when two firms have directors or executives who sit on the board of a third firm. Sharing innovation, new ideas, new approaches, tacit knowledge, and overall cooperation are the motives behind joining in an interlocking directorate.”

Baccini, Marroni (September 2013): “An interlocking directorates (ID) occurs when a person sitting on the board of directors of a firm also sits on the board of another firm. According to Louis Brandeis (1933) “the practice of interlocking directorates is the root of many evils. It offends laws human and divine. Applied to rival corporations, it tends to the suppression of competition”. Others suggest that ID can be explained as the result of a strategic decision of firms, in view for example of monitoring sources of environmental uncertainty, and that the lack of direct evidence of real anticompetitive effects makes it difficult to elaborate a regulation (ABA, 1984; Schoorman et al., 1981). Indeed, the main trait of ID is ambiguity (Gerber, 2007).

From a competition policy perspective, competing firms have to take their business decisions independently to avoid collusion and anticompetitive behaviour; ID may reduce or eliminate competition and facilitate collusion through the exchange of information (Gonzalez Diaz, 2012). Moreover, a same director sitting on the boards of competing firms may have an incentive to lessen competitive pressure amongst them (OFT, 2010; OECD, 2008). In contrast from a company perspective, ID can generate efficiencies, in terms of improving business decisions and, in some circumstances, consumer and social welfare (OFT, 2010; Mizruchi, 1996). In particular, vertical interlocks can facilitate tying arrangements, vertical integration, and reciprocal or exclusive dealing (OECD, 2008). As a consequence, vertical ID are considered benign for consumers, except in cases where rivals can be foreclosed, and therefore competition intervention scrutinizes horizontal collusive ID only (Gabrielsen et al. 2011).”

Let us provide the examples of interlocking interconnecting directors’ networks in the board of directors in the firms in Europe, North America and Asia as in the academic literature. Investigating the composition of the boards of directors in European firms, it makes sense to note the observation in Loderer, Peyer (September 5 2001, 2002): “It is possible that board overlap occurs in part as a means for banks to obtain new business or consolidate the existing one. There is also evidence that board overlap occurs unintentionally as a consequence of the fact that good directors attract many mandates.” The board of directors overlap problem in the Swiss firms has been researched in Loderer, Martin (1997), Loderer, Peyer (September 5 2001, 2002), Perry, Peyer (September 2002, January 2005).
Fig. 4 shows a schematic illustration of the boards of directors overlap between the two firms, which is a number of directors they have in common, in *Loderer, Peyer (September 5 2001, 2002)*.

**Fig. 4. Schematic illustration of boards of directors overlap (after Loderer, Peyer (September 5 2001, 2002)).**

Tab. 1 Provides the examples of boards of directors overlaps in Switzerland in *Loderer, Peyer (September 5 2001, 2002)*.

<table>
<thead>
<tr>
<th></th>
<th>Rainer E. Gut COB of Credit Suisse Holding</th>
<th>Helmut Maucher COB of Nestlé</th>
<th>Pierre Borgeaud COB of Sulzer AG</th>
<th>Niklaus Senn COB of Union Bank of Switzerland</th>
<th>Peter Späli COB of Winterthur Versicherungen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Suisse Holding</td>
<td>*</td>
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<tr>
<td>Nestlé</td>
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<td>Sulzer AG</td>
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<td>Union Bank of Switzerland</td>
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<tr>
<td>Winterthur Versicherungen</td>
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</tbody>
</table>

**Tab. 1. Examples of boards of directors overlaps in Switzerland (after Loderer, Peyer (September 5 2001, 2002)).**
Tab. 2 demonstrates the descriptive statistics of Swiss firms listed on the Zurich Stock Exchange in Loderer, Peyer (September 5 2001, 2002).

| Tab. 2. Descriptive statistics of Swiss firms listed on the Zurich Stock Exchange. Panel A displays statistics for all sample firms. Panel B contains only the 66 firms that are listed in all four sample years (surviving firms) (after Loderer, Peyer (September 5 2001, 2002)).

Tab. 3 depicts the board of directors overlap in the 25 largest and the 25 smallest firms in Loderer, Peyer (September 5 2001, 2002)).

| Tab. 3. Board overlap in the 25 largest and the 25 smallest firms. Panel A contains statistics on the 25 largest firms listed on the Zurich Stock exchange in each of the four sample years. Panel B contains statistics on the 25 smallest firms listed on the Zurich Stock exchange in each of the four sample years (after Loderer, Peyer (September 5 2001, 2002)).
Tab. 4 reports the board overlap statistics in the internationally vs. domestically oriented firms in Loderer, Peyer (September 5 2001, 2002)).

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Internationally oriented firms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of firms</td>
<td>88</td>
<td>98</td>
</tr>
<tr>
<td>Median market value of equity (millions of SFr.)</td>
<td>513</td>
<td>677</td>
</tr>
<tr>
<td>Average board size</td>
<td>9.6</td>
<td>8.6</td>
</tr>
<tr>
<td>Average board overlap</td>
<td>11.7</td>
<td>7.8</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel B: Domestically oriented firms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of firms</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Median market value of equity (millions of SFr.)</td>
<td>130</td>
<td>153</td>
</tr>
<tr>
<td>Average board size</td>
<td>9.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Average board overlap</td>
<td>6.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Board size</th>
<th>Board overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison tests internationally oriented vs. domestically oriented: t-statistics</strong></td>
<td>0.30</td>
<td>0.39</td>
</tr>
<tr>
<td>Bank overlap</td>
<td>3.36</td>
<td>3.02</td>
</tr>
</tbody>
</table>

**Tab. 4.** Board overlap in internationally vs. domestically oriented firms. Internationally oriented firms have sales outside Switzerland that exceed 20% of total sales. (after Loderer, Peyer (September 5 2001, 2002)).

Tab. 5 provides the information on the banks and the boards of directors overlap for the firms listed on the Zurich Stock Exchange in Switzerland.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Directors</td>
<td>203</td>
<td>214</td>
<td>321</td>
<td>227</td>
</tr>
<tr>
<td>Board overlap</td>
<td>300</td>
<td>328</td>
<td>424</td>
<td>208</td>
</tr>
<tr>
<td>Total sample</td>
<td>714</td>
<td>761</td>
<td>1,111</td>
<td>1,093</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)/(2)</td>
<td>28.4%</td>
<td>28.1%</td>
<td>28.9%</td>
<td>20.1%</td>
</tr>
</tbody>
</table>

**Tab. 5.** Banks and board overlap. Descriptive statistics for firms listed on the Zurich Stock Exchange. Columns (1) and (2) show number of directors and board overlap observed in the subsample of banks and in the total sample, respectively. The last column shows the ratio of the numbers in columns (1) and (2) (after Loderer, Peyer (September 5 2001, 2002)).
It is necessary to mention that there are multiple evidences of presence of the board of directors overlaps in the Swiss firms. For example, discussing the Swatch Group in the Swiss watch industry, Donzé (2011) writes: “In 1983, the various companies were grouped together into three sub-holdings, depending on their type of activity (complete watches; movements and parts; other), and initially characterized by rationalization. This policy was directed by a four-member Executive Management Board. Chaired by Pierre Arnold, CEO of the Migros chain store and a member of several Boards of Directors (CFF, Swissair), it also included three division managers from both merged companies (Ernest Thomke for watch production, Andor Helti for high-tech and Carl M. Meyer for finances). This board worked under the supervision of Nicolas G. Hayek, who was engaged until 1986 as a special adviser to the Board of Directors, and went on to become the real seat of power within SG.” Therefore, it can be evidently seen that the practice, when the directors take a number of seats in the boards of directors in the Swiss firms is well spread.

The interlocking directorships in the Italian listed companies in Italy in 1998 – 2006 have been researched in Santella, Drago, Polo (November 11 2007), where it was shown that a high percentage of the Italian listed companies are connected with each other through an interlinking networks of directors. The highest level of connectivity among the interlocking directors is observed in the boards of directors in the Italian Blue Chips. Santella, Drago, Polo (November 11 2007) demonstrate that all the financial Italian Blue Chips are continuously connected with each other through an interlinking network of directors in the researched period of time from 1998 to 2006.

Santella, Drago, Polo (November 11 2007) highlight the following reasons for the interlocking directors networks formation: collusion, cooptation, monitoring, legitimacy, career advancement, and social cohesion. Santella, Drago, Polo (November 11 2007) write: “The idea is that firms invite on their board representatives of the various resources they depend on to reduce environmental uncertainty and maintaining their position in the market. For this reason companies have on their boards bankers, suppliers, clients (Pfeffer e Salancik, 1978). As regards monitoring, information theories hold that there are information asymmetries between creditors and debtors, since creditors, that is banks, know less about the quality of debtors. Interlocking is one of those institutions that can help surmount information asymmetry (Mariolis, 1975). Its function is to monitor debtors by offering access to internal information. Through membership in directorates and boards banks are able to keep the company management under their influence. Dooley (1969) finds that less solvent firms are likely to be interlocked with banks. Later studies also report that firms with high debt-to-equity ratios (Pfeffer, 1972) or organizations with an
increased demand for capital (Mizruchi and Stearns, 1988) have a higher tendency to interlock their boards. The quest for legitimacy is a further source of interlocking (Selznick, 1957). In order to better their reputation firms invite on their boards individuals with ties to important organizations.”

In addition, Santella, Drago, Polo (November 11 2007) explain: “Moving from a firm perspective to an individual director perspective, that is from a demand perspective to a supply perspective, Zajac (1988) states that one reason for interlocks is the fact that individuals join boards for financial remuneration, prestige, and contacts that may prove useful in securing subsequent employment opportunities. Furthermore, according to Useem (1984), interlocks are a tool to promote upper-class cohesion creating a business elite. Such incentives for directors to assume multiple directorships might have negative consequences. According to Ferris et al. (2003) and Fich and Shivdasani (2006), multiple directorships place an excessive burden on directors with a negative impact on their ability to monitor and influence managers (business hypothesis).”

As far as the interlocking directors networks in the firms in Italy is concerned, Santella, Drago, Polo (November 11 2007) make the following conclusions: “We find that about 94% of all sampled directors sit on one or two boards in every one of the nine years considered. We observe that it is difficult for such directors to move to three or more directorships. We then explore the features of those directors who have more than two directorships at any given year and therefore ensure the bulk of the connectivity among the Italian listed companies. We find a group of 75 directors out of a total of 4270 directors who over the nine years considered have at least 23 directorships (on average about 2.5 every year). We define them for brevity the Lords of the Italian stock market. They are overwhelmingly male (just three female directors among the 75 Lords) and in an important number of cases they are Chairmen or CEOs; one third of them are also significant shareholders in one or more listed companies. Starting from the observation that Lords tend to belong to families of directors, we find 53 families that add up at least to 23 directorships in nine years. The first five families have more than 100 directorships and the first ten have a higher number of directorships than the first Lord.”
Tab. 6 shows a review of literature on the interlocking directors in the board of directors in the firms in Santella, Drago, Polo (November 11 2007).

<table>
<thead>
<tr>
<th>Authors</th>
<th>Results</th>
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<tbody>
<tr>
<td>Elouaer 2006, Dooley 1969</td>
<td>“Financial Interlocks occurs for several reasons. First, companies that are in financial difficulty tend to form a close association with one or more financial houses. Second, banks find it advantageous to be connected with large firms through electing company officers to the bank’s board of directors; that may attract large deposits as well as secure a reliable customer for bank loans. Third, these financial interlocks also arise from the trust operations of banks. (Dooley [1969]).”</td>
</tr>
<tr>
<td>Koenig, Gogel, and Sonquist, 1979, Burt, 1983</td>
<td>Mechanism for interfirm collusion and cooperation</td>
</tr>
<tr>
<td>Pfeffer and Salancik, 1978; Kotz, 1978; Mazurch, 1982; Mazurch and Stearns, 1994</td>
<td>They enable firms (especially banks) to reduce dependence of coopt, control, and/or monitor others</td>
</tr>
<tr>
<td>Zentner, 1974; Palmer, 1983 Radcliff 1980</td>
<td>They promote upper-class cohesion and capital accumulation</td>
</tr>
<tr>
<td>Zajac, 1988 Kramarz Thesmar, 2006</td>
<td>They are a mechanism for personal career advancement</td>
</tr>
<tr>
<td>Selznick, 1957; DiMaggio and Powell, 1983</td>
<td>They are a source of legitimacy</td>
</tr>
<tr>
<td>Usecn, 1984; Davis, 1991; Hauschild, 1993) (for a review, see Mazurch, 1996)</td>
<td>They are a source of information about business practices</td>
</tr>
</tbody>
</table>

**Tab. 6. The function of interlocks. Review of the empirical evidence (after Santella, Drago, Polo (November 11 2007)).**

Tab. 7 informs on the positive and negative impacts of interlocking directors in the board of directors in the firms in Santella, Drago, Polo (November 11 2007).

<table>
<thead>
<tr>
<th>Authors</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Autori vari in Barucci 2006</td>
<td>Probabilità di cambiamento dell’amministratore delegato è legata negativamente alla performance della società</td>
</tr>
<tr>
<td>Interlocking and shareholder value</td>
<td>Negative. Interlocks related to personal advantages of directors.</td>
</tr>
<tr>
<td>Varie ipotesi in Barucci 2006 Pag.52-55</td>
<td>Positive. Interlocks related to leverage of the firm (Bank director in board of a not financial high leveraged form)</td>
</tr>
</tbody>
</table>

**Tab. 7. Positive and negative impacts of interlocking directors in the board of directors in the firms (after Santella, Drago, Polo (November 11 2007)).**
Tab. 8 shows the literature on **interlocking directors** in Santella, Drago, Polo (Nov 2007).

<table>
<thead>
<tr>
<th>Country/year</th>
<th>Author</th>
<th>Results</th>
<th>Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (1970/1990)</td>
<td>Netelin (2005)</td>
<td>The intercorporate network of 1990 is broader, more cohesive and more densely connected than that of 1970. However, there is still minimal change in the diversity of network connections. So, the study concludes that interlocking directors are still an important aspect of business practices.</td>
<td>Network analysis (directors)</td>
</tr>
<tr>
<td>Canada</td>
<td>Oster (2010)</td>
<td>The Canadian network is an example of a mixed system of interlocking directorates. There is an increased density of directorate connections in the financial sector, which is reflected in the network connections of other countries. This is reflected in the diversity of the network connections of other countries. The study concludes that interlocking directors are still an important aspect of business practices.</td>
<td>Network analysis, Descriptive</td>
</tr>
<tr>
<td>European Union countries</td>
<td>Rodríguez, Calabuig, Olmo (2012)</td>
<td>The network analysis of the European Union network of interlocking directorates shows that the network is highly connected, with a high degree of centralization. The study concludes that interlocking directors are still an important aspect of business practices.</td>
<td>Network analysis, Descriptive</td>
</tr>
<tr>
<td>European Union countries</td>
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<td>Network analysis, Descriptive</td>
</tr>
<tr>
<td>France (1990/2005)</td>
<td>Houen (2005)</td>
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**Tab. 8:** Detailed information on published literature on interlocking directors in board of directors in firms in various countries (after Santella, Drago, Polo (November 11 2007)).
Tab. 9 gives some data on a number of directorships by a director in the board of directors in the Italian listed firms in 1998-2006 in Santella, Drago, Polo (November 11 2007).

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Tab. 9. A number of directorships by director in board of directors in Italian listed firms in 1998-2006 (after Santella, Drago, Polo (November 11 2007)).
Tab. 10 shows the directors with more than 23 directorships in the board of directors in the Italian listed firms in nine years (1998-2006) in Santella, Drago, Polo (November 11 2007).

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Tab. 10. Directors with more than 23 directorships in board of directors in Italian listed firms in nine years (1998-2006) (after Santella, Drago, Polo (November 11 2007)).
Tab. 11 displays the characteristics of interlocking directorship network of top 100 companies in Italy in 2010 in Baccini, Marroni (September 2013).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Degree</th>
<th>All Closeness centrality</th>
<th>Normalized all degree centrality</th>
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Tab. 11. The characteristics of interlocking directorship network of top 100 companies in Italy in 2010 (after Baccini, Marroni (September 2013)).
Fig. 5 shows the *interlocking directorship network* of the top 100 companies in Italy in 2010 in Baccini, Marroni (September 2013).

**Fig. 5.** The interlocking directorship network of the top 100 companies in Italy in 2010.  
Yellow color denotes the directorships from financial industry  
*(after Baccini, Marroni (September 2013)).*
Analyzing the composition of the boards of directors in the North American firms, we would like to attract an attention to the research on the interlocking directorship network of the top 100 companies in the USA in Baccini, Marroni (September 2013).

Baccini, Marroni (September 2013) explain: “Concerns regarding monopoly and big companies were widespread at the beginning of the twentieth of century in the U.S. and as a consequence ID became a hot political issue. In 1908 the Democratic Party platform proposed a law to prohibit it, and in 1912 the platforms of all three national parties called for ID legislation to supplement the Sherman Act. In the build-up of the legislation, two committees investigated and documented the extent of interlocking directorates. Brandeis, an influential advisor to President Woodrow Wilson, published articles highly critical of the practice (1915). The issues raised by these committees and commentators were broader: they concerned collusion, information exchange and conflicts of interest. Policy proposals were directed toward the prohibition of almost any kind of interlock (Travers, 1968). Congress approached the problem of ID selectively, limiting both the classes of corporations and the kinds of ID subject to regulation (ABA, 1984); and in fact Section 8 of the Clayton Act, enacted in 1914 and still effective today, prohibits ID for competing corporations larger than a certain size (Waller, 2011). Congress also decided to leave the regulation of conflict of interest of the boards of directors and other concerns to state fiduciary duty laws, the securities laws of the 1930s, and to other legislation. Revisions to Section 8 followed quickly upon the statute's 1914 passage, but the most significant changes took place in the last quarter of the XXth century. In 1978 Congress enacted the Depository Institution Management Interlocks Act (1978) to discipline bank interlocks and expanded the role of agencies to grant exemption. The exclusion of banks represented a significant break in the history of Section 8: substantial portions of earlier versions of Section 8 had dealt with banking interlocks, and many of the early amendments to the Section focused exclusively on modifying the banking provisions of the act. In 1990 a modification excluded relatively small companies from coverage under the law. Current wording of this rule prohibits any person from serving as a director and officer “in any two corporations (...) that are (...) by virtue of their business and location of operation, competitors, so that the elimination of competition by agreement between them would constitute a violation of any of the antitrust law” (United States Code, 2013).”
Table 12 demonstrates the characteristics of interlocking directorship network of top 100 companies in the USA in 2011 (after Baccini, Marroni (September 2013)).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Degree</th>
<th>Closeness centrality</th>
<th>Normalized closeness</th>
<th>Betweenness centrality</th>
</tr>
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<td>1</td>
<td>JPMorgan Chase &amp; Co.</td>
<td>7</td>
<td>0.273</td>
<td>0.067</td>
<td>0.044</td>
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<tr>
<td>3</td>
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<td>0.221</td>
<td>0.057</td>
<td>0.031</td>
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<tr>
<td>5</td>
<td>Wells Fargo &amp; Co.</td>
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<td>0.216</td>
<td>0.057</td>
<td>0.031</td>
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<tr>
<td>6</td>
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<td>0.216</td>
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<td>0.031</td>
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</table>
Fig. 6 displays the interlocking directorship network of the top 100 companies in the USA in 2011 in Baccini, Marroni (September 2013).

Fig. 6. The interlocking directorship network of the top 100 companies in the USA in 2011.

Yellow color denotes the directorships from financial industry
(after Baccini, Marroni (September 2013)).
The interlocking interconnecting directors networks in the Canadian firms have been described in Ornstein (1984), Rowley (1997, 1998, 2000), Elms, Berman, Rowley (2000), Rowley (June 3, 2005), Rowley, Baum (2008), Carroll, Malcolm (August 1999). The second author had a wonderful opportunity to discuss the research problem on the board’ of directors overlap in the Canadian firms in Rowley (June 3, 2005). The Canadian boards of directors, which have the strong influences on the public opinion or the business and political processes in Canada, are mainly governed / chaired by the elected (appointed) directors from the USA. For example, the board of director at the Torstar Corporation in Toronto, Canada is governed by a professor from Fuqua Business School at Duke University, North Carolina, USA, because the Torstar Corporation is frequently used by the US authorities to control the Canadian officials in the Canada.

Researching the composition of the boards of directors in Asian firms, Humphry Hung (July 2003) writes: “The model proposes that a board of directors can be regarded as a strategic device of a corporation to influence and obtain resources through the business and interpersonal networks of directors. The choice of networks is therefore critical for the interlocking to be effective. The selection of inbound directors and external corporations for outbound directors can be used to achieve the strategic goals of the organizations.”

Humphry Hung (July 2003) continues to explain: “A board of directors can be a powerful tool in the strategic management process. Hung (1998) identified six roles of board of directors: link, coordinate, control, strategize, maintain and support. These roles serve to assist the organizations to achieve their corporate objectives. Directors' resource endowment will be imperative for their governing boards to fulfill their roles effectively (Burt, 1997; Stuart, 1998; Gulati & Garguilo, 1999). With an appropriate mix of directors, an organization can maximize the utilization of the networks it embeds or intends to penetrate. Board composition can be used as a device to enhance competitive advantages through acquiring comparative advantages of resource endowment by interlocking directorates. A board of director is actually a low-cost reservoir of resources and also channels for the corporation to gain access to relevant organizational networks and senior executives of the organization to reach appropriate corporate elites’ networks.”

Humphry Hung (July 2003) concludes: “The need for strategic analysis of the resource endowment of the incumbent organization is a prerequisite condition for a strategic use of boards. A careful selection of both organizational and corporate elites' interpersonal networks may pave the way for an appropriate choice of inbound directors. Based on the model, board effectiveness should be measured by the extent the governing board has contributed toward the
response of the organization in meeting the challenge of the environment. An appropriate board composition can provide considerable contributions to the performance of the organization.”

The measurements on the extent and implications of director interlocking in the pre-war Japanese banking industry in Asia have been conducted in Okazaki, Yokoyama (October 2001).

Winning virtuous strategies creation by interlocking interconnecting directors in boards of directors during strategic governance of firms

Going from the information theory and information communication theory in Shannon (1948), Yaglom A M, Yaglom I M (1983), we know that the information can be transmitted in the analogue and digital formats in the XI century. Therefore, the authors would like to formulate the theory of the board of directors as well as the interlocking interconnecting directors’ networks in the boards of directors in the firms, going from the information theory and information communication theory perspectives in Shannon (1948), Yaglom A M, Yaglom I M (1983). The authors make a logical assumption that the director works with the information in the firm, performing various kinds of manipulations with the information to form his opinions and make his decisions on the business related issues in the firm.

Let us focus on a possible representation of the director in terms of the information communication theory. In the proposed theoretical framework, the authors come up with a research idea that the director works to make the decisions on the a number of different business related tasks in the firm by doing the following things

1. the information sensing and detection,
2. the information filtering,
3. the information processing,
4. the information resonant absorption,
5. the information analysis,
6. the decision making, using the available information.

Speaking about the information sensing, we can conditionally imagine that the director is a sensing and detecting device with the embedded optical, sound, chemical sensors and detectors, which can gather the information data streams in the information fields.

Considering the information filtering, it would be interesting to say that every director has the accumulated knowledge base, subject oriented skills developed during his education at university, professional experiences obtained in the process of work, can allow the director to tune into the selected information data streams at certain frequencies and to filter out the undesired information streams, working at the board of directors in the firm. The filtered information by every director is different, but some correlations may occur. Moreover, the filtered information can be distorted during the information filtering process, because of various factors such as the existing imperfections in the director’s professional education, professional experiences, and problems with the data communication channels.
Discussing the **information processing**, we would like to make a theoretical proposition that the director can be represented as an information processing element with the Harvard director’s mindset architecture or the von Neumann director’s mindset architecture or some other possible director's mindset architectures in agreement with the digital signal processing and business administration sciences. Let us suppose that the classical von Neumann director’s mindset architecture has a single memory to store the data and program instructions; and the Harvard director’s mindset architecture has the two separate memories to keep the data and program instructions, achieving a high degree of concurrency in Hwang, Briggs (1984), Anceau (1986), Fountain (1987), Chen (editor) (1988), Van de Goor (1989), Prisch (1998), Wanhammar (1999). Thus, we firmly believe that the director’s mindset architecture may have the multiple distinctive impacts on the information processing volume, quality and time, resulting in an appearance of the different professional director’s characteristics. In other words, the nature of the director’s mindset architecture can partly explain an observation of variations in the functional performance of the board of directors, resulting in the different paths of enterprises evolution.

Focusing on the **information resonant absorption**, the authors want to note that the director’s resonant absorptive capacity in respect to the information, that is his ability to obtain and store the knowledge and information from the external environment, is defined by the director’s professional education, professional experiences, etc. The absorption phenomena in the economics has been researched in Cohen, Levinthal (1989, 1990), Kumar, Nti (1998), Lane, Lubatkin (1998), Farina (2008). The director’s resonant absorptive capacity in respect to the information is to some degree analogous to the resonant absorption phenomena in the condensed matter and soft condensed matter in the physics and chemistry, which has been researched by the authors early:


2. The absorption of the electromagnetic signals in the condensed matter (the high pure metals and superconductors) at the ultrasonic frequencies has been investigated in the solid


Going to the topics of the information analysis and subsequent decision making by the director in the board of directors in the firm, let us focus on a possible representation of the board of directors in terms of the information communication theory. In the predefined set of coordinates, the board of directors with a certain number of elected appointed directors can be theoretically represented as

1. An electronically scanned electronically steered phased array radar with a certain number of active elements (directors), which can sense the information and tune into the selected information carrier frequencies bands in the information fields;

2. A filters bank with a certain number of information filters, which tunes into a certain data streams frequencies and reject the unnecessary information streams in the adjacent channels over all the frequencies range;

3. An array of digital signal processors with the Harvard / von Neumann architectures, which process the digitized data streams, using the predefined information processing algorithms, which can be implemented in the hardware or the software;

4. A memory chipset with the ultra fast short and long term memories, which store the absorbed information and provides a fast access to the absorbed information.

Now, let the authors formulate the Ledenyov theory on the winning virtuous business strategies creation by the directors at the resonant absorption of discrete information in the diffusion - type financial economic systems with the induced nonlinearities. The Ledenyov theory postulates that the director with the highest information absorption capacity, who experience the phenomenon of resonant - type absorption of information, is able to create the winning virtuous strategies through the decision making process on the available business

Let us add a few important research remarks, which should be considered during an accurate characterization of the overlapping interconnecting interlocking directors networks in the boards of directors in the firms in the frames of the presented corporate governance research.
Continuing the discussion on the accurate characterization of the overlapping interconnecting interlocking directors networks in the boards of directors in the firms, the authors would like to note that the wireline information communication networks (ADSL), wireless information communication networks (GSM, WCDMA, UMTS), the optical information communication networks (SONET, ATM, all optical CDMA) can be accurately characterized by 1) the transmitted data stream measurements, and 2) the existing bit error rate measurements (BER), using the eye diagram and the special measurement equipment, in accordance with the US Federal Communication Commission (FCC) technical requirements. We would like to add that 1) the director’s boards seats accumulation number, 2) the overlapping interconnecting interlocking directors networks configuration, and 3) the director’s centrality (the Freeman Degree [the potentiality to act or communicate with a specified number of directors] in Freeman (1979a, b) and Betweenness Centralization [the number of paths that pass through a node] as the measures of connections density of a director in the core network) in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms are the only parameters, which describe the overlapping interconnecting interlocking directors networks performance in the business administration science literature so far. The authors propose to use both 1) the transmitted information data-stream measurements, and 2) the existing bit error rate measurements (BER) in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms to accurately characterize the overlapping interconnecting interlocking directors networks performance and the director’s competence and effectiveness. In other words, the authors suggest that the information, which is generated, transmitted and received by the director in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms can accurately characterize the overlapping interconnecting interlocking directors networks performance, and tell the true story about the director’s competence and effectiveness, impacting the involved firms’ valuations. Let us highlight the existing differences between the presently used parameters such as the 1) the director’s boards seats accumulation number, 2) the overlapping interconnecting interlocking directors networks configuration, and 3) the director’s centrality (the Freeman Degree and Betweenness) on one side and the proposed parameters such as 1) the transmitted data stream measurements, and 2) the existing bit error rate measurements (BER) on another side of the coin. We would like to explain that the director can have a big director’s boards seats accumulation number, an advanced overlapping interconnecting interlocking director’s professional networks configuration, a high degree of centrality, however, at the same time, the director can generate, transmit, receive the low information data
streams (the information data flows) in the advanced overlapping interconnecting interlocking director’s professional networks, behaving as a passive observer and making the little or no useful contributions to the boards of directors work in the considered firms. In other words, let the authors repeat that, in our opinion, the information, which is generated, transmitted and received by the director in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms is the only important parameter, which can accurately characterize the director’s competence and effectiveness during his/her work assignments in the boards of directors in the firms. In any firm, the work performance, shown by every director, will ultimately impact the work performance, demonstrated by the board of directors, which will certainly be reflected in the firm’s valuation.

We do believe that the generated, transmitted, and received information data streams in the interlocking interlinking interconnecting directors’ networks have a highly asymmetric nature, because of some reasons. In our opinion, every director has the different education, professional experience, accumulated knowledge base and can allocate the different amounts of time to work at the boards of directors in the firms, hence the director will generate, transmit, receive the various information data streams (the information data flows), resulting in the asymmetric information data streams appearance in the interlocking interlinking interconnecting directors’ networks in the boards of directors in the firms.

Speaking about the accurate characterization of the overlapping interconnecting interlocking directors networks in the boards of directors in the firms, we would like to emphasize that the conducted empirical research reveals another interesting fact that the positive and negative feedback loops, which can be created by the interlocking directors networks in the boards of directors in the firms, can quite possibly lead to the destructive coordination among the directors in the boards of directors in the firms by eliminating the randomness element and introducing the greater uniformity in the pursuing business strategies (the destructive coordination term is well described in Whitehead (2011, 2014)).

We think that the stability of interlocking interconnecting directors’ network depends on the nature of stochastic dynamic processes in the interlocking interconnecting directors’ network, hence it can be impacted by the election / appointment / introduction of a new directors into the overlapping interconnecting interlocking directors networks in the boards of directors in the firms in the time domain in Anishenko, Vadivasova, Astakhov (1999), Kuznetsov (2001). For example, it is a well known fact that a fast random addition of the energy consumers to the energy distribution networks may result in a shift of the energy distribution networks out of a stable state, because of the origination of the stochastic dynamic resonance.
The same processes can have place in the case of the electronic circuits with the interconnected networks of electronic components, hence the stability of electronic circuits is considered as an important parameter. The stability of wireless communications networks with the millions of active users is assumed to be quite important parameter as well.

Making the concluding comments on the strategy creation issue, the authors think that the different levels of the information sensing, information filtering, information processing, information absorption, information analysis and decision making with the obtained information by the director may have the certain positive or negative impacts on the director’s winning virtuous strategy creation ability in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms. Of course, the most complicated task for every wise director is to adjust to the optimal levels of the information sensing, information filtering, information processing, information absorption, information analysis, decision making, which can allow the winning virtuous strategy creation in the overlapping interconnecting interlocking directors networks in the boards of directors in the firms.

*We would like to mention that the excessive or insufficient levels of the information sensing, information filtering, information processing, information absorption, information analysis by the director may result in the bifurcations and chaos appearances in the frames of a decision making process on the winning virtuous strategy creation in the case of presence of the considered overlapping interconnecting interlocking directors networks in the boards of directors in the firms.*

Using the knowledge base in the probability theory in De Laplace (1812), Bunyakovsky (1846), Chebyshev (1846, 1867, 1891), Markov (1890, 1899, 1900, 1906, 1907, 1908, 1910, 1911, 1912, 1913), Kolmogorov (1938, 1985, 1986), Wiener (1949), Brush (1968, 1977), Shiryaev (1974, 1988, 1995), Pugachev (1979), the authors derived the appropriate universal formula to compute the probability number of the additional directorship mandate issues, depending on a set of already existing directorship mandates in the case of the interconnecting interlocking directors’ networks in the boards of directors in the firms, $P(b + 1|b)$, in Milakovic, Raddant, Birg (2009), Alfarano, Milakovic (2009); and developed the **MicroID software program**, which makes the actual probabilistic prediction toward the director’s election / appointment in the boards of directors in the firms, taking to the consideration both the director’s technical characteristics and the interconnecting interlocking director’s network parameters. We tested the MicroID software program, improved the computing recursive algorithm, and evaluated the accuracy of developed prediction models, comparing the obtained computing results with the real-world director’s election / appointment numbers in the boards of directors in the firms in the considered cases of research interest.
Conclusion

The article presented an original research on the strategy creation by the interlocking interconnecting directors in the boards of directors in the firms in an information century. We reviewed the possible structures of the board of directors, and show that there are the interlocking directors networks in the boards of directors in a big number of firms. Researching the strategic governance of firms, we highlight a fact that the director makes the information sensing, filtering, processing, resonant absorption, analysis, decision making, hence it can be empirically represented as a digital signal processor with the Harvard or von Neumann director’s mindset architectures. We think that the board of directors can be theoretically represented as the electronically-scanned electronically-steered phased array radar with a certain number of active antenna elements, filters banks, digital signal processors, memory chipsets in agreement with the digital signal processing and business administration sciences. Using the above theoretical assumptions, we formulate the Ledenyov theory on the winning virtuous strategies creation by the interlocking interconnecting directors in the boards of directors in the firms, which make the businesses in the conditions of the diffusion - type financial economic systems with the induced nonlinearities. We suggest that 1) the transmitted/received data stream measurements, 2) the bit error rate measurements have to be used to accurately characterize the interlocking interlinking interconnecting directors networks in addition to the well known parameters such as the director’s boards seats accumulation number, centrality, Freeman degree, Betweenness and network configuration. We believe that the generated, transmitted, and received information data streams in the interlocking interlinking interconnecting directors’ networks have a highly asymmetric nature, because of some reasons. We think that the positive and negative feedback loops, which can be created by the interlocking directors networks in the boards of directors in the firms, can quite possibly lead to the destructive coordination among the directors by eliminating the randomness element and by introducing the greater uniformity in the pursuing business strategies. We derived the appropriate universal formula and developed the MicroID software program to compute the probability number of the additional directorship mandates issues, depending on a set of already existing directorship mandates in the case of the interconnecting interlocking directors’ networks in the boards of directors in the firms. We applied the accumulated knowledge bases in the nuclear physics, condensed matter physics, space physics, mathematical physics, econophysics and software engineering to achieve our main innovative advanced research goal, namely to improve our understanding on the winning virtuous strategies creation by the
interlocking interconnecting directors in the boards of directors in the firms in the information century.

Acknowledgement

The directors in the boards of directors in the firms face a number of business challenges as a result of appearing disruptions in the economics in an information age. In this introductory condensed research article, the authors use an original research approach in an attempt to find a possible solution for the strategy creation problem, which has to be solved by the directors in the boards of directors during the strategic governance of firms. The international students prepared the brief abstracts of our invited lectures at the leading universities around the World over the last two decade, and then the authors combined our lecture notes with the brief abstracts of our invited lectures, aiming to write a research article. We also decided to include some our thoughts, expressed during the Q&A sessions after the presented lectures and kindly recorded by our students. In addition, the authors included the most interesting comments, professional advises, private opinions on the research subject by the directors of firms, recorded during a few thousands of business meetings in Europe, North America and Asia. In our opinion, the presented research findings may be in the scope of interest by the MBA students, professors in the business administration, management, finances, economics sciences, directors in the boards of directors, chairmen of the boards of directors, subject experts, and business leaders, who would like to stay up to the date on the recent developments in the business administration science.

The first author’s knowledge on the origins of the nonlinearities in the complex systems in the electrical, electronic, computer and financial engineering has been obtained during the intensive innovative scientific collaboration with Prof. Janina E. Mazierska, Personal Chair, Electrical and Computer Engineering Department, James Cook University, Townsville, Australia and former Dean, Electrical and Computer Engineering Department, James Cook University, Townsville, Australia, and former IEEE Director Region 10 in Australia, and IEEE Fellow. The first author would like to acknowledge Prof. Janina E. Mazierska by expressing his sincere gratitude for the kind scientific advices on how to develop the logical mathematical analysis skills, the scientific problems analytic solving ability and the abstract scientific thinking to tackle the complex scientific problems on the nonlinearities in the microwave superconductivity as well as on the nonlinearities in the economics, applying the interdisciplinary scientific knowledge together with the advanced computer modeling techniques.
in the course of the cutting-edge highly innovative research projects at James Cook University in Townsville in Queensland in Australia in 2000 – 2014 after the graduation from V. N. Karazyn Kharkov National University in Kharkov in Ukraine in 1994 – 1999.

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A certain part of an introductory condensed research article has been written during the first author’s yachting with the Australian friends in Melbourne, Victoria, Australia and in Brisbane, Queensland, Australia, when a number of the creative research ideas and important research findings on the business strategy creation by the directors in the boards of directors in the firms, came to his mind. Most of the ideas have been discussed with the Australian friends, when on the yachts. Sometimes, the thoughtful discussions have been further conducted during the “numerous meetings without the ties” with the great Australian philosophers, professors, scientists, businessmen, lawyers, governmental officials and political leaders in the relaxing trusted mutual-respect atmosphere, characterized by the pluralism of research opinions on the
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After the graduation from V. N. Karazyn Kharkov National University in Kharkov in Ukraine in 1993, the second author worked on the research programs in a number of universities and institutions around the World. Thinking about this research paper, the second author would like to kindly acknowledge the numerous private communications with the participants of the V. Ya. Bunyakovsky international conference with the special focus on the V. Ya. Bunyakovsky’s research contributions to the mathematical theory of probability and its modern applications in the econophysics and econometrics, which had place during a tour to the Town of Bar, Vinnytsya Region, State of Ukraine in the time of the conference, organized by the Institute of Mathematics of National Academy of Sciences of Ukraine (NASU), Kyiv, Ukraine on August 20 – 21, 2004. Absorbing the brilliant research ideas during a fruitful exchange by the scientific opinions among the conference attendees, the second author came up with a remarkable conclusion that the foundations of the mathematical theory of probability by V. Ya. Bunyakovsky enable us to perform a more accurate scientific analysis and characterization of the complex research problems on the business strategy creation by the directors in the boards of directors in the firms. The first author has been worked on the research article, discussing the
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