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The Dynamics of Private Equity, Innovation, and the Board of Directors

Empirical Evidence from Finland

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ABSTRACT:

The academia and finance professionals have debated for decades over the origin of the private equity funds' superior returns. The historical returns show that private equity investors have been able to generate higher returns than the markets on average year after year. As a consequence, the focal sector has grown globally rapidly. According to a report by Bureau van Dijk (2019), private equity investments accounted globally 26 % of the total M&A deal count in year 2018 and 16 % in terms of deal value. The development is evident also in Finland. In 2018, Finnish companies attracted the most VC funding of all European countries in comparison to the GDP (FVCA, 2019).

The impact of private equity transactions has been studied extensively yet most of the literature focus on economic performance and corporate governance framework. Although innovation is one of the key drivers for economic growth, research on technological change has remained slight. This thesis contributes to the academic literature by trying to fill that gap by combining these three elements. In other words, the purpose is to study the relationships between private equity investments, board members' social linkages and post-acquisition innovations.

The data sample used for the empirical analysis comprises 401 venture capital and buyout deals that completed between years 2010 and 2015 and where the target is a company registered in Finland. The sample contains in total 340 individual firms.

The empirical analysis is conducted utilising quantitative methods. Logistic panel regression measures the propensity for a firm to file an eventually granted patent application. In order to measure the post-investment innovation intensity, an OLS panel regression is applied. Finally, to examine whether the private equity investors' aim is in the end more on spurring innovation or on product development and commercialisation, an OLS panel regression is employed to measure firm performance in term of sales.

The results show that increased social capital correlates positively with both innovation and firm performance. However, innovation activities prior to receiving the investment have stronger impact and implies that instead of spurring new innovations, private equity investors focus on developing the existing innovations. The results for firm performance also show that PE investors' focus is more on financial engineering as there is no correlation between increased innovation and increased sales.

KEYWORDS: Private equity; Innovation; Social capital; Board of directors

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1 Introduction

The academic community and the corporate world have both been looking for the magic wand private equity (PE) investors are holding as they seem to have been able to generate significantly higher returns than the markets consecutively for decades. The academia also debates over the objectives and incentives of private equity investors towards their target companies. However, before diving deeper into value creation processes of entrepreneurial minds of private equity investors, let's start from the beginning by defining what private equity is and where it all began.

Private equity is the opposite of public equity, i.e. being listed on public stock exchange. Often private equity investing is connected to the concept of active ownership. However, the definition of private equity as a term is relatively context specific. Typically, PE investments are understood to describe investments in companies at mature stage. In a sense also Venture Capital (VC) investments are private equity investments. Therefore, the broad definition of PE covers investments in private companies at any phase, all the way from seed funding to mature and declining and/or restructuring. Reckoning with the research set-up, the narrow definition is used; PE- and VC terms are kept apart in order to study and compare them by their distinguishing features.

Private equity sector in present form is said to have emerged from KKR's buyout of Houdaille Industries in 1979. Since then the growth has been rapid, starting from the United States, reaching the United Kingdom in 1990's and thereafter spreading to Asia and Europe in the 2000s (Klein, Chapman, & Mondelli, 2013).

Globally private equity has strengthened its role as a form of funding a year after year. Excluding the peak years of 2006 and 2007, the trend has been positive ever since 1996. In succession to the Global Financial Crisis, investors have been more careful with the target firms and focusing on firms that are less sensitive to changes in business cycles. (Bain & Company, 2019)

Private equity sector does not have a standardised vocabulary and terms; thus statistics differ depending on the source. Despite the lack of unionised language, the significance of private equity investments is evident. According to Bureau Van Dijk, the long-term trend on deal count is positive. Private equity deals (including private equity and venture capital) accounted for 26% of the total number of 97,709 M&A deals announced and completed worldwide in 2018. In terms of deal value, a total of USD 825,766 million was invested through PE and VC investors which equals 15.6 % of the total value of M&A deals. (Bureau Van Dijk, 2019)

Europe, and especially the Nordic countries have increased their attraction as targets for foreign PE funds during the past few years. In 2018, Finnish companies received the most VC funding of all European countries in comparison to the GDP. In total, EUR 479 million was invested in Finnish start-up firms. In terms of buyout investments, Finland climbed ten positions up to fourth place after Denmark, the Netherlands and Sweden. (FVCA, 2019)

A recent study by KPMG Finland and Finnish Venture Capital Association (FVCA) (2019) presents the impact of private equity investors have had on their target firms in Finland. Research shows that on average the three-year cumulative average growth rate (CAGR) of portfolio companies (PC) of Finnish private equity funds has been 22.8% between years 2010 to 2017. That is 19 percentage points more than in the control group. The growth is reasoned with strategic expertise, development of reporting and management systems, creation of new compensation and engagement models as well as the contacts and social networks which the private equity investors bring into the target company. On the other hand, growth comes from the firm's continuous ability to increase performance by redefining strategy, optimizing processes and designing new and original products.

Innovation is found to be an essential driver to succeed in competitive markets in the long run (Hill & Snell, 1989). A study by Kortum and Lerner (2000) examines issued patents in the US between year 1965 and 1992 and find that venture capital is positively associated with the number of issued patents. Moreover, the study shows that activities of venture capitalists explain some 8 % of the industrial innovation in 1983 to 1992.

More recently, a report by World Intellectual Property Organization (2019) shows that innovation, measured in terms of patent application, has increased worldwide for 15 years in a row except in 2009 amid the financial crisis. In total, 3.3 million patent applications were filed in 2018. China, the U.S. and Japan lead the race in absolute number of applications, yet when compared to applications per unit of GDP Finland rises to 7th following Denmark and Sweden. The number of Patent Cooperation Treaty (PCT) applications filed globally by Finnish companies increased by 14.7% from 2017 to 2018.

The situation where private equity investments and innovation have increased significantly and especially Finland during the past decade creates an intriguing set-up for a research. Parpaleix, Levillain and Blanche (2018) note that in the long run the key element for business growth is the development of capability to sustain innovation. Therefore, it is important to study the drivers behind innovation in order to preserve economic growth.

On the other hand, Jensen (1989) argue that private equity investors generate economic efficiencies through superior corporate governance practices. After the acquisition, private equity investors are known to revamp the firm inside out. That means also changing the directors of the executive board, management team, and sometimes the CEO. New board members are often a “professional board members” or experts of a specific industry or business model etcetera. Furthermore, these individuals have knowledge and skills that are needed to develop the company according to mutual goals set by the investors and the company together. These experts are also often well-connected and have multiple board seats in other firms. Consequently, their personal social network and social

capital is high. Although, a logical assumption would be that higher social capital brings added value the case is not so simple. This study focuses on the added value the external linkages bring to support firm innovation and firm performance. The results will then help the private equity investors to improve the structure of the board as the board dynamics is important factor for it to work as a team as Golden and Zajac (2001) argue that as the number of directors increases it may persuade other inconveniences such as free-riding and emergency of factions. Alongside the benefit for the companies that are seeking for funding from VC and BO investors, the results of this study provide guidance on the practices the investors actually apply in the company and what can be expected post-acquisition. In practice, the pro is that the members of management team in the target company know the right questions to focus on in the negotiations and avoid misleading. Next chapter seizes more profoundly on the specific research questions.

1.1 Purpose of the study

The impact of private equity transactions has been studied extensively yet most of the literature focus on economic performance and corporate governance framework. In addition, studies by Achleitner, Braun and Engel (2011) and Ughetto (2010) remark the lack of profound research on value creation of private equity mechanisms. Moreover, although innovation is one of the key drivers for economic growth, research on technological change have remained slight. This thesis contributes to academic literature by trying to fill that gap by combining these three elements. In other words, the purpose is to study the relationships between private equity investments, board members' social interlocks and post-investment innovations.

There are several research questions for my study to answer to. First of all, the purpose of private equity investor is to maximize the target's financial and operational performance. In order to do so, they often change board members to individuals who are believed to have the skills and connections to improve the company. The research question then is do new board members add value and increase the performance? Secondly, how large is the fraction of added value that originates from board member's linkages?

In terms of innovation, the aim is to examine the relationship between social networks and innovation. Research question is stated as do higher social capital and wider social networks increase ability to sustain or even increase innovation. Those questions are also the base for the first hypothesis for the research:

H_0: Increase in social capital of the executive board leads to decrease in firm innovation
H_1: Increase in social capital of the executive board leads to increase in firm innovation

Lastly, I will put all above-mentioned together. If social capital drives innovation and private equity investors can bring added value to the firm by changing board members, do those specific new board members bring that particular addition to innovation and could partly explain the excessive growth in portfolio companies. Hence, the second hypothesis is:

H_0: Increase in social capital of the executive board decrease financial performance of the target company
H_1: Increase in social capital of the executive board increase financial performance of the target company

1.2 Structure of the study

The structure of the paper is following. First, the private equity sector and its characteristics are defined. That chapter includes discussion of different transaction and fund types and the structure of a private equity fund. After that, the theoretical framework is presented. Chapter presents the most common theories of corporate governance and social capital. The theoretical part of the study is finalized with prior empirical results. Discussion is built around value creation and findings on how private equity investors and social capital is previously found to affect firm innovation.

Empirical part of this study starts with presentation of data used in actual analysis. First is presented the procedure of data collection and then a detailed description of all the variables used in the analysis. After that is presented the methodology for the analysis that comprises three different methods: descriptive statistics, logistic regression and ordinary least squares method. Chapter empirical results naturally presents the findings of empirical analysis that uses the aforementioned methods. The results are discussed in the final chapter before drawing the conclusion.

2 Private equity

This chapter defines the concept of private equity to help to understand the overall industry. It starts by defining the key terms and presenting the industry characteristics. Following that are introduced the different transaction and ownership types and the chapter finishes by discussing the ownership flexibility and influence.

2.1 Definition and characteristics

In its broadest sense, private equity (PE) means the opposite of public equity. Invest Europe (previously European Venture Capital and Private Equity Association, EVCA) defines private equity as follows: “Private equity is a form of equity investment into private companies not listed on the stock exchange. It is a medium to long-term investment, characterised by active ownership. Private equity builds better businesses by strengthening management expertise, delivering operational improvements and helping companies to access new markets.”

Finnish Venture Capital Association (FVCA) (2019) refers to private equity as investments in companies which are not quoted on stock markets but have good potential for development. Private equity is therefore an umbrella term for alternative investments that comprises investments in private companies at all stages of growth (EVCA, 2007). In order to distinguish the differences between the investment types this research refers to the term PE as the private equity sector in general regardless of the growth stage of the target company. Distinction is made according to different fund types which are presented in chapter 2.2.

2.2 Private equity fund types

Private equity investments can be divided into two categories: buyouts and venture capital. Buyout (BO) funds typically invest in companies that are more mature than venture capitalist portfolio companies but still growing. They focus on companies at expansion

or development stage where the business is already running and generating profits. New capital is used to for example add production capacity and sales power, finance acquisitions, develop new products and/or enhance the working capital of the firm. Some buyout funds are specialized in companies suffering from financial distress or which are otherwise in turnaround point in their life cycle. (EVCA, 2007)

Venture capital funds invest in companies at earlier stage in company life cycle. That includes seed, start-up and later-stage funding. In seed funding stage the business is in research phase, developing and designing the idea or concept and it has not yet been properly accelerated. Thus, investments made during the phase in question are often personal, made by individuals such as the founder(s) of the company and/or a business angel. (EVCA 2007; Virtanen 1996: 97) Focus of this thesis is particularly in private equity funds and hence seed funding is not included in the scope of research.

Venture capital funds look for companies with high growth potential and therefore their scope is often on innovative sectors, such as electronics, IT, life sciences and biotechnology. These companies are usually in start-up phase and the financing received from investors is used for product research and development, initial marketing and employee training. At later-stage of venture capital, the product has been developed and the financing is need for commercialisation and selling but the company is not yet profit-making. These are typically third or fourth financing rounds (EVCA, 2007; Invest Europe, 2017).

The level of innovation is at its peak at this stage but at the same time risk of failure is also the highest (EVCA, 2007). In fact, Morgan and Abetti (2004) state high technology ventures to be so risky that venture capital and private equity are the only possible financiers. Furthermore, apart from difference in company development stages, venture capital and buyout funds differ in the size of their investments. Venture capitalists invest in minority stakes and take overall a more passive role in the company than the funds that are focused in buyouts. Buyout funds on the contrary tend to acquire majority or

controlling stakes of the portfolio companies and at the same time take stronger control over the company (Invest Europe, 2017). Different transaction types and forms of company takeovers are discussed more in chapter 2.2.1.

VC and PE funds also differ in their investment objectives. According to British Private Equity and Venture Capital Association (BVCA) generally VC funds invest in companies that have a short if any history of profitability and are cash hungry. Private equity funds' scope is on the other hand in more mature companies. Also, they often focus on reducing inefficiencies and stimulate business growth. (BVCA, n.d.)

In addition to VC and BO funds Invest Europe (2017) presents three other fund types: generalist fund, growth fund and mezzanine fund. Growth funds make usually minority investments companies that are at more mature stage. These firms are in need of financing to expand, improve their business operations and/or enter new markets. Generalist funds do not have a particular strategy in terms of development level of the company and therefore tend to invest in companies at all stages. Mezzanine funds are the pioneers of financial engineering within private equity industry as these funds use a hybrid of debt and equity utilizing equity-based options (e.g. warrants) and lower-priority (sub-ordinated) debt.

2.2.1 Buyout types

Incumbent academic literature for private equity comprehends several ways to classify different PE transactions. Typically, transactions are divided into outside-driven and inside-driven transactions. Figure 1 presents the division of buyout types and most common transaction types according to the initiator of the transaction.

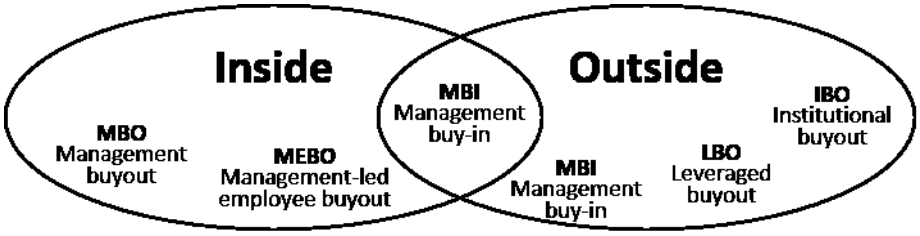

Figure 1: Summary of buyout transaction types (in line with Thaussi, 2016)

The most common types of outside-driven transactions are leveraged buyouts (LBOs), management buy-ins (MBIs) and institutional (or investor-led) buyouts (IBOs). LBOs are often cited as the typical PE transactions due to PE funds mostly financing their investments using a substantial share of debt capital (Kaplan & Strömberg, 2009). IBO is a transaction where there are only institutional acquirers. However, an IBO can be related to LBO in case the new investors utilize leverage. The key element in outside-driven transactions is the replacement of the incumbent management team. In IBO and LBO transactions the new owners bring new managers whereas, in MBI transaction the new managers are also the owners as they invest personally in the target company (Gilligan & Wright, 2014, p. 216; Talmor & Vasvari, 2011, p. 271; Wood & Wright, 2009).

In inside-driven transactions, the existing management team acquires the company possibly alongside a PE firm. In management buyout (MBO), only the management team takes part in the takeover but in management-led employee buyout (MEBO) also the company employees are offered an equity stake of the firm (Wood & Wright, 2009). These transactions can be also LBOs without an outsider takeover as the acquirers rarely have enough capital without the utilization of leverage.

MBI and MBO's differences occur in the level of information as the existing management team has more information about the company. A hybrid combining features of both insider- and outsider-driven transactions is called BIMBO. It is a mix of MBI and MBO that is created to help reducing the informational asymmetries in MBIs (Wood & Wright 2009).

The subject of this research is to study the impact that outsiders are able to bring into the target companies and therefore this paper focuses more on the outside-driven transactions whit emphasis especially on MBIs and IBOs.

2.3 Private equity fund structure and stakeholders

Private equity firms can be classed as investment management companies. In Finland, the companies are organized as limited partnerships (Möller, Lehtimaja, Sikander & Somervuori, 2013, p. 81). Figure 2 illustrates the structure and stakeholders of a PE fund. The representatives of the private equity firm, usually fund managers, are called General partner (GP). Limited partners (LPs) are the investors that provide most of the capital into the fund. The LPs are typically institutional investors (banks, pension funds, and insurance companies), funds-of-funds, family investment vehicles or other wealthy individuals. (FVCA, 2008)

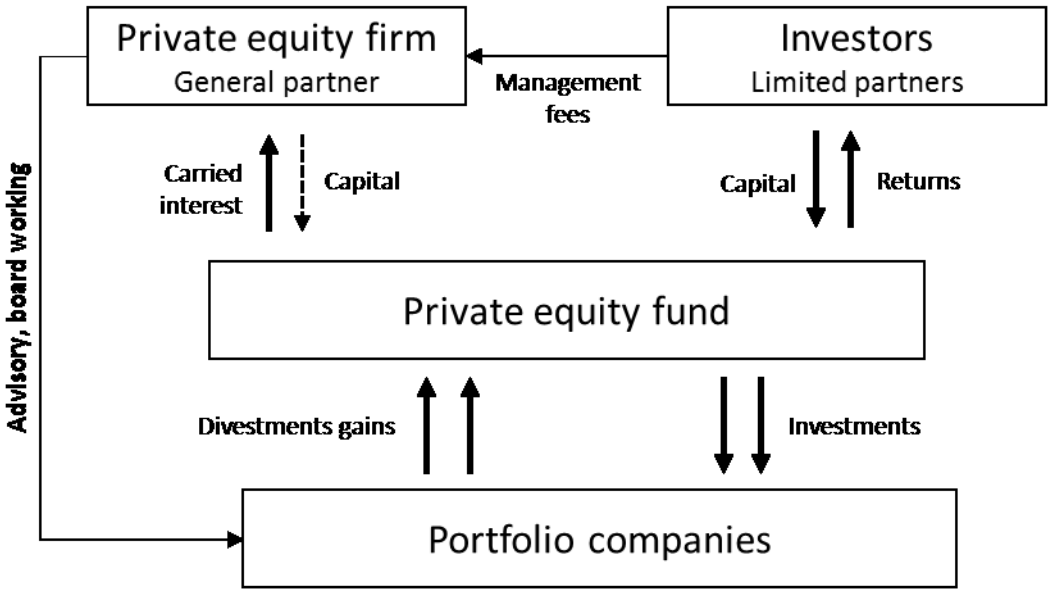

Figure 2: Private equity fund structure

Private equity funds have typically a lifetime of ten years which can be divided into four phases: fundraising, target selection, investment period, and exit.

The fundraising phase usually lasts up to one year. Most PE funds are “close-ended” meaning that after the LPs have committed to invest in the fund they are not permitted to make withdraws until the end of the fund’s lifetime. At this stage, the GP also defines the fund’s lifespan and investment strategy which includes decisions on the growth stage and industries of the target companies. (EVCA, 2007; Strömberg, 2009)

After raising the capital, the fund managers usually have up to five years to make the investments. As the investments are most often realised in three to seven years, the second half of the 10-year lifetime is used for follow-up investments and exits from the portfolio companies. The time period meant for returning capital to the investors can be extended up to eight years.

GP makes investment decisions according to the investment strategy acknowledging the covenants in the fund agreement. The covenants typically draw fund level restrictions on how much can be invested in one company as well as on the types of financial instruments, including debt, that can be utilised. (Metrick and Yasuda, 2011)

Limited partners pay general partners annually a compensation called management fee, for managing the fund on their behalf. Management fee is the only fixed component in GPs cash flow. However, usually PE firm’s revenue is mostly generated by carried interest which is performance-based component. The amount of received carried interest is based on the carry level that is defined in the fund agreement. Generally, the carry level is 20% meaning that after the GP earns 20 cents of each euro that is earned after committed capital is returned to LPs. Other two fees, transaction and monitoring fees, are common with buyout funds but not with VC funds. (Kaplan & Strömberg, 2008; Metrick & Yasuda, 2011)

General partners’ main goal is to maximize the value of their investments. The unique feature of private equity investors in comparison to shareholders of quoted companies is that they do not only provide the funding but also are actively involved in the company

to increase the value. They exercise different types of shareholder activism by for example monitoring the financial performance of the companies (cf. Gorman & Sahlman, 1989; Jensen, 1989). In order to support growth and entrepreneurial behaviour, PE investors often participate in strategic planning and decision-making through board working (cf. Sapienza, Manigart & Vermeir, 1996; Wright, Hoskisson, Busenitz & Dial, 2000; Bruining, Verwaal & Wright, 2013). Hellman and Puri (2002) emphasise that especially in venture capital investments, the investors are able to add value by helping in systemising the internal processes and professionalising the organisation. Value-creation methods of private equity investments are discussed more profoundly in literature review part of the research.

At exit phase, the PE firm divests the ownership in a target company and generates returns in successful trade. There are four common routes for exit: a sale to a trade buyer (trade sale), a sale to another PE investor (secondary buyout), management buyout or an initial public offering (IPO) where the company is listed on a public stock exchange. At this point, the fund starts returning the invested capital to the limited partners accompanied with possible returns. If all the committed capital is invested and the fund collected a suitable amount of capital in returns from exits, general partners can start forming a new fund. Evidently, the success of the previous fund impacts the popularity and consequently size of the next fund. (EVCA, 2007)

3 Theoretical framework

Theoretical framework in this research is formed around value creation process in private equity investments. More specifically, the framework describes how corporate governance, especially board work and decision making; social capital, as well as external and internal ties of the directors, are linked to innovation. This chapter also discusses these aforementioned factors' ability to create value in the target company.

3.1 Corporate governance

A generally accepted view is that a company's main responsibility is to create value for its owners. Company's board of directors is in a key role to create strategy for implementation. Thus, although board members do not participate on the operational level in the company, they are in the spotlight in value creation in the company as simultaneously practicing good corporate governance. This chapter represents three theories for those practices: agency theory, hegemony theory, and entrepreneurial approach.

Board of directors is, from legal perspective, presumed to control management's actions. Board members are therefore legally responsible if failing to make knowledgeable decisions for the firm's best interest (Johnson, Daily & Ellstrand, 1996). According to managerial hegemony theory, the CEO and corporate management are supposed to influence the board (D'Aveni & Kesner, 1993; Kosnik, 1987; Mallette & Fowler, 1992; Stiles, 2001). Furthermore, board members are expected to agree with top management's decisions as they have been appointed and selected by the management and/or due to their lack of knowledge of the operations and processes in the business resulting in not wanting to risk the status and board compensation by disagreeing (Stevenson & Radin, 2009).

One of the main concerns in finance literature and especially in research of private equity value creation are agency problems between the owners and the management team (cf. Davis, Haltiwanger, Jarmin, Lerner & Miranda, 2011; Harris, Siegel & Wright, 2005; Lichtenberg & Siegel, 1990). Studies have found two main mechanisms to tackle these

problems through improved corporate governance: management incentives and active ownership. Paying attention to management incentives is suggested to reduce need for monitoring. On the other hand, reduction of monitoring costs with actions of active ownership can help minimizing agency costs.

According to agency theory (Fama & Jensen, 1983; Young, Stedham & Beekun, 2000) board members can be ineffective to influence decision-making. Theory assumes the relationship between the owners and the managers to be a contract between principals and agents. The problems emerge when management is separated from the income sources of ownership, and management then tries to maximize their own wealth and power, occasionally against the interest of the shareholders.

Jensen (1986) has studied the effects of agency theory and corporate governance actions in private equity investments. He argues managers to have incentives to invest free cash flow at below the cost of capital or to spend inefficiencies. Therefore, added leverage may help in reduction of agency cost of free cash flow. Firstly, obligation to make debt payments reduces the amount of available cash for managers to waste but also it increases motivation in the whole organisation to be more efficient. Secondly, limited partners and creditors, of which first mentioned have a significant share of equity and latter need to be assured to finance new projects, monitor the company more closely when the level of debt is higher.

Both, hegemony and agency theories consider independent, outside board members important in terms of resisting and reducing too opportunistic behaviour in managers (Frankforter, Berman & Jones, 2000; Kosnik, 1987). Hegemony theory refers to weak board monitoring as lack of independence of directors. According to the hegemony theory, independent directors that were not selected by the existing management, that do not serve, have not served in the management of the firm, nor have any business relations with the firm, should be more willing to influence the decisions than the dependent

directors that have a tie of a kind or other obligation or interest in the firm. Correspondingly, from agency theory's viewpoint, independent directors are seen less prone to connive with managers for their own benefit. (Fama & Jensen, 1983)

More recent studies discussing the relationship between corporate governance and private equity present a concept of entrepreneurial approach. In favour of PE, the studies argue that "entrepreneurship should be understood not as particular empirical phenomenon" (e.g. self-employment, start-ups, and new-product innovation) but as a general, abstract function, as a way of thinking or acting" (Klein et al., 2013; Klein, 2008). This approach refers to Knight (1921), Casson (1982), and Foss and Klein (2012) by treating entrepreneurship as "judgemental decision making under uncertainty". In this context, judgement is understood as making decisions which are not possible to represent using formal models or decision rules but are still not associated with chance or luck.

Dissimilar to other entrepreneurial features like alertness (Kirzner, 1973), judgement is unmistakable in the ownership of productive assets. Under uncertain conditions, judgement mirrors the utmost decision authority about formation and use of valuable resources. In order to promote financial or other gain, entrepreneurs enact time after time to incorporate heterogeneous capital resources which features are personally recognised. (Klein et al., 2013)

Private equity firms are in various ways detected to be more entrepreneurial than publicly traded firms. General Partners are said to be among the most significant entrepreneurs, and the members of the management team of their portfolio companies have more in common with entrepreneurs than with general managers (Wright et al., 2000; Wright, Hoskisson & Busenitz, 2001). There are arguments in favour and against whether PE companies are able to create innovation, start-ups and other phenomena that are usually linked to entrepreneurship. Empirical findings of the topic in question are discussed in chapter 4.2.

3.2 Social capital

The concept of social capital was originated in the classics of sociology already in the nineteenth century yet there are three sociologists that have made a significant contribution to more recent development: Ronald Burt, James Coleman, and Robert Putnam. All three offer somewhat different definitions of social capital. Coleman (1990, p. 304) argued social capital to be created "when the relations among persons change in ways that facilitate action". Whereas Coleman's definition emphasises social capital as a combination of relations and resources, Burt's approach focuses on describing social capital as relations and networks of relations per se. He defines social capital as relationships with others – "friends, colleagues, and more general contacts through whom you receive opportunities to use your financial and human capital" (Burt, 1992, p. 9). The third approach is centralized around groups instead of individuals. Putnam (1993, p. 167) describes social capital as "features of social organisation, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinating actions". He also overruns Coleman's approach by including moral resources such as trust and norms.

Alternatively, Nahapiet and Ghosal's (1998) approach combines individuals and groups. Despite the concept being abstract in nature, they suggest social capital to be considered as a property of an individual or a group that enables them to attain something that is otherwise inaccessible to them. Ronald Burt has later deepened his earlier view into a straightforward notion that refers people with wider network to be more successful than others. He characterizes social capital being "the contextual complement to human capital", in which "the social capital metaphor is that the people who do better are somehow better connected" (Burt, 2000).

Business research typically observe social capital in the organization by examining the quantity or the quality of the ties. Baker (1990) refers to social capital as the number of formal and informal connections inside an organisation. The more connections a firm has, the more social capital it possesses, and as a result transfer as a greater advantage for a company. A research focusing on the other line of study, the quality of the ties,

presents an explanation of inter-firm performance differences with the strength of the relationships (Nahapiet & Ghoshal, 1998). According to the same study, the reason for the differences lies behind the relational aspects of social interactions, and thus amongst companies in which the ties are stronger seize greater trust, cooperation and legitimacy. Although both findings received praise among the academics, some have suggested social capital and its advantages to not purely arise from one or the other, but instead from the combination of quantity and quality of the connections in the firm's network (cf. Arenius, 2002).

3.2.1 Social capital as network

In a frequently cited study, Nahapiet and Ghoshal (1998) describe a framework that explains how social capital may promote value creation in corporations. Their framework identifies three dimensions of social capital: structural, relational, and cognitive. The structural dimension aligns significantly with how network is represented in the networking theory as it illustrates the way detached links and their configurations connect one actor to another. In other words, it includes the ties within a social network and the location of an actor's connections inside the social structure of interaction. Structural dimension can be defined using measures like density, hierarchy, and connectivity. (Nahapiet & Ghoshal, 1998)

Relational dimension, on the other hand, focuses particularly on the quality of the ties an actor has, emphasising those which might influence one's behaviour (Weber & Weber, 2007). People accept the agreed rules and cooperate and act in the common interest through the personal connections they have. Hence relational dimension essentially acknowledges in each individual relationship the traits, such as trust, respect, and friendships that affect the norms, obligations and conduct of actors (Nahapiet & Ghoshal, 1998, p. 243).

Cognitive dimension "refers to those resources providing shared representations, interpretations, and systems of meaning among parties" (Nahapiet & Ghoshal, 1998, p. 244).

Arenius (2002, p. 55) argues that the cognitive properties enable "the common understanding of collective goals and of proper ways to interact with one another."

Another approach on theories of social capital focuses on networks between individuals. Researchers have identified two different network structures, dense and sparse networks, and recently have started a debate over the beneficial effects of the two. Coleman (1988) argues that members of a dense network trust each other to respect obligations which as a result, decreases the uncertainty of exchanges as well as increases the ability to cooperate in the inquiry of interests. The amount of available social capital for an actor is then possible to derive from the closure of the network around him or her. Granovetter (1985) has similar observations but in different form as he argues common third parties having a positive impact in promoting trust between actors and reducing the risk of opportunism which could influence cooperative relationships.

Alguezaui and Filieri (2010) derive their definition for the density of a network from Coleman's (1988) argument referring to it as the degree of tie redundancy and interrelation between the members in the firm. In other words, a network is cohesive when all actors in the network are linked to each other.

On the contrary, Granovetter argued as early as in 1973 in favour of the strength of weak ties providing the base for the advocates of brokerage[1]. Burt (1992) further developed the concept highlighting the benefits of sparse network configurations. As a result, emerged the structural network theory from which is derived the definition for sparse network. Instead of emphasising "the utility of consistent norms fostered by cohesive networks", the sparse network theory declares the benefits of social capital to be a result of diversity of information and brokerage opportunities which emerge from absence of link between separate bundles in a social configuration.

[1] Brokerage is, at its simplest, defined as a process that links otherwise unconnected actors and a broker as an intermediary who act as a link between these two actors (Stovel & Shaw, 2012).

On the track of Portes (1998), Stevenson and Radin (2009) question the definitions that combine social relations and potential causes and outcomes such as norms of trust and social obligation. They argue such definitions lead to causal circularity. Firstly, they question whether social capital is therefore a characteristic of civic engagement or a way to develop civic engagement in a society. Secondly, they suspect is trust "as a component of social capital necessary for participation in civic affairs or an outcome of civic participation."

Portes (1998) argues that it is inevitable to distinguish who has social capital, the sources of social capital, and the resources created by social capital in order to avoid tautological definitions and causal circularity. Several researchers have further developed and narrowed the concept to consider only social relations and the outcomes of the relations in question.

Separation degrees and lengths of paths are frequently used terms in social network theory. They can be measured as a number of contacted intermediaries in order to pass a message from one person to another in a network (Nicholson, Alexander and Kiel, 2004). Figure 3 presents interlocks between companies and how they become a network through connected board members. This figure presents links between four companies that all have four board members. Part A shows a typical intercorporate network where each board represents a participating company linking all the whole board to two other companies in the network.

Part B represents the same situation as Part A with exception of showing the number of participating individuals. Solid lines illustrate links inside the board whereas dashed lines connect two separate boards through a shared director that has two positions. Part C then illustrates the real degree of separation of board interlocks. This is a simplified representation where an individual can hold maximum of two directorships and only one of the board members in the company can be in that situation. In real life, and what is the situation with the data of this research, that the networks are significantly more complex

and wider as the number of board members can be larger and several directors of one board may have multiple positions in other boards.

Linkages between board members are particularly important in terms of private equity investments as the new owners often either replace and/or bring new directors on the board. As a result, the network around the firm widens by the number of connections of those individuals.

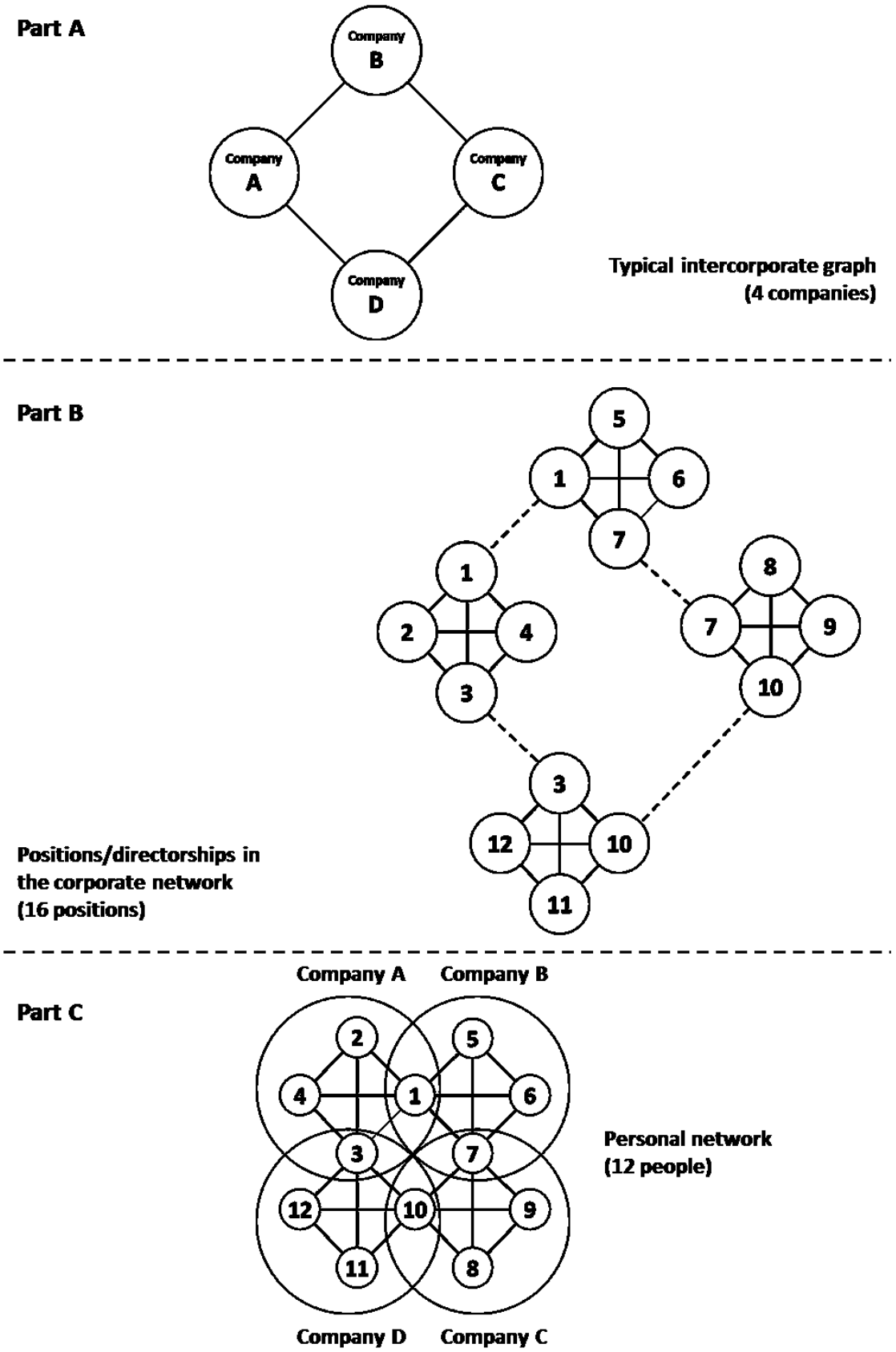

Figure 3: The intercorporate network (in line with Nicholson, Alexander & Kiel, 2004)

When social capital is only seen as a network of ties between individuals, it allows to make a distinction between the creation of ties and the outcomes, e.g. trust. Kramer and Cook (2004) highlight that a bond between two actors can lead to consensus and joint outcomes but not certainly to trust. Board members usually share a mutual interest to cooperate to solve problems as they all benefit as investors but that does not necessarily result in trust amongst board members (Stevenson & Radin, 2009).

Innovations are seen as an output of cooperation and uninterrupted interaction between the company and external parties. Company's competitiveness is based on innovation whose basis is on socially embedded learning processes but is limited by the economy-wide ability to learn. That is, why firms today depend on their external networks which have a vital role in creating, developing, and exploiting new opportunities to create added value. Hence, social capital caters the company the tools to connect with distinctive resources and a configuration of relationships, consequently enhancing the company's abilities to innovate. (Alguezaui & Filieri, 2010)

4 Prior empirical results

As previously mentioned, private equity, innovation and board interlocks have not previously been studied together. Therefore, this chapter starts by discussing objectives of private equity investments in general. Each of the subchapters discusses two of the focus areas of this thesis, either private equity, board working and corporate governance, or innovation. First two are discussed in the first subchapters. Following two subchapters are dedicated for innovation as first shows results of relation to private equity and second to social capital. The chapter finishes by evaluation of a created synthesis to support composition of hypotheses.

The academics have debated for decades over superiority of PE firms' investments and the incentive creation tools they use on their portfolio companies. In general, studies focusing on the first wave of PE-backed investments in the 1980 reflect mostly positive results in target firm performance explained by the superiority of private equity governance. More recent findings on the other hand are somewhat more critical and cautious. Although most of the literature investigating private equity investments find support for private equity investors' targets to outperform their peers, overall there is no strong evidence in terms of buyouts (Wilson, Wright, Siegel & Scholes, 2012).

In the centre is the investment horizon, whether PE firms intend to generate value on short- or long-term. Those in favour of superiority of LBO governance structure argue it to enable incentives for managers to create value by cutting unprofitable unrestricted expenses and seeking profit-making opportunities for growth (Boucly, Sraer & Thesmar, 2011; Jensen, 1986; Wright et al, 2001). For a contrary, the detractors argue PE firms to have a short-term investment horizon which endorses to aim for short-term returns while simultaneously the high leverage deflects cash from long-term placements in the direction of debt-service (Rappaport, 1990).

Amess, Stiebale and Wright (2016) suggest innovation to be the solution as it creates long-term returns through long-term investments. However, there are also other proposals. Jensen (1989) show two possibilities how buyouts create economic efficiencies through superior corporate governance practiced by the GPs in evening managers' incentives. Then there is the question whether the GPs are able to bring anything else to the board than control and discipline or not. This chapter presents possible solutions for those dilemmas through results of academic literature on the focal topics.

4.1 Evidence on value creation through corporate governance

Agency problems are widely debated topic in companies but also in the corporate governance literature. It is proposed that monitoring and controlling through practices of active ownership are effective tools to reduce those problems as managers have a frequent mandate to report to the board and there is a mutual understanding that they are easily replaceable if targets are not achieved (Nikoskelainen & Wright, 2007). Simultaneously, while agency problems are reduced, the opportunities for value creation increase.

Kaplan and Strömberg (2009) present three types of actions on how private equity firms create value: financial engineering, operational engineering and governance engineering. Financial engineering focuses mainly on incentives and motivation of the management team. Governance engineering is linked to actions that the private equity firm takes to control the board of directors of the target company. Generally, the boards of companies belonging to a private equity family, are smaller in size but more active than those of comparable public companies. PE firms usually allocate board seats by taking three for themselves, giving one or two for representative(s) of management and one or two for outsiders (Gompers, Kaplan & Mukharlyamov, 2016).

Braun and Latham (2009) imply that board structure could act as a predictor for financial performance. Results in their research show that increase in board size post-transaction is positively correlated with increased operational performance. For a contrary, if the board size is decreased, it can be associated with negative changes in the performance.

As a conclusion, the authors suggest that changes in board structure is one of the possible tools for value creation in LBOs to improve the operational performance.

Through operational engineering, PE firms involve the industry and operating expertise while creating added value to the target company (Kaplan & Strömberg, 2009). In practice, they hire industry professionals with operative expertise from focal industry alongside the transaction specialists. In addition, there might also be other external consultants and advisors involved in the process. While operating partners, the PE team members, identify post-investment sources for value creation, external consultant's role is most significant in conducting a pre-investment commercial due diligence (Gompers et al., 2016). Although PE firms tend to stay out of the operational level functions in the portfolio company, as part of value creation process they are often part of value creation process through involvement in reform of strategy and/or business model and engaging in the implementation through operational engineering by changing the management team members such as the CEO and CFO (Gompers et al., 2016).

In fact, within 100 days after the investment, 39 % of the CEOs in the portfolio companies are replaced and 69 % at some point during the investment period (Acharya, Gottschalg, Hahn & Kehoe, 2013). Consistent with last finding, Guo, Hotchkiss and Song (2011) find the CEO replacement rate of 37 % while pointing out that improvements are greater if the CEO is replaced at the time of the investment. Moreover, Acharya et al. (2013) report general partners with operational background to generate higher returns in organic deals whereas GPs with financial background outperform in inorganic deals[2].

4.2 Private equity and innovation

Most studies on relationship between private equity and innovation are focused on VC backed deals. That is understandable as usually innovation is connected to young companies operating in technology sectors that are the more appealing targets for venture

[2] Term organic deal refers to a deal without major M&A activities i.e. value creation is focused more on operational improvements (Acharya et al., 2013)

capitalists than for private equity funds. These studies, however, have differing findings on innovativeness.

The earlier studies on firms' innovativeness have conducted the empirical analysis by examining R&D expenditures (Lichtenberg & Siegel, 1990; Long & Ravenscraft, 1993). That is, however, a questionable measure as it is impossible to make a distinction between productive and unproductive expenditures (Amess, et al., 2016). Nonetheless, Zahra (1995) suggests that PE firms are able to improve product development and commercialise the technologies of the PCs through more effective usage of R&D expenditures in MBOs. This finding confirms PE funds to be able to serve superior managerial and technical expertise that provides the target companies to conquer new markets and possibilities for innovation. The effect is explained to be a result of providing incentives to embrace entrepreneurial practicalities and strategies for innovation in order to make better use of the investments in R&D (Bruining et al, 2013; Link, Ruhm & Siegel, 2014).

There are a handful of other studies that tend to find differing results whether private equity investors are able to increase level of innovation in the target companies. A study from Kortum and Lerner (2000) is one of the most cited papers aiming to explain the impact private equity investors have on innovation in their portfolio companies. They examine issued patents in the US between years 1965 and 1992 and find increased venture capital activity to have a significant positive effect to the number of issued patents. They also imply that venture capitalists would explain some 8% of the total industrial innovation in the US in 1983-1992.

For a contrary, Popov and Roosenboom (2012) report findings from European VC funds that have not been able to spur innovation as strongly as their American rivals. They analyse VC investments from 21 European countries in 1991-2005. After comparing the results to Kortum and Lerner (2000), they demonstrate European VC funds to have had a mostly positive impact on patenting activity but simultaneously they question the significance of the result as the results vary remarkably between different countries. They

explain the VC effect on innovation to be greater in countries which have low barriers for entrepreneurship and venturing as well as convenient regulatory and tax environment for VC funds.

Engel and Keilbach (2007) have an alternative argument as they suggest positive results to be an outcome of selecting companies that are innovative in lieu of venture capitalists facilitating innovation. They study companies that have received funding from German VC funds, compare them to peers which have not received similar funding and examine patent applications of both groups. They report VC backed companies to be more innovative than their peers, but the focal companies were more innovative already before the investments were made. In other words, results indicate that instead of increasing innovation, the investors commercialise the innovations of their portfolio companies. Engel and Keilbach's results support the findings of Hellmann and Puri (2000) which indicate innovative firms to have higher potential to become targets for VC investors.

Lerner, Sørensen and Strömberg (2011) argue that portfolio companies' patenting activity does not change after initial investment but instead the citation frequency of the focal companies increases. However, they were not able to clarify whether the greater economic impact, which is derives from producing research, is a result of selection or causal effect.

As discussed earlier, the academics debate whether private equity investors aim to create value either on long- or short-term. Amess et al. (2016) contribute on the debate and in the end show that empirical analysis of innovation activity is competent in solving this controversy as investments in innovation usually require making placements that create returns for longer-term. They find that PE-backed LBOs to have a positive casual effect on patenting as well as quality-adjusted-patents in terms of number of citations. Moreover, they report evidence that suggest PE firms to be able to relax financial restrictions in their portfolio companies and consequently enable greater innovation activity. Thirdly,

they show that LBOs impact particularly contemporary patenting instead of strategic patenting and the effect is mostly driven by private-to-private transactions in industries that are financially dependent. Finding is in line with Morgan and Abetti (2004) that argue high-tech firms to be so risky that VC and PE investors are the only option to receive financing from.

Most of the studies on the value creation and impact of private equity firms consider the funds to be homogenous. Ughetto (2010) however notes that there might actually be several fund-level characteristics that impact the patent activity of the target companies. In other words, PE firm's size, geographical location and stage specialisation as well as other deal characteristics, such as invested amount and the number of investors, correlate with the patent activity. Nonetheless, the sample lacks firms that are not PE-backed which creates a certain limitation for full interpretation whether LBOs that are PE-backed steer automatically to higher level of patenting activity or not.

4.3 Social capital and innovation

Theoretical framework established two perspectives to study social capital and linkages between individuals, including board members: quality and quantity of the ties. Several studies find a greater number of board members to have a positive impact on the firm's performance as more people have access to wider set of external resources (Pfeffer, 1972; Pfeffer & Salanick, 1978) and competences (Zahra et al., 2000). Golden and Zajac (2001), however, point out that as number of directors increases, it may lead to other detriments, such as free-riding and emergency of factions. Furthermore, larger number of directors is found to be associated with higher conflict risk between the board members (Forbes & Milliken, 1999). All these aspects affect negatively the decision-making, and consequently strategy formation and innovation, in the firm. However, there is only a weak evidence to support that conclusion (Minichilli, Zattoni & Zona, 2009).

Previous studies of the relationship between social capital and innovation have emphasised the role of external actors and the social interactions with these actors to be drivers

for higher level of innovation in a company. Landry, Amara and Lamari (2002) show that increased level of social capital (participation assets and relational assets) increases innovation in a firm more than any other independent variable in their analysis. This finding is associated with the effect where social capital takes a form of research network asset.

The founders of new ventures do not build their consecutive network of ties as they also bring their personal and prior connections with them to their latest establishments (Hite & Hesterley, 2001). These interpersonal ties are vital in company's early stages, but the social capital of the founders becomes more insufficient in providing the added resources for further development and expansion of the business (Arenius, 2002).

Ahuja (2000) presents how benefits of social network in a framework of R&D alliances enhances company's abilities for innovation. He examines social capital by comparing direct and indirect ties and finds social capital to have a positive impact on the number R&D alliances. These alliances generate three advantages: knowledge sharing and complementary competences among partners as well as economies of scale in R&D programs. Another discovery in his study is related to the relationship of direct and indirect ties. He finds that the impact of indirect ties on innovation is mitigated by the number of direct ties.

Several studies find social interactions affecting firm's innovation activity positively, yet it has stayed inconclusive what kind of network structure is optimal for supporting and increasing innovation performance. The academic also debates over the opportunities and threats of different social configurations, especially cohesive and sparse networks, on innovations in a firm. (Ahuja, 2000; Brass, 2003; Burt, 2004; Uzzi & Spiro, 2005; Fleming, Mingo & Chen, 2007).

Most of the studies on board working are focused on the board characteristics and their impact on firm performance. Based on findings cited in previous sections, it is clear that

the board has an essential role not only in terms of firm value and performance but also in terms of innovation and value creation. The board members are important participants in operations as advisors and in their monitoring role. However, the board members level of engagement is found to be significantly correlated with aforementioned attributes. Whether the impact is positive or negative is inconclusive and dependent on the applied theory (Zona, Gomez-Mejia & Withers, 2018).

4.4 Synthesis

Concerning the studies discussed in this chapter, it is clear that previous researches are relatively tightly narrowed. The previous results focus on either VC backed or BO backed and even in terms of buyouts the focus is often solely on LBOs or MBOs. However, this paper is aiming to explain differences between the transaction types by distinguishing the two general concepts, BO and VC, in the empirical part of the research.

Furthermore, the amount of recent studies and even post-financial crisis are limited. One explanation could be that the outcomes of the transactions need to be observed for several years after the transaction which limits the possible time period farther in the history.

Regardless of the limitations and drawbacks, it is possible to make deductions to support the hypotheses introduced as a part of introduction. In terms of corporate governance, changes made at the time of investment makes improvements greater. Hence it could be expected corporate governance actions to have a positive impact on innovation and financial performance of the company.

As a recap from previous empirical results it is evident that the impact of changes investors make in the company is the greatest when commenced right in the beginning of the investment period. Instead of initiating and spurring innovation, especially the VC investors aim to commercialise the developed innovations. Yet at the same time, previous

results argue that increase in social capital would also increase innovation and the role of social capital is emphasised at an early stage of company life cycle.

5 Data and methodology

5.1 Data

5.1.1 Data collection

The data sample comprises of private equity and venture capital deals from year 2010 to 2015. The set including target company names, transaction types and information on acquirer(s) was received from the Finnish Venture Capital Association (FVCA). Deals between years 2010 and 2012 are self-reported to FVCA by its member firms. Next three years, 2013 to 2015, are collected from public media sources.

Sample includes deals where either the target company or the investing fund is Finnish. The total deal count between years 2010 and 2015 is 491. However, since the focus is on Finnish companies, transactions made by a Finnish fund in foreign companies were extracted after which the sample contains 473 transactions. After excluding transactions that were double in the original sample and companies for which none of the financial figures were found the complete sample comprise 401 deals. Since several companies have completed multiple funding rounds, the sample comprises 340 individual firms.

In order to avoid survivorship bias, the sample comprises each company that has received private equity funding within chosen timeframe. That means also companies that have defaulted or otherwise ceased after receiving the investment are included in the sample if the financials are available until default.

Data was collected for each company in the sample for the investment year “year 0” and three subsequent fiscal years; “year 1”, “year 2”, and “year 3”. This time period is chosen as it is frequently used window in prior academic studies concerning private equity investments (see e.g. Amess et al., 2016; Lerner et al., 2011; Tykvová & Borell, 2012). Alemany and Marti (2005) find out that private equity investors’ average holding period is

around three years. Moreover, Cressy, Munari and Malipiero (2007) present that the operating profitability of the buyout target companies increase significantly over the first three years after the investment. These findings support the application of the three-year observation period in this research.

Accounting information and firm attribute data (such as NACE industry codes[3] and unique numerical identification codes) for target companies were retrieved using Valu8 platform which aggregates private company information in European countries. As data set received from FVCA includes only company names, the first batch of data from Valu8 had a notable amount of missing values. This situation occurs if the company has changed name or it has been merged to another company. Problem was solved by checking one by one the unique business identification numbers for each company from other public sources and databases provided by Suomen Asiakastieto, Finder.fi, Duunitori and ytunnus.fi.

Data on patents and patent citations were derived from Orbis database provided by Bureau van Dijk (BvD). Information was matched using BvD identification numbers for each company.

Data collection procedure faced some problems in terms of the quality. The method avoids the selection bias as the data is completely collected from external databases which are not based on questionnaire answers or information disclosed on voluntary bases. Although each company in Finland is mandated to report financial information to the Finnish Patent and Registration Office, that is also the source of Valu8, in total 22 % of the data points were missing when the data was retrieved utilising the application programming interface (API). Most of the missing values were filled manually, utilising scanned original financial statement documents provided on Valu8 or financial statement information on Orbis database. Also, Orbis receives the financial information from

[3] Table 16 in Appendix 1 contains the list of classifications and the distribution of the sample by industry.

the Finnish Patent and Registration Office, so the credibility and comparability of the data remains.

In case where one of a few values is missing from financial information, the values were estimated according to Table 1. In the end, only 20 out of 12832 data points were interpolated. The estimation of number of employees make an exception to methods described in the table. If a company was not in bankrupt (produces sales and total assets are larger than zero), number of employees receive a value of 1 instead of zero when the first value is missing. Estimation was based on assumption that the company must have at least one employee running the operations.

Table 1. Estimation of Missing Data Values

This table presents the procedure for estimation of missing values. The purpose is to generate estimates for missing values in order to increase the growth rates of estimated measures in the final analysis. Estimation was done according to type of the missing value and to the type of the company. Estimation was done only in case it was possible to estimate with high reliability; otherwise the company were excluded from the final sample.

Type of missing value	**Estimation procedure**
First value missing	First value is considered as zero
Missing value is between two existing values	Missing value is linearly interpolated
Missing value is the last value for an active company	Missing value is the last reported value
Missing value is the last value for an inactive company	Missing value is zero

Final challenge to overcome in collecting comparable sample was linked to differing fiscal years between the companies. In other words, all the companies do not report on calendar year basis and therefore fiscal years need to be matched. The problem was solved by matching the fiscal year to the closest calendar year. For example, if a company's fiscal year starts on the 1st of April and ends the 31st of March, it is considered to match the fiscal year starting in January in the same year. In some cases, the duration of a fiscal year is irregular i.e. when a company is established in October the first fiscal year could be extended to last more than 12 months, until the end of next calendar year. Then the values were linearly calibrated to represent a 12-month equivalent.

5.1.2 Variables

The purpose of this research is to study the impact of private equity investors on the target firms' performance and innovation. The variables used in the empirical analysis are chosen to represent as accurately as possible the different factors affecting the objects under the scope. Several other variables were tested, and Table 2 presents those variables that were chosen and are included in the study. The table also provides the abbreviation for each variable that is utilised later in representation of the regression equations and description of each variable and its type of value.

Table 2. Description of variables used in empirical analysis

This table presents the different variables that are used in the empirical analysis of this research. Variables are presented by their type in accordance to their role in the regression analysis. Also, abbreviation and more detailed description of each variable is included. All the financial figures are in Euros.

Variable	Sign	Description
Dependent variables		
Sales	S	Natural logarithm of total sales in a given year
Patent application	PATA	= 1 if applied for patent, 0 else
Explanatory variables		
Board size	BS	Average number of board members in a given year[4]
New linkages	NL	Natural logarithm of number of linkages brought in by new board members in a given year
Chair's linkages	CML	Natural logarithm of total number of linkages the chair of the board has
Other member's linkages	OML	Natural logarithm of total number of linkages the other member(s) than the chair has/have
CEO change	CEOC	= 1 if CEO changed, else 0
Chair change	CMC	= 1 if Chair changed, else 0
CEO's directorship	CEOM	= 1 if CEO is board member, else 0
Employees	E	Natural logarithm of total number of employees
Total assets	TA	Natural logarithm of total book value of assets
Asset turnover	AT	Sales / Total assets

[4] Complete formula presented on the page 44

Intangible assets	IA	Natural logarithm of total book value of intangible assets
Firm age	FAGE	Natural logarithm of firm age in years in a given year
EBITDA-%	EM	EBITDA-margin
High-tech industry	HT	= 1 if high-tech firm, else 0
New patents	NG	Natural logarithm of number of filed patent applications that have later been granted
Patent stock	PS	Natural logarithm of depreciated sum of patent applications
Patents a priori	PREPAT	= 1 if company had patent application prior to the investment

Previous studies utilise three different measures to proxy innovation: patents, intangible assets and research and development expenditure (R&D) (see e.g. Alemany & Martí, 2005; Kortum & Lerner, 2000; Lerner et al., 2011). This research uses the first two mentioned as availability of data on R&D expenditure is limited. Utilising two different allows to measure the fit for the purpose.

Intangible assets (IA) are logarithmic absolute values measured for each year. Patents on the other hand are observed from different angles. There are two continuous variables and two categorical. New patents (NG) is the total number of filed new patent applications[5] during given year that have been eventually granted. The actual date when patent applications are granted, is not available and therefore also the granted patents are applied by the application year since in reality the length of the granting process may differ significantly according to two reasons. The length of the granting process depends on the characteristics of the invention the patent is applied for and on the country where the application is filed in. However, that way the delays in the process are controlled (Ahuja & Katila, 2001; Trajtenberg, 1990; Ughetto, 2010).

In addition to the continuous variables the regression analysis utilises two dummy variables of patents. Patent application (PATA) receives a value of 1 if a firm has filed a new

[5] An application is counted as individual application although it could be related to same innovation or finding as another application. In other words, similar applications are counted separately if applied, for example, in another country.

patent application in a given year and the patent has been granted later. For the second categorical variable is given a value of 1 if a firm had filed a patent application already before receiving funding. Patents a priori (PREPAT) thus provides the possibility to measure the impact of pre-investment patents have during the years after receiving the funding. Patent stock (PS) following Blundell, Griffith and Windmeijer (1995), is calculated as the sum of total past patents and depreciated with 15 % depreciation rate. Also, other previous studies use similar measure for patent activity (Ahuja & Katila, 2001; Ughetto, 2010).

Board size (BS) represents the average number of board members in a given year. It is calculated followingly

$$Board\ Size = \frac{(BS\ beginning\ of\ the\ year) + (BS\ end\ of\ the\ year)}{2}. \qquad (1)$$

The three different variables of linkages are proxies for the social connections of the directors that they have through their external board seats in a given year. The structure of the linkages is presented in figure 3 in sub-chapter 3.2.1. The variable counts all the other board members the person has shared a board with and the CEO of the company. Comparing results of the chair's linkages (CML) and the other board members' linkages (OML) provides information on whose connections are more relevant. Important aspect here is that the data of the linkages includes only connections in Finland as the matching has been based on unique ID number that has not been possible to create for individuals that do not have a Finnish identification number.

As previously explained, the purpose of the research is to also study the impact the new board members and their connections have on the firm performance and innovation. That measure is proxied by 'new linkages' (NL) which represents the total number of contacts the new directors bring with them when joining the board in a given year.

Alongside the continuous variables there are four other categorical variables. Previous studies show that 69% of CEOs are changed within sometime during the investment period (Acharya et al., 2013). However, chairman changes have not been studied before in this field of research. In order to observe the impact, the new leaders might have in the target company this research uses two different variables. CEO change (CEOC) receives value of 1 if the CEO of the firm has changed in a given year. Chair change (CMC) behaves similarly replacing the CEO with the Chair. CEOM proxies for the CEO's directorship an receives value of 1 if the CEO is also a board member.

Asset turnover, sales-to-assets, proxies for firm efficiency. It is calculated by dividing total sales with total assets and represents how well the firm utilises the assets. Other financial figures include sales and total assets. In addition, two different profit measures are included in the models: EBITDA-margin and net profit margin. EBITDA is often used as a proxy for free cash flow and is thus able to represent operational changes completed in the company (Acharya et al. 2013; Achleitner et al. 2011; Guo et al. 2011). Following items are presented are winsorized at 1 % and 99 % level in order to remove the effect of outliers: total assets, intangible assets, sales, and EBITDA-margin. The first three items are transformed to logarithmic scale after winsorizing.

5.1.3 Descriptive statistics

The purpose of descriptive statistics is to provide insight in the data sample. Descriptive statistics are observed from four different perspectives. First part conducts the whole data sample. The second part inspects a subsample comprising firms that are included in the 75^{th} percentile according to total number of linkages the board members have in order to examine the characteristics of companies that have wide social network. Another comparison to the whole sample is made by inspecting subsample of companies that have filed a patent application already before receiving the funding. Finally, a year-by-year analysis highlights the key differences between firms according to the investment type.

Figure 4 shows the distribution of the 401 transactions in the data sample divided by the investment year and investment type. To mark the main points, the increase in number of transactions throughout the years is evident. Especially the number of venture capital transactions has surged, from 36 in 2010 to 114 in 2015 with cumulative average growth rate of 26.0 %. The 49 transactions in total in 2010 account for only 12.2 % of the total sample whereas the 142 transactions in 2015 take a share of 35.4 %. However, the lowest point in the sample appear to be the year 2012.

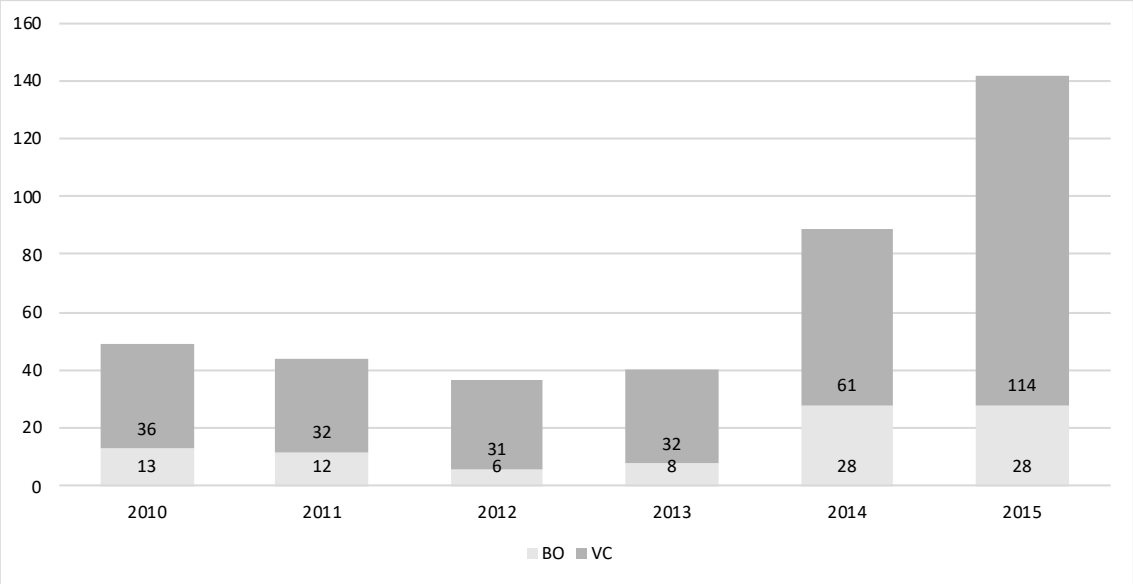

Figure 4: Data sample division by investment year and investment type

Table 3 shows that 24 % of firms included in the sample have received buyout funding and accordingly, 76 % of the firms venture capital funding. The age of the firms ranges from 0 to 75 yet an average firm is almost eight years old and has around 71 employees. The average sales of a firm are around 15 million euros and total assets some 21 million euros. It is evident that most of the firms are in their early years and still growing as the mean EBITDA-margin is negative,

-3.50 %

The average number of board members is 3.65. Although previous studies have concentrated on the CEO changes, the changes of the Chairs are actually more common as during the whole observed time window, CEO is changed on average in 13 % and the chair in 22 % of the deals. A closer look to these changes and comparison to previous studies is made as part of the year-by-year analysis while comparing the different investment types.

When looking at the number of linkages, it is evident that the board members are often well connected. The chairs have on average around 38 linkages through other board seats and other board members 74 in total. Moreover, a new board member increases the social capital of the firm on average by 18 linkages when joining the board.

A prior to completing a deal, a target firm has filed an eventually granted patent application in 28 % of the total cases. The average value of the patent stock is 1.52 and an average firm files 0.23 patent applications over the observed four-year period. Concerning that the firms included in the sample are distributed across 53 different sectors, 48 % operate in high-tech sectors. The share is very high as the share of high-tech exports from total exports in Finland was still only 17.6 % in 2008 (Statistics Finland, 2009). That could mean that there lies a selection bias and that private equity investors seek for companies with high innovation intensity.

Table 3. Whole sample

This table presents descriptive statistics for the whole sample of the variables used in the empirical analysis.

	Mean	SD	Min	Max
Investment type	0.24	0.43	0.00	1.00
Age	7.70	8.54	0.00	75.00
log(age)	1.83	0.80	0.00	4.33
Employees	71.02	250.65	0.00	3420.00
log(employees)	2.67	1.60	0.00	8.14
Sales	14857049	54204074	0.00	420278522
log(Sales)	11.74	5.59	0.00	19.86
Total assets	13745445	41077740	0.00	292478650
log(total assets)	13.84	3.99	0.00	19.49
Intangible assets	2087404	5567947	0.00	34074840
log(intangible assets)	10.64	5.53	0.00	17.34
EBITDA-%	-3.50	13.70	-98.40	1.06
Board size	3.65	1.44	0.00	9.50
CEO change	0.13	0.34	0.00	1.00
Chair change	0.22	0.41	0.00	1.00
CEO directorship	0.42	0.49	0.00	1.00
Chair linkages	37.61	43.18	0.00	275.00
log(chair linkages)	2.65	1.74	0.00	5.62
Other linkages	74.49	70.70	0.00	401.00
log(other linkages)	3.58	1.58	0.00	6.00
New linkages	18.29	37.95	0.00	273.00
log(new linkages)	1.20	1.79	0.00	5.61
Patents a priori	0.28	0.45	0.00	1.00
Patent stock	1.52	4.41	0.00	58.68
log(patent stock)	0.44	0.79	0.00	4.09
New patents	0.23	1.00	0.00	15.00
log(new patents)	0.10	0.35	0.00	2.77
High Tech	0.48	0.50	0.00	1.00
Observations	1604	1604	1604	1604

Table 4 presents descriptive statistics for firms that are well-connected. That means the firms are included in the 75th percentile when distributed according to total number of linkages the board members have. That counts firms whose directors have in total 166 or more linkages.

It appears that well-connected firms generate close to double in sales than an average firm in the whole sample. More than 15 million euros per fiscal year to be exact. Chairs and new board members of well-connected firms have on average more than double the amount of connections in comparison to the whole sample. The difference is even bigger

in terms of other board members as the mean equals around 163.09 in comparison to 74.49 in the whole sample.

The table shows that well-connected firms operate more often in other than high-tech sector as the share of deals completed in high-tech sectors is 11 percentage points lower in comparison to the whole sample. Nevertheless, the share of firms with prior patents does not differ from the whole sample, but the average patent stock is higher, 1.81. However, these firms file less new eventually granted patent applications the mean being only 0.18. That implies that well-connected firms are more mature and possibly beyond the product development phase already.

Table 4. Well-connected firms

This table presents descriptive statistics for subsample of well-connected firms. The firms included in this sample are in the 75th percentile when measured by the total number of linkages the board members have.

	Mean	SD	Min	Max
Sales	29712980	75682880	0.00	420278522
Board size	4.51	1.18	0.00	9.50
CEO change	0.15	0.36	0.00	1.00
Chair change	0.30	0.46	0.00	1.00
CEO directorship	0.34	0.48	0.00	1.00
Chair linkages	77.93	51.94	0.00	275.00
Other linkages	163.09	68.70	7.00	401.00
New linkages	33.87	55.83	0.00	273.00
Patents a priori	0.29	0.46	0.00	1.00
Patent stock	1.81	4.81	0.00	47.65
New patents	0.18	0.79	0.00	8.00
High-tech	0.37	0.48	0.00	1.00
Observations	402	402	402	402

Table 5 presents descriptive statistics of deals with target companies that have history of innovation prior to receiving private equity funding. The average sales of these firms are around 8 million more than for an average firm in the whole sample. There are two possible explanation: 1) the firms are more mature and farther in growth stages than an average firm in the sample, or 2) innovation increases firm performance in terms of sales. Size of the board is somewhat similar with an average of four directors in comparison to 3.65 in the whole sample. Furthermore, the CEO and the chair are replaced with similar

frequency, as 15 % of the CEOs are replaced and 23 % of the chairs. However, the CEOs hold less frequently a dual position as the CEO and a board member. Only 36 % of the CEOs hold a directorship as the same figure is 43 % with the whole sample.

In terms of social capital, innovative firms are more connected than a target firm on average. Their chairs have on average four more linkages and other board members 10 more linkages in total in comparison to the whole sample. However, new board members do not bring significantly more linkages as the difference to the whole sample is only one person. That could imply that higher level of social capital is correlated with higher innovation intensity.

Somewhat surprising is that the share of the high-tech firms is only two percentage points higher than in the whole sample equalling 50 % of the subsample. That could imply that high tech firms are not remarkably more innovative than firms operating in other sectors. Another possible explanation could be that since innovation is measured only in terms of patents, firms operating in high tech sectors do not prefer patenting as valuable protection for intellectual property.

Table 5. Pre-investment innovation

This table presents descriptive statistics for subsample of firms with prior innovative activities. The firms included in the sample have filed a patent application already before receiving PE funding.

	Mean	SD	Min	Max
Sales	22726736	78362044	0.00	420278522
Board size	4.00	1.25	1.00	7.00
CEO change	0.15	0.36	0.00	1.00
Chair change	0.23	0.42	0.00	1.00
CEO directorship	0.36	0.48	0.00	1.00
Chair linkages	41.01	44.58	0.00	210.00
Other linkages	85.53	67.91	0.00	341.00
New linkages	19.40	37.06	0.00	222.00
Patent stock	5.27	7.06	0.03	58.68
New patents	0.74	1.75	0.00	15.00
High-tech	0.50	0.50	0.00	1.00
Observations	448	448	448	448

Tables 17 to 24 in appendices 2 and 3 show a more detailed description of buyout and venture capital target companies and comparison between these two investment types'

scopes. The variables presented in these tables are limited to proxies for corporate governance, social capital and innovation.

On the corporate governance side, the post-transaction changes are stronger in terms of buyouts. 20 % of the BO targets' CEOs are replaced during the investment year, the rate decreases to 11 % in year 1 but increases again to 14 % and 16 % during years 2 and 3, respectively. In venture capital investments changes are milder as the highest value, 15 % occur in year 0 and has the low point in year 3 at 9 %. As previously mentioned, chair changes are less studied than CEO replacements. The average rate is significantly higher in BO transactions in comparison to the whole sample as 48 % of the firm's that have received funding from a buyout fund replace the chair during the year of investment. The rate decreases, though, to 18 % and 19 % in year 2 and 3, respectively. In venture capital investments the rate is lower, ranging from 26 % in year 0 to 16 % in year 3. Although the replacement rate is relatively lower than what Acharya et al. (2013) report, it is evident that the CEOs are replaced most often at the time of investment or relatively quickly after.

The differences between the BO and VC target firms concerning the corporate governance practices executed post-acquisition, is most likely linked to the differences in BO and VC funds' investment strategies. As previously mentioned, VC investors make most often minority investments whereas BO investors tend to acquire majority shares and hence take in overall a more controlling role in the company. Another evidence is that after receiving a BO investment the CEO is more rarely a board member, in year 3 only 26 % whereas in VC backed the same figure is 40 %.

In terms of social capital, the descriptive statistics show that the boards of BO target firms are better connected than those of VC targets. The average number of board links the chair of the board has in year 0 is 25.57 in VC backed firms and 53.27 in buyouts. The number of connections other board members have, is also higher in those firms that have received funding from a buyout fund, on average 99.53 in year 0. The same figure

is 58.77 for VC backed firms. An interesting finding is that the number of linkages other board members than the chair have, increases over the years in those firms that have received VC funding, but the change is opposite in those that have received funding from buyout funds. Same pattern is also evident in terms of added social capital, in other words the linkages brought in by the new board members. That means that social capital actually decreases in those firms that have received buyout funding.

Another interesting finding is that the number of new contacts brought in the board is *remarkably* higher in the investment year than during the consecutive years. As a part of BO transactions, the number of new linkages brought as part of changes in the board structure is on average 75.11 and 29.64 in VC transactions in year 0. The figures for rest of the years are 20.78, 13.82, 10.51 and 10.98, 10.33, and 7.59, respectively. As Guo et al. (2011) reports that improvements are greater if the CEO is replaced at the time of the investment. Hence, an intriguing perspective for further research would be to examine whether the same theory applies also for changes in board structure.

A general assumption is that venture capitalists invest in more innovative companies in the beginning but also, focus more on developing the firm innovation-wise than the GPs of buyout funds. Nevertheless, the descriptive statistics imply that there is not significant difference in post-investment innovation intensity between BO and VC target firms. Number of new patents remains above zero, but the patent stock decreases over the years after the investment. The peak is in year 1 with VC targets, summing 1.47 and in year 0 at 2.16 with BO targets. However, comparison of new patents show that VC targets are still more innovative for two years after receiving the funding as on average they file 0.33 applications during year 0 and 1 whereas BO targets respective figures are 0.39 and 0.23. Evidently innovation slows down in both target types as VC targets file an average 0.08 applications in year 3 and BO targets 0.18. That could imply that the companies are more likely already innovative at the time of acquisition and investors aim is then rather more on other activities, such as commercialisation of the existing innovations than on spurring new innovations.

5.2 Methodology

Figure 5 presents the structure of the empirical part of this study. It shows that methodology is divided in two parts on the higher level in this research: to innovation and firm performance. Innovation is further divided into two different sections that both utilise different statistical method. The first studies the odds for a target to file an eventually granted new patent application and the factors that affect the propensity. The method utilised for that is a logistic regression. The second part studies the innovation intensity with ordinary least squares (OLS) panel regression.

After studying the innovation activities of the target firms, the scope is on the firm performance. Here the aim is to explain the impact of the different measures on the target company's performance in terms of sales by employing an OLS method. All the models are employed for dependent variable measuring immediate effect and also, the impact of changes to one year after. However, it should be taken account that the number of observations is then one fourth smaller for the last-mentioned model.

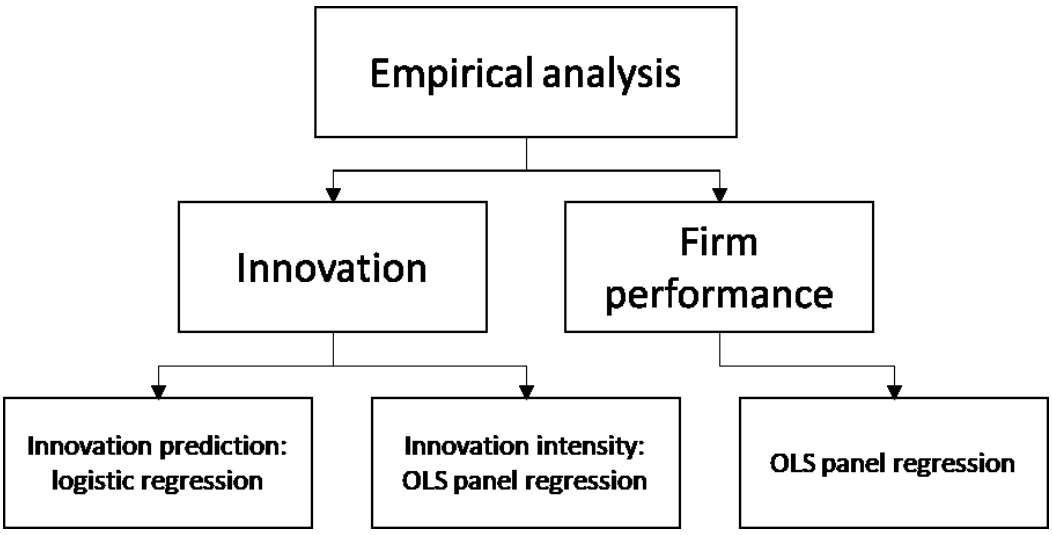

Figure 5. Structure of the empirical analysis

5.2.1 Innovation

5.2.1.1 Logistic regression model

The purpose of logistic regression model is to examine the changes in social capital and corporate governance have on the innovation propensity after receiving private equity funding. This kind of method has not been tested in previous literature and thus provides new information of factors that affect the firm's intentions for innovation. In practice, this is conducted by estimating the propensity for a firm to file a patent application in a given year. The simplified version of the regression equation is the following

$$Patent\ application\ \{1,0\} = f(\beta_0 + \beta_1 CMC_{it} + \beta_2 CEOC_{it} + \beta_3 CEOM_{it} + \beta_4 CML_{it} + \beta_5 OML_{it} + \beta_6 NL_{it} + \beta_7 BS_{it} + \beta_8 PrePat_{it} + \beta_9 PS_{it} + Control\ Variables_{it}). \quad (2)$$

The dependent variable is a binary variable that has value of 1 if a firm *i* as filed a patent application in a given year. Since often applied changes do not affect immediately, the same model is run with the same dependent variable led by one year. The independent variables are focused on variables expected to explain changes in social capital and corporate governance of the firm. CMC refers to change of the chair of the board and CEOC similarly to change of the CEO. CEOM represents CEO's directorship.

The continuous variables are linked to social connections the directors have and board structure. CML and OML refer to linkages the existing board members have in their personal networks. NL refers to connections new board members bring to the network when joining the board in a given year. BS stands for board size.

In order to study the impact of prior investment activities on the future innovation, the model employs also two variables proxying those actions. PrePat refers to the innovation activities prior to investment as it has value of 1 if the firm has filed, a later granted,

patent application by the year 0. Patent stock (PS) on the other hand measures the total value of the patent applications the firm holds.

Since high-tech sectors have been suggested to show dissimilarity in patenting activity in comparison to other sectors, a dummy variable controlling for those differences is applied in the model. Other control variables comprise firm-specific variables: total assets, firm age, number of employees, asset turnover, and EBITDA-margin and investment type (BO/VC).

5.2.1.2 Ordinary least squares model

The aim of the OLS model is to measure innovation intensity. The model follows the previous literature on corporate governance and innovation (e.g. Balsmeier, Fleming & Manso, 2017; Kortum & Lerner, 2000). However, alongside corporate governance the model in this research employs also social capital measures. Equations 3 and 4 show the exact models:

$$\log(1 + NG_{i,t}) = \alpha + \beta_0 + \beta_1 CMC_{it} + \beta_2 CEOC_{it} + \beta_3 CEOM_{it} + \beta_4 CML_{it} + \beta_5 OML_{it} + \beta_6 NL_{it} + \beta_7 BS_{it} + \beta_8 PrePat_{it} + \beta_9 PS_{it} + Control\ Variables_{it}\ . \quad (3)$$

$$\log(1 + NG_{i,t+1}) = \alpha + \beta_0 + \beta_1 CMC_{it} + \beta_2 CEOC_{it} + \beta_3 CEOM_{it} + \beta_4 CML_{it} + \beta_5 OML_{it} + \beta_6 NL_{it} + \beta_7 BS_{it} + \beta_8 PrePat_{it} + \beta_9 PS_{it} + Control\ Variables_{it}. \quad (4)$$

The dependent variable is number of new eventually granted patent application filed during year t or t + 1. In order to control for time varying differences and differences in innovation intensity across different industries, the variations of the model utilise time and industry fixed-effects. Models has the same control variables as the logistic regression with exception to variable controlling for high-tech sector as the model utilises industry fixed-effect.

The model was tested also for a subsample consisting companies with total number of >10 or >50 patent applications prior to receiving investment in order to examine whether there corporate governance and social capital impacts innovation intensity differently in highly innovative firms, but the sample remained so small that it did not provide a sufficient amount of significant and unbiased results. However, that would be interesting set up for further research with larger sample size.

5.2.2 Firm performance

Companies' goal is to maximise the value of their innovations and thus, commercialisation is an important part of the process after the research and development phase. Third part of the empirical analysis focuses on the angle, how the corporate governance actions employed by the private equity investor and changes in the social network and corporate governance affect the commercialisation of their innovations. For this purpose, are employed the following OLS equations

$$\log(1 + Sales)_{i,t} = \alpha + \beta_1 BS_{it} + \beta_2 CEOC_{it} + \beta_3 CMC_{it} + \beta_4 CEOM_{it} + \beta_4 CML_{it} + \beta_6 OML_{it} + \beta_7 NL_{it} + \beta_8 NG_{it} + \beta_{10} PS_{it} + \beta_{10} PrePat_{it} + Control\ variables, \quad (5)$$

$$\log(1 + Sales)_{i,t+1} = \alpha + \beta_1 BS_{it} + \beta_2 CEOC_{it} + \beta_3 CMC_{it} + \beta_4 CEOM_{it} + \beta_4 CML_{it} + \beta_6 OML_{it} + \beta_7 NL_{it} + \beta_8 NG_{it} + \beta_{10} PS_{it} + \beta_{10} PrePat_{it} + Control\ variables. \quad (6)$$

Dependent variable in the model is natural logarithm of sales for a firm *i*. α is constant and each β_j represents the estimated coefficient. The independent variables proxy changes in corporate governance, social capital and innovation. The control variables include firm-specific variables are same as in previous OLS model with one addition. Since intangible assets include for example goodwill, it is then possible to measure the impact of inorganic growth. However, due to multicollinearity between intangible assets and total assets, the variables could not be included in same models. The other control variables include number of employees, asset turnover, intangible assets, EBITDA-margin, and investment type.

The model is tested with random-effects and industry fixed-effects in order to measure the impact of differences between industries. Time fixed-effect was tested as well, but it did not show statistical significance or increase the overall performance of the model measured as R^2 and adjusted R^2.

6 Empirical results

The empirical analysis of the study comprises four parts. As presented in methodology, the empirical analysis for innovation is divided in two. First are presented results for innovation propensity and then for innovation intensity. After that is discussed the results of regression analysis focusing on effects that corporate governance, social capital and innovation have on firm performance. Finally, the results are tested for robustness utilising cross-sectional OLS regression for year-by-year analysis of innovation intensity and firm performance.

6.1 Innovation

6.1.1 Innovation propensity

The logistic regression method is used to measure the factors affecting propensity for a company to file an eventually granted patent application. Table 6 presents results for dependent variable at time t and table 7 at time t + 1. The results show that the key corporate governance actions, change of the CEO or the chair, do not affect the firm's propensity to file an eventually granted patent application. CEO change is positive and statistically significant at 10 % level only in model 2 when the dependent variable is led by one year and it is not controlled for the exposure to high-tech sectors. Furthermore, the board size does not have statistically significant impact on the innovation propensity. The descriptive statistics show that the rate for different corporate governance changes is relatively low. That is the plausible reason for the lack of significant results.

Social capital, on the other hand, provides strong positive on innovation propensity. An increase of linkages in the network of other board members than the chair increases the propensity for a firm to file an eventually granted patent application. The effect is evident in the same year and increases the propensity also for the following year. The linkages of new board members provide similar findings. However, the effect of the added social capital in terms of new board members strengthens for the year after as the coefficients

are even higher coefficients ranging from 1.261 to 1.427. The results could indicate that as social capital increases the propensity, the effect would be similar to innovation intensity. In that case, the result would support previous finding of Landy et al. (2002) that find increased social capital to affect the firm innovation positively.

Observing the control variables, it appears that total assets, firm age and investment type all have a positive impact on the propensity to file an eventually granted patent application. In other words, the stronger the financial performance and the more mature the company is, the more likely the innovation is sustained also after receiving PE funding. Changes in firm's efficiency (asset turnover) have mostly immediate effect on innovation and not delayed.

Previously presented descriptive statistics show that most of the firms in the sample that operate in high-tech sector have received VC funding instead of BO funding. Moreover, according to the descriptive statistics there is not in the end a significant difference in the number of eventually granted patent applications. Therefore, it is surprising here that firms that have received buyout funding are more likely to sustain innovation than those that have received VC funding. Moreover, exposure to the high-tech sector, nonetheless, shows a strong positive impact on the innovation propensity. This finding, however, is anticipated.

The key finding is that firms that have history of being innovative, have higher propensity for filing an eventually granted patent application again as well. It is evident also from pseudo R^2 statistics as prior innovation activities have strong impact on the firm's propensity to file an eventually granted patent application since models 2-6 have significantly higher pseudo R^2 value than model 1. In general, these models (excl. model 1) also seem to fit for prediction of innovation propensity as the values settle between 0.2 to 0.4 (McFadden, 1974). The values range from 0.364 to 0.372 when measuring immediate impact and from 0.255 to 0.322 with the led dependent variable.

Table 6. Innovation propensity

Table presents results of logistic panel regression where dependent variable is a binary variable 'Patent application' at time *t*. Coefficients are exponentiated. In parentheses are displayed the t-statistics. Model uses Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
Total assets	**1.146*** **	**1.096*** **	**1.137*** **	**1.133*** **	**1.100*** **	**1.102*** **
	(3.874)	(2.965)	(3.594)	(3.771)	(2.811)	(2.861)
Asset turnover	**0.552*** **	**0.784** **	**0.759** **	**0.760** **	**0.770** **	**0.779** **
	(-4.371)	(-2.246)	(-2.369)	(-2.437)	(-2.218)	(-2.127)
EBITDA-%	0.997	1.003	1.000	1.000	1.004	1.004
	(-0.755)	(0.594)	(0.047)	(-0.090)	(0.720)	(0.700)
Employees	**1.158** **	1.083	1.126	**1.160** **	1.042	1.048
	(2.309)	(0.941)	(1.555)	(2.043)	(0.451)	(0.526)
Age	1.048	**0.595*** **	**0.665*** **	**0.671*** **	**0.601*** **	**0.593*** **
	(0.466)	(-3.499)	(-3.510)	(-3.518)	(-3.258)	(-3.440)
Board size	1.079	1.086	1.079	1.093	1.084	1.079
	(1.390)	(1.129)	(1.106)	(1.301)	(1.102)	(1.031)
CEO change	1.200	1.111	1.146	1.136	1.115	1.109
	(0.931)	(0.371)	(0.571)	(0.545)	(0.378)	(0.361)
Chair change	0.943	0.741	0.917	0.940	0.726	0.737
	(-0.311)	(-1.238)	(-0.401)	(-0.285)	(-1.319)	(-1.264)
CEO directorship	0.840	1.251	1.110	1.066	1.289	1.303
	(-1.218)	(1.292)	(0.652)	(0.397)	(1.453)	(1.515)
Chair linkages	0.969	1.016	1.014	0.992	1.035	1.037
	(-0.678)	(0.281)	(0.273)	(-0.153)	(0.614)	(0.635)
Other linkages	0.983	**0.821*** **	**0.876** **	**0.853** **	**0.844** **	**0.842** **
	(-0.309)	(-2.806)	(-2.046)	(-2.461)	(-2.452)	(-2.467)
New linkages	**1.087** *	**1.141** **	1.048	1.060	**1.136** **	**1.127** **
	(1.831)	(2.201)	(0.898)	(1.112)	(2.116)	(1.993)
Investment type	**0.306*** **	**0.328*** **	**0.555** **	**0.396*** **	**0.441** **	**0.455** **
	(-5.173)	(-3.871)	(-2.185)	(-3.702)	(-2.574)	(-2.482)
Patents a priori		1.350	**15.170*** **	**14.368*** **		1.461
		(0.838)	(15.174)	(15.346)		(1.039)
Patent stock		**5.844*** **			**6.876*** **	**5.766*** **
		(7.749)			(14.833)	(7.588)
High-tech			**1.985*** **		**1.873*** **	**1.906*** **
			(3.904)		(3.347)	(3.391)
Observations	1604	1604	1604	1604	1604	1604
Pseudo R^2	0.075	0.364	0.284	0.273	0.371	0.372
chi2	70.358	338.351	332.557	340.446	297.450	324.739
p	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 7. Innovation propensity t + 1

Table presents results of logistic panel regression where dependent variable is a binary variable 'Patent application' at time *t + 1*. Coefficients are exponentiated. In parentheses are displayed the t-statistics. Model uses Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
Total assets	**1.137****	**1.095*****	**1.133*****	**1.127*****	**1.099****	**1.102*****
	(2.470)	(2.580)	(2.582)	(2.641)	(2.523)	(2.577)
Asset turnover	**0.630*****	0.859	0.857	**0.838***	0.852	0.870
	(-3.399)	(-1.636)	(-1.544)	(-1.789)	(-1.559)	(-1.408)
EBITDA-%	**0.992***	0.994	0.992	0.992	0.994	0.994
	(-1.705)	(-1.247)	(-1.603)	(-1.571)	(-1.282)	(-1.296)
Employees	**1.161****	1.066	1.118	**1.156***	1.011	1.029
	(2.083)	(0.724)	(1.319)	(1.805)	(0.109)	(0.307)
Age	1.080	**0.719****	**0.738****	**0.740****	**0.749***	**0.722****
	(0.682)	(-2.299)	(-2.479)	(-2.478)	(-1.889)	(-2.232)
Board size	1.089	1.086	1.070	1.090	1.081	1.072
	(1.272)	(0.979)	(0.833)	(1.076)	(0.928)	(0.824)
CEO change	0.862	**0.625***	0.750	0.736	0.625	0.630
	(-0.660)	(-1.651)	(-1.107)	(-1.181)	(-1.616)	(-1.611)
Chair change	0.886	0.732	0.841	0.872	0.686	0.710
	(-0.553)	(-1.173)	(-0.687)	(-0.534)	(-1.426)	(-1.308)
CEO directorship	0.765	1.046	0.969	0.938	1.055	1.075
	(-1.612)	(0.230)	(-0.169)	(-0.345)	(0.276)	(0.371)
Chair linkages	0.976	0.985	1.002	0.984	1.000	1.001
	(-0.447)	(-0.239)	(0.030)	(-0.262)	(0.002)	(0.024)
Other linkages	0.922	**0.794*****	**0.843****	**0.819*****	**0.817****	**0.815****
	(-1.211)	(-2.781)	(-2.218)	(-2.616)	(-2.474)	(-2.493)
New linkages	**1.261*****	**1.407*****	**1.278*****	**1.282*****	**1.427*****	**1.402*****
	(4.294)	(5.298)	(4.039)	(4.075)	(5.452)	(5.248)
Investment type	**0.278*****	**0.329*****	**0.523***	**0.367*****	**0.432****	**0.460****
	(-4.427)	(-3.353)	(-1.933)	(-3.264)	(-2.266)	(-2.102)
Patents a priori		**1.870***	**12.631*****	**11.982*****		**2.034***
		(1.672)	(12.299)	(12.531)		(1.877)
Patent stock		**3.748*****			**5.009*****	**3.652*****
		(6.105)			(12.360)	(6.060)
High-tech			**2.123*****		**1.956*****	**2.019*****
			(3.640)		(3.120)	(3.222)
Observations	1203	1203	1203	1203	1203	1203
Pseudo R^2	0.082	0.311	0.268	0.255	0.317	0.322
chi2	65.564	237.925	227.128	236.224	210.656	231.126
p	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

6.1.2 Innovation intensity

The OLS method measures the impact of corporate governance actions, changes in social capital and innovation activities prior to receiving PE funding, on the firm's innovation intensity. Table 8 contains results for the models where the applied dependent variable is natural logarithm of the number of filed new patent applications at time t. Table 9 presents results for the same models with the exception on the dependent variable that is led by one year in comparison to the independent and control variables.

The results in previous chapter show that chair's linkages have no effect on innovation propensity. However, the differing in terms of innovation intensity; positive and statistically significant. According to the descriptive statistics, the average number of chair linkages is around 38. Hence, an increase of one chair linkage increases the number of patent applications on average by 0.03 % [6] to 0.04 % the same year. The impact is slightly lower to following year's intensity, 0.02-0.03%.

The linkages of other board members, on the other hand, have a negative impact on the innovation intensity. A one link increase in other linkages decreases the innovation intensity at the time by 0.02-0.03 % and the following year 0.01-0.02 %. New linkages, however, present the strongest impact which is also positive. An additional linkage in the social network of a new board member increases innovation intensity on average by 0.08-0.12% the year after joining the board. This finding is understandable as rarely a person joining the board is able to affect the business or operations immediately, especially if joining late in the fiscal year. Overall it seems that social capital indeed has a positive effect on firm's innovation intensity and the finding is in accordance with previous results of Landry et al. (2002).

The dummy variable of prior investment activities imposes negative effect on innovation intensity although it affects the propensity in positive manner. Patent stock, on the other

[6] formula: $\frac{1}{\frac{average\ value}{100}} * coefficient$

hand, shows a positive result. Despite the negative coefficient for the dummy variable of prior patent activities, the results support the ideology of the innovative firm's sustaining innovation; an increase in patent stock by one application the increases the number of patent applications by around 15 % the year after. The interpretation of the results is that PE investors sustain innovation in firms that have been innovative prior to acquisition but they do not necessarily emerge totally new innovations.

The control variables do not show much significant impact on the innovation intensity although total assets and the investment type have a positive and significant effect on the propensity to file an eventually granted patent application. Total assets show to have a positive impact on the innovation propensity, but the effect is insignificant in terms of innovation intensity. That could imply that financial stability creates support to file the patent application but, in the end, it does not seem to affect the firm's decision. Lastly, the finding concerning investment type is inconsistent with general assumptions of VC backed firms to be more innovative than BO backed. However, the result is expected based on the findings in descriptive statistics.

Despite several control variables showing statistically insignificant role the models appear to be moderate fit as the values are above 0.25 for each model alternative, yet the immediate effect is better explained by these models than "the future". However, it is comprehensible as the sample size is one fourth smaller for the latter.

Table 8. Innovation intensity

Table presents results of OLS panel regression where dependent variable is a natural logarithm of number of filed new patent applications at the time t. Industry fixed-effect controls for differences between different sectors and time fixed-effect for variation between years after the investment. In parentheses are displayed the t-statistics. Model uses Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)
Total assets	0.002	0.001	0.001	0.000
	(1.077)	(0.764)	(0.536)	(0.200)
Asset turnover	**0.000****	**0.000***	**0.000****	**0.000***
	(2.074)	(1.686)	(2.149)	(1.777)
EBITDA-%	-0.001	-0.000	-0.000	-0.000
	(-0.736)	(-0.641)	(-0.474)	(-0.397)
Employees	0.005	**0.010***	0.007	**0.011****
	(1.130)	(1.899)	(1.361)	(2.240)
Age	**-0.050*****	**-0.060*****	**-0.041*****	**-0.048*****
	(-4.842)	(-5.172)	(-4.047)	(-4.143)
Board size	0.004	-0.002	0.004	-0.002
	(0.797)	(-0.367)	(0.829)	(-0.374)
CEO change	0.012	0.011	0.017	0.016
	(0.507)	(0.466)	(0.692)	(0.660)
Chair change	0.009	0.011	0.008	0.010
	(0.451)	(0.542)	(0.407)	(0.516)
CEO directorship	0.014	0.014	0.010	0.011
	(1.018)	(0.979)	(0.744)	(0.750)
Chair linkages	**0.011****	**0.015*****	**0.012****	**0.016*****
	(2.171)	(2.664)	(2.475)	(2.949)
Other linkages	**-0.019*****	**-0.016*****	**-0.018*****	**-0.015*****
	(-3.873)	(-2.866)	(-3.690)	(-2.685)
New linkages	-0.000	-0.004	-0.006	-0.010*
	(-0.095)	(-0.752)	(-1.175)	(-1.860)
Patents a priori	**-0.251*****	**-0.284*****	**-0.251*****	**-0.285*****
	(-6.065)	(-6.703)	(-6.116)	(-6.785)
Patent stock	**0.392*****	**0.425*****	**0.390*****	**0.423*****
	(10.865)	(11.904)	(10.921)	(12.025)
Investment type	0.013	0.020	0.010	0.015
	(0.739)	(0.743)	(0.557)	(0.561)
Constant	0.068***	0.127***	0.100***	0.156***
	(3.066)	(4.038)	(3.740)	(3.699)
Industry fixed-effect	No	Yes	No	Yes
Time fixed-effect	No	No	Yes	Yes
Observations	1604	1604	1604	1604
R^2	0.409	0.455	0.417	0.463
Adjusted R^2	0.403	0.432	0.410	0.439

* p<0.1, ** p<0.05, *** p<0.01

Table 9. Innovation intensity t + 1

Table presents results of OLS panel regression where dependent variable is a natural logarithm of number of filed new patent applications at the time t+1. Industry fixed-effect controls for differences between different sectors and time fixed-effect for variation between years after the investment. In parentheses are displayed the t-statistics. Model uses Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)
Total assets	0.001	0.001	0.001	0.001
	(0.567)	(0.725)	(0.442)	(0.568)
Asset turnover	**0.000***	**0.000***	**0.000***	**0.000***
	(1.693)	(1.745)	(1.819)	(1.813)
EBITDA-%	-0.001	-0.001	-0.001	-0.001
	(-1.266)	(-1.080)	(-1.197)	(-1.029)
Employees	**0.011***	**0.014****	**0.011***	**0.014****
	(1.773)	(2.109)	(1.820)	(2.183)
Age	**-0.032*****	**-0.045*****	**-0.027****	**-0.040*****
	(-2.627)	(-3.169)	(-2.301)	(-2.801)
Board size	0.004	-0.001	0.004	-0.002
	(0.559)	(-0.196)	(0.558)	(-0.208)
CEO change	-0.008	-0.014	-0.005	-0.011
	(-0.311)	(-0.504)	(-0.173)	(-0.387)
Chair change	-0.023	-0.021	-0.022	-0.019
	(-1.013)	(-0.897)	(-0.962)	(-0.835)
CEO directorship	-0.003	-0.004	-0.005	-0.006
	(-0.220)	(-0.252)	(-0.338)	(-0.335)
Chair linkages	**0.009***	**0.011***	**0.011****	**0.012****
	(1.775)	(1.829)	(2.011)	(2.027)
Other linkages	**-0.016*****	**-0.013****	**-0.014****	**-0.011***
	(-2.780)	(-2.114)	(-2.489)	(-1.832)
New linkages	**0.022*****	**0.021*****	**0.015****	**0.015****
	(3.500)	(3.459)	(2.415)	(2.348)
Patents a priori	**-0.108****	**-0.090***	**-0.108****	**-0.091***
	(-2.212)	(-1.743)	(-2.225)	(-1.764)
Patent stock	**0.231*****	**0.228*****	**0.230*****	**0.227*****
	(6.106)	(5.739)	(6.112)	(5.769)
Investment type	-0.014	0.001	-0.014	0.000
	(-0.653)	(0.043)	(-0.653)	(0.008)
Constant	0.026	0.089**	0.055**	0.109**
	(1.141)	(2.403)	(2.119)	(2.464)
Industry fixed-effect	No	Yes	No	Yes
Time fixed-effect	No	No	Yes	Yes
Observations	1203	1203	1203	1203
R^2	0.227	0.281	0.232	0.285
Adjusted R^2	0.217	0.238	0.221	0.242

* p<0.1, ** p<0.05, *** p<0.01

6.2 Firm performance

The aim of the OLS method measuring firm performance is to explore how corporate governance actions, changes in social capital and innovation affect the firm's sales. Tables 10 and 11 presents results for the focal regression analyses.

For corporate governance activities, only board size shows statistically significant results. When the model is controlled for total assets, it appears that when the size of the board increases by one additional director, the firm's sales decrease by 0.19 %. However, the effect does not seem to last for the following year. Nonetheless, there is no logical explanation why the effect is evident only when the model controls for total assets and not when the intangible assets are included instead. Formation of conclusive response whether the results support prior findings, hence, requires further research.

Social capital, on the other hand, shows statistically significant and more consistent results for firm performance. First of all, chair linkages are positively associated with firm performance, despite the applied model. An additional chair link increases the sales by 0.3-0.6 % during the same fiscal year. This addition increases sales further by 0.4-0.6 % the following year.

The linkages of other board members do not have as long-lasting effect on firm performance. A one additional linkage boosts sales by 0.3-0.4 % the same year. The year after does not seem to be affected by this increase as only one out of the four models show statistically significant coefficient and even that is weak, at 10 % significance level.

New linkages, on the other hand, show a contrarian behaviour. The same-year effects do not show statistical significance when the model is controlled for industry specific differences, but the results are the opposite for the following year. An additional linkage in the network of the newly joined board member increases the firm performance by 0.9 %. The findings are in line with Pfeffer (1972) and Pfeffer and Salanick (1978) as the results

show that increase in external resources through board linkages improves firm performance. Hence, it can be concluded that increased social capital improves firm performance and the null hypothesis “increase in social capital decrease financial performance of the target company” is rejected.

An interesting finding is that innovation’s effect on firm is mostly insignificant. Only patent stock shows to have a negative impact, and that in the models that use random-effects estimator. It means that in innovation intensive sectors the effect applies, but when those differences are controlled, innovation does not affect the firm performance in whole. The deduction is that firms operating in innovation intensive sectors do not succeed better than firms operating in other fields of business. One possibility is also that actually, PE investors have not been able commercialise the inventions as well as could be expected.

Investment type also shows a positive and significant impact on firm performance. A firm that has received buyout funding, generates overall 1.3-1.4 % more sales than a firm that has received VC funding. However, when the model controls for industry differences, the impact drops to 0.6%. That implies that the BO and VC funds investment strategies differ also in terms of industries. Nonetheless, the finding is also an outcome of difference in investment strategy concerning maturity as often companies that are already at later stage, generate more sales than younger firms.

The control variables show to have significant impact on firm performance as well. When the significant and positive impact of intangible assets on firm performance and the insignificant role of innovation are combined, it can be concluded that PE investors focus on other growth activities than spurring innovation of inventions. Since corporate governance activities show mostly insignificant impact as well, PE investors aim seems to be in financial engineering and efficiency improvements rather than developing the business through governance and operational engineering. The finding support results of

Cressy et al. (2007) that argue the reason for PE targets post-buyout profitability is an outcome of PE investors' skilled financial engineering.

Table 10. Firm performance

Table presents results of OLS panel regression where dependent variable is the natural logarithm of sales at the time *t*. Industry fixed-effect controls for differences between different sectors. In parentheses are displayed the t-statistics. Model uses Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)
Intangible assets	**0.139*** **		**0.154*** **	
	(5.047)		(5.666)	
Total assets		**0.606*** **		**0.626*** **
		(25.074)		(25.511)
Asset turnover	0.064	**0.069***	0.047	**0.053***
	(1.411)	(1.715)	(1.440)	(1.811)
EBITDA-%	**0.010** **	**0.019*** **	0.002	**0.011** **
	(2.557)	(5.026)	(0.384)	(2.059)
Age	**1.741*** **	**1.179*** **	**1.704*** **	**1.080*** **
	(17.873)	(14.619)	(17.134)	(13.334)
Employees	**0.626*** **	**0.766*** **	**0.595*** **	**0.762*** **
	(4.267)	(6.292)	(3.711)	(5.825)
Board size	-0.096	**-0.189** **	-0.097	**-0.186** **
	(-1.016)	(-2.223)	(-1.052)	(-2.290)
CEO change	0.243	0.126	0.233	0.135
	(0.866)	(0.475)	(0.825)	(0.508)
Chair change	0.281	0.158	0.185	0.069
	(1.034)	(0.624)	(0.700)	(0.284)
CEO directorship	0.175	0.183	-0.047	-0.083
	(0.834)	(0.969)	(-0.222)	(-0.440)
Chair linkages	**0.187*** **	**0.116***	**0.215*** **	**0.151** **
	(2.722)	(1.824)	(3.065)	(2.353)
Other linkages	**0.289*** **	**0.189** **	**0.321*** **	**0.186** **
	(3.081)	(2.253)	(3.481)	(2.285)
New linkages	**-0.112***	**-0.109***	-0.076	-0.065
	(-1.750)	(-1.846)	(-1.205)	(-1.144)
New patents	0.257	0.125	-0.090	-0.209
	(0.712)	(0.351)	(-0.236)	(-0.554)
Patent stock	**-0.450***	**-0.520** **	0.229	0.142
	(-1.753)	(-2.087)	(0.768)	(0.488)
Patents a priori	-0.132	-0.007	-0.558	-0.324
	(-0.330)	(-0.019)	(-1.165)	(-0.707)
Investment type	**1.373*** **	**0.641*** **	**1.296*** **	**0.611** **
	(4.931)	(3.293)	(3.861)	(2.240)
Constant	3.106***	-1.430***	7.223***	2.384***
	(6.885)	(-4.509)	(12.767)	(4.863)
Industry fixed-effect	No	No	Yes	Yes
Observations	1604	1604	1604	1604
R^2	0.499	0.593	0.567	0.658
Adjusted R^2	0.494	0.589	0.548	0.643

Table 11. Firm performance t + 1

Table presents results of OLS panel regression where dependent variable is the natural logarithm of sales at the time *t+1.* Industry fixed-effect controls for differences between different sectors. In parentheses are displayed the t-statistics. Models use Huber–White correction methods for standard error estimation.

	(1)	(2)	(3)	(4)
Intangible assets	**0.065****		**0.083****	
	(2.010)		(2.572)	
Total assets		**0.433*****		**0.442*****
		(8.883)		(9.032)
Asset turnover	-0.007	0.001	-0.023	-0.015
	(-0.243)	(0.049)	(-1.363)	(-0.947)
EBITDA-%	0.006	**0.012****	-0.001	0.005
	(0.994)	(1.977)	(-0.147)	(0.689)
Age	**1.879*****	**1.503*****	**1.797*****	**1.395*****
	(15.527)	(12.870)	(14.499)	(11.447)
Employees	0.055	0.077	-0.009	0.031
	(0.328)	(0.493)	(-0.050)	(0.181)
Board size	-0.072	-0.183	-0.068	-0.168
	(-0.603)	(-1.593)	(-0.583)	(-1.520)
CEO change	-0.488	-0.569	-0.389	-0.461
	(-1.250)	(-1.482)	(-0.974)	(-1.162)
Chair change	-0.380	-0.427	-0.424	-0.457
	(-1.121)	(-1.309)	(-1.271)	(-1.425)
CEO directorship	0.109	0.181	-0.215	-0.185
	(0.421)	(0.728)	(-0.830)	(-0.750)
Chair linkages	**0.225*****	**0.165****	**0.221****	**0.164****
	(2.675)	(2.017)	(2.541)	(1.967)
Other linkages	0.166	0.116	**0.224***	0.155
	(1.447)	(1.062)	(1.942)	(1.414)
New linkages	**0.132***	0.121	**0.168****	**0.162****
	(1.664)	(1.573)	(2.140)	(2.131)
New patents	0.433	0.293	0.180	0.060
	(1.078)	(0.720)	(0.434)	(0.143)
Patent stock	**-0.600****	**-0.649****	0.082	0.015
	(-2.005)	(-2.178)	(0.235)	(0.044)
Patents a priori	0.390	0.508	-0.088	0.110
	(0.849)	(1.136)	(-0.156)	(0.197)
Investment type	**1.407*****	**0.806****	**1.519*****	**0.982*****
	(3.914)	(2.529)	(3.714)	(2.657)
Constant	5.003***	1.518**	9.589***	5.991***
	(9.497)	(2.304)	(16.405)	(8.342)
Industry fixed-effect	No	No	Yes	Yes
Observations	1203	1203	1203	1203
R^2	0.413	0.460	0.503	0.546
Adjusted R^2	0.406	0.452	0.473	0.519

6.3 Robustness tests

In order to check the robustness of the main results, this study employs cross-sectional regression analyses on a yearly basis. Simultaneously, the test provides additional information on the timing of the executed post-investment actions. The tests are presented for innovation intensity and firm performance limiting the variables to those proxying corporate governance, social capital and innovation.

6.3.1 Innovation intensity

Tables 12 and 13 presents results for the year-by-year analysis to examine innovation intensity. Same coefficients show significant impact than those in the panel regressions, yet in terms of social capital, the significant correlations show to cluster to different post-investment years depending on the variable. An increase in the number of chair linkages seem to affect innovation intensity significantly only during years 1 and 2. An increase in other board members' linkages, however, has an opposite effect during the year of investment.

Also, in terms of new linkages, a similar pattern is evident in comparison to the results of the pooled regressions. The results for immediate reaction are still statistically insignificant for throughout the observed time-window. The model with a dependent variable led by one year, on the other hand, shows that the linkages of new board members that have joined the board at the time of investment, have a positive impact on the firm performance. An additional link in the network of the newly joined board member, increases the innovation intensity by 0.2 % for the following year.

Figure 6 in Appendix 4 confirms the observation that is made based on the descriptive statistics that both, the number of new linkages brought in and the number of filed eventually granted new patent applications, decrease significantly during the consecutive years after the initial investment. That also explains why the results of year-by-year analysis show insignificant behavior for the ulterior years after the investment year.

The robustness tests confirm the significant role of the patent stock to innovation intensity subsequently although patents a priori again show a contrarian impact. Also, similarly to the social capital, the role is more significant in the beginning of the investment period.

Models with several lagged variables of corporate governance and social capital changes were tested, but they did not provide significant results. That implies that changes that are made, by the order of the PE investors, are not long lasting. Despite the brief effect, it cannot be denied that increased social capital would not increase innovation. Hence, based on the findings of the regression analyses, the null hypothesis stating that "increase in social capital of the executive board leads to decrease in firm innovation" can be rejected as increase in social capital increases firm innovation.

In conclusion, the results show that PE investors increase the innovation intensity and thus, the result is contrarian to prior findings which suggest that PE investors do not increase innovation (see e.g. Lerner et al., 2011) yet follow the findings of Landry et al. (2002). Nonetheless, the suggested implication is that instead of emerging new innovation, PE investors sustain the innovation in firms that have been innovative already prior to the acquisition.

Table 12. Robustness test: Innovation intensity

Table presents results of OLS cross-sectional regressions year-by-year where dependent variable is a natural logarithm of number of filed new patent applications at the time t. In parentheses are displayed the t-statistics. Models use Huber–White correction methods for standard error estimation.

t	0	1	2	3
Board size	-0.011	-0.003	-0.005	0.005
	(-0.769)	(-0.308)	(-0.587)	(0.624)
CEO change	0.017	-0.068	-0.015	-0.011
	(0.277)	(-1.368)	(-0.333)	(-0.330)
Chair change	0.008	-0.015	-0.025	-0.005
	(0.179)	(-0.457)	(-0.647)	(-0.132)
CEO directorship	0.016	0.027	0.000	-0.017
	(0.437)	(0.924)	(0.015)	(-0.853)
Chair linkages	0.014	0.016	**0.027*****	0.003
	(1.002)	(1.402)	(3.006)	(0.363)
Other linkages	**-0.031****	-0.014	-0.007	0.002
	(-2.017)	(-1.330)	(-0.667)	(0.298)
New linkages	0.002	-0.005	-0.008	-0.006
	(0.153)	(-0.457)	(-0.871)	(-0.571)
Patents a priori	**-0.189***	**-0.495*****	**-0.261*****	**-0.259*****
	(-1.654)	(-5.482)	(-4.093)	(-3.770)
Patent stock	**0.475*****	**0.592*****	**0.343*****	**0.278*****
	(5.224)	(8.824)	(6.012)	(4.287)
Constant	0.153**	0.062	0.073	-0.011
	(2.518)	(1.278)	(1.000)	(-0.274)
Industry fixed-effects	Yes	Yes	Yes	Yes
Observations	401	401	401	401
R^2	0.526	0.611	0.448	0.408
Adjusted R^2	0.441	0.541	0.348	0.301

* p<0.1, ** p<0.05, *** p<0.01

Table 13. Robustness test: Innovation intensity t + 1

Table presents results of OLS cross-sectional regression year-by-year where dependent variable is a natural logarithm of number of filed new patent applications at the time t + 1. In parentheses are displayed the t-statistics. Models use Huber–White correction methods for standard error estimation.

t	0	1	2
Board size	-0.010	-0.005	0.005
	(-0.557)	(-0.539)	(0.481)
CEO change	-0.009	**-0.083***	-0.004
	(-0.156)	(-1.868)	(-0.104)
Chair change	-0.042	-0.032	-0.036
	(-0.796)	(-0.946)	(-1.070)
CEO directorship	0.008	-0.012	-0.027
	(0.220)	(-0.492)	(-1.355)
Chair linkages	0.014	**0.020****	0.002
	(1.042)	(2.222)	(0.296)
Other linkages	-0.023	0.001	-0.001
	(-1.390)	(0.076)	(-0.111)
New linkages	**0.036*****	-0.000	**0.017***
	(2.615)	(-0.030)	(1.691)
Patents a priori	-0.099	**-0.121***	**-0.176*****
	(-0.728)	(-1.790)	(-2.645)
Patent stock	**0.314*****	**0.233*****	**0.198*****
	(3.315)	(4.470)	(3.237)
Constant	0.121*	0.022	0.016
	(1.823)	(0.526)	(0.303)
Industry fixed-effects	Yes	Yes	Yes
Observations	401	401	401
R^2	0.358	0.314	0.295
Adjusted R^2	0.243	0.191	0.169

6.3.2 Firm performance

Tables 14 and 15 show results for robustness tests of firm performance. The most significant finding is that linkages of other board members impose a robust, positive and significant impact on firm performance from year 1 onwards. New linkages on the other hand show a positive effect only in terms of linkages that are brought at the time of investment. However, an interesting observation in Table 15 is that new linkages lose the significance when intangible assets are not included in the model, yet there is not a logical explanation for the phenomena. The reason why new linkages do not show significant results after the first year, is similar to what is explained in the previous chapter concerning innovation intensity; the number of new board members, and consequently new linkages, do not increase significantly after the most impactful changes are made at the time of the investment.

When the observations regarding other linkages and new linkages are combined, it can be concluded that the linkages of the new board members (other than the chair) that join the board at the time of the investment, affect the firm performance positively and significantly at least the first three years of the post-investment period. Since the other linkages show a positive and significant impact for consecutive years, the insignificant value of new linkages in model 2 at time 0 does not weaken the conclusion.

Whereas Guo et al. (2011) finding that CEOs that are replaced at the time of investment, the improvements are greater, the results of this study do not support the suggestion as the change of the CEO does not show a significant impact on firm performance. However, the result is most likely due to the low replacement rate of the CEOs, as the descriptive statistics show. Nonetheless, the above finding concerning changes in the board structure implies that those actions should be completed at the time of investment as they affect firm performance positively at that time. It should be, however, taken on account that the finding can be a product of the fact that most changes are made at the time of investment. Hence, the remarkably greater amount of observations makes the result more likely significant at that time.

A variable that shows positive and significant behaviour throughout the observed time-window, is intangible assets. Furthermore, the impact appears to increase over the years. The finding implies that PE investors focus on the inorganic growth through post-investment mergers and acquisitions as the processes for incremental acquisitions take time to complete and to start affecting the firm performance. However, although the impact on firm performance in terms of sales, is positive, it cannot me concluded whether those transactions have been successful as a whole. For that matter, it would require inspection of the cost structure, and EBITDA and profit margins.

One of the research questions is that if PE investors are able to increase the firm innovation through external linkages, does it consequently increase the firm performance. The conclusion of the results is that PE investors increase innovation intensity and propensity as well as firm performance, and the increase in external resources is one of the main factors behind the effect. However, the increased innovation is not the source for the increase in firm performance.

Table 14. Robustness test: Firm performance

Table presents results of OLS cross-sectional regressions year-by-year where dependent variable is the natural logarithm of sales at the time *t.* Industry fixed-effect controls for differences between different sectors. In parentheses are displayed the t-statistics. Models use Huber–White correction methods for standard error estimation.

t	0	1	2	3
Intangible assets	**0.263*** **	**0.282*** **	**0.470*** **	**0.527*** **
	(4.681)	(4.285)	(7.732)	(8.775)
Board size	**0.449***	0.077	0.158	-0.009
	(1.844)	(0.373)	(0.731)	(-0.039)
CEO change	-0.672	0.187	0.651	1.389
	(-0.878)	(0.273)	(1.081)	(1.511)
Chair change	**1.755** **	0.079	0.415	-0.154
	(2.393)	(0.123)	(0.648)	(-0.177)
CEO directorship	-0.196	-0.600	-0.516	-0.023
	(-0.365)	(-1.096)	(-0.978)	(-0.041)
Chair linkages	0.305	0.254	0.220	0.121
	(1.514)	(1.450)	(1.288)	(0.703)
Other linkages	0.151	**0.523** **	**0.387***	**0.588** **
	(0.523)	(2.192)	(1.667)	(2.585)
New linkages	-0.205	0.009	-0.140	-0.186
	(-1.093)	(0.058)	(-0.902)	(-0.988)
New patents	-0.769	0.813	0.490	-0.256
	(-0.928)	(0.888)	(0.541)	(-0.222)
Patents a priori	**-2.839** **	-0.827	-1.338	-0.440
	(-1.997)	(-0.728)	(-1.169)	(-0.400)
Patent stock	**1.743** **	0.342	0.518	0.226
	(2.111)	(0.439)	(0.729)	(0.343)
Constant	7.408***	7.884***	5.126***	3.929***
	(6.935)	(7.372)	(3.617)	(3.231)
Industry fixed-effects	Yes	Yes	Yes	Yes
Observations	401	401	401	400
R^2	0.380	0.343	0.480	0.483
Adjusted R^2	0.264	0.220	0.382	0.386

* p<0.1, ** p<0.05, *** p<0.01

Table 15. Robustness test: Firm performance t + 1

Table presents results of OLS cross-sectional regressions year-by-year where dependent variable is the natural logarithm of sales at the time *t+1.* Industry fixed-effect controls for differences between different sectors. In parentheses are displayed the t-statistics. Models use Huber–White correction methods for standard error estimation.

	(1)	(1)	(1)	(2)	(2)	(2)
t	0	1	2	0	1	2
Intangible assets	**0.165*** **	**0.347*** **	**0.461*** **			
	(3.026)	(4.988)	(6.867)			
Board size	0.186	0.001	0.069	0.342	0.262	0.400
	(0.798)	(0.006)	(0.252)	(1.450)	(1.228)	(1.425)
CEO change	-1.261	-0.133	-0.140	-1.103	0.290	0.474
	(-1.640)	(-0.149)	(-0.149)	(-1.428)	(0.327)	(0.487)
Chair change	-0.119	0.430	-0.345	0.010	0.378	-0.805
	(-0.170)	(0.592)	(-0.392)	(0.014)	(0.522)	(-0.871)
CEO directorship	-0.130	**-1.039***	-0.311	-0.176	**-1.161***	-0.145
	(-0.245)	(-1.869)	(-0.516)	(-0.324)	(-1.955)	(-0.220)
Chair linkages	**0.407** **	0.208	0.142	**0.455** **	0.218	0.227
	(2.124)	(1.118)	(0.725)	(2.332)	(1.126)	(1.048)
Other linkages	0.259	**0.504** **	**0.449***	0.353	**0.642** **	**0.582** **
	(1.006)	(2.048)	(1.708)	(1.339)	(2.456)	(2.164)
New linkages	**0.354** **	0.003	-0.118	0.283	0.030	-0.052
	(1.997)	(0.017)	(-0.553)	(1.570)	(0.189)	(-0.216)
New patents	0.623	0.413	0.490	0.616	0.637	0.600
	(0.799)	(0.487)	(0.521)	(0.781)	(0.786)	(0.646)
Patents a priori	-0.653	-1.684	-1.054	-0.857	-1.591	-1.229
	(-0.581)	(-1.283)	(-0.942)	(-0.761)	(-1.218)	(-1.002)
Patent stock	0.459	0.626	0.674	0.675	0.825	1.076
	(0.641)	(0.786)	(1.029)	(0.944)	(1.079)	(1.649)
Constant	9.723***	7.726***	5.394***	10.569***	10.211***	8.168***
	(10.325)	(6.845)	(3.247)	(11.516)	(9.609)	(4.600)
Industry fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	401	401	401	401	401	401
R^2	0.320	0.392	0.375	0.297	0.318	0.246
Adjusted R^2	0.193	0.278	0.258	0.168	0.192	0.107

* p<0.1, ** p<0.05, *** p<0.01

7 Conclusion

This study investigates the effect of corporate governance practices and social capital on innovation and firm performance after a Finland-based company has received funding from a VC or BO fund between years 2010 and 2015. The study is conducted by examining 401 deals for the post-investment innovation and firm performance with logistic and OLS panel regressions. The main results are reviewed in robustness checks in the form of cross-sectional regression analysis conducted on a yearly basis.

Theories and prior results from research concerning private equity sector, corporate governance and social capital create the foundation the empirical analysis of this study. There is a never-ending debate in the academia whether private equity investors aim to increase the target firm's performance sustainably in the long-run or to maximise own profits for shorter time-horizon. To this day, private equity investors have been known to focus more on corporate governance practices to improve the economic efficiencies in the target firm. However, since principles of economics state that technological development is the key element to sustain economic growth in the long run, innovation has been presented to be the solution for the dilemma.

Prior empirical results show that board members' social capital affects firm innovation significantly, but it has remained inconclusive whether the effect is positive or negative. A general assumption is that higher level of social capital is linked to larger set of external resources and hence, would also improve firm innovation and consequently firm performance.

The key finding of the empirical analysis is that increased social capital is positively associated with both innovation and firm performance and the result is consistent with prior empirical findings. Especially, the new directors are able to create value in the company by bringing additional external resources through their other board connections. Combining the results of board size and social capital, it is evident that although board size

does not increase remarkably, the changes PE investors make in the board structure increase both innovation and firm performance. However, there does not seem to be correlation between these two effects. Hence, it can be concluded that PE investors increase the innovation in companies that have been innovative already before the acquisition. However, the increased innovation does not affect the firm performance meaning that there is no evidence of successful commercialisation of the inventions.

Moreover, the strong and significant positive effect of intangible assets against firm performance indicates that PE investors focus more on inorganic growth created through mergers and acquisitions than spurring organic growth through innovation. Nevertheless, it can be stated that the increased social capital the PE investors bring with them to the firm, is one of the possible reasons and source for the returns above market average that they have been able generate. That implication is a plausible idea for further research as the deduction cannot be confirmed without comparison to a control group.

Finally, as stated in the beginning, innovation is one of the primary sources for sustainable economic growth. In the light of above presented evidences, private equity sector's role to increase economic growth in the long-run is questionable. Nonetheless, that is a seed for another research.

The setup of this study could also be extended in the future to examine the links between board of directors and fund-level characteristics as well as the board members personal characteristics and background. Possible research questions could be whether the number of linkages and number of external board seats are correlated with the acquired share and level of engagement to the firm. Then on the other hand, is the population of well-connected individuals homogenous and what kind of attributes are they appointed with. In the end, it would be important to know whether there is a threshold where additional external linkages bring harm than good.

Finally, since the insignificant result of CEO replacements is most likely an outcome of low replacement rate, it would be intriguing to know 1) what kind of impact the few new CEOs have had on the firm, and 2) would higher replacement rate have positive or negative impact on firm innovation and performance. Naturally, the CEOs characteristics and compatibility play an important role to the success so a research of the key competences would add value for the investors that review the candidates.

7.1 Limitations

The limitations of this study are mostly a result of limited availability of the data. Innovation as a concept is abstract and vast, but the focus is here limited to patent activity. As previously mentioned, other studies have used before also for example R&D expenses but due to limited availability of data of those, patenting activity is chosen as the used approach and measure. Another methodological limitation is that the results have not been compared to a control group. Thus, interpretation of the results requires caution. For example, it is not proven that the new linkages brought by the PE investor add more value than new linkages in a firm that has not received PE-funding.

In terms of social capital, the border line is drawn to include only the CEO and the board members. First of all, the topic of the study would have become too wide and second, the data concerning other external experts and consultants included in the investment process is scarce. Also, the data of external linkages is limited to individuals that have Finnish personal identification number. Finally, the time-window is limited to start from year 2010 as deals before that are not provided in the data set that was received from the Finnish Venture Capital Association.

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Appendices

Appendix 1. NACE Rev. 2 industry codes

Table 16. Industry codes and sample distribution

Code	NACE Rev. 2	Count
10	Manufacture of food products	1
13	Manufacture of textiles	1
16	Manufacture of wood	2
17	Manufacture of paper and paper products	3
18	Printing and reproduction of recorded media	1
20	Manufacture of chemicals and chemical products	2
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	1
22	Manufacture of rubber and plastic products	4
23	Manufacture of other non-metallic mineral products	2
24	Manufacture of basic metals	2
25	Manufacture of fabricated metal products, except machinery and equipment	7
26	Manufacture of computer, electronic and optical products	18
27	Manufacture of electrical equipment	6
28	Manufacture of machinery and equipment n.e.c.	6
29	Manufacture of motor vehicles, trailers and semi-trailers	2
30	Manufacture of other transport equipment	2
32	Other manufacturing	11
33	Repair and installation of machinery and equipment	1
35	Electricity, gas, steam and air conditioning supply	1
41	Construction of buildings	3
42	Civil engineering	4
43	Specialised construction activities	6
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	1
46	Wholesale trade, except of motor vehicles and motorcycles	11
47	Retail trade, except of motor vehicles and motorcycles	9
52	Warehousing and support activities for transportation	1
55	Accommodation	2
56	Food and beverage service activities	2
58	Publishing activities	2
59	Motion picture, video and television programme production, sound recording and music publishing activities	1
61	Telecommunications	6
62	Computer programming, consultancy and related activities	101
63	Information service activities	12
64	Financial service activities, except insurance and pension funding	5
66	Activities auxiliary to financial services and insurance activities	3
68	Real estate activities	2
70	Activities of head offices; management consultancy activities	12
71	Architectural and engineering activities; technical testing and analysis	22
72	Scientific research and development	22
73	Advertising and market research	2
74	Other professional, scientific and technical activities	4
75	Veterinary activities	1
77	Rental and leasing activities	2
79	Travel agency, tour operator and other reservation service and related activities	1
81	Services to buildings and landscape activities	1
82	Office administrative, office support and other business support activities	3
86	Human health activities	12
87	Residential care activities	1
88	Social work activities without accommodation	3
90	Creative, arts and entertainment activities	1
93	Sports activities and amusement and recreation activities	5
96	Other personal service activities	2
99	Activities of extraterritorial organisations and bodies	2
	∑	340

Appendix 2. Descriptive statistics: buyout transactions

Table 17. BO transactions year 0

	Mean	SD	Min	Max
Board size	3.17	1.42	0.00	7.00
CEO change	0.20	0.40	0.00	1.00
Chair change	0.48	0.50	0.00	1.00
CEO directorship	0.37	0.48	0.00	1.00
Chair linkages	53.27	45.24	0.00	180.00
Other linkages	99.53	83.64	0.00	364.00
New linkages	75.11	65.53	0.00	273.00
Patents a priori	0.20	0.40	0.00	1.00
Patent stock	2.16	8.30	0.00	58.68
New patents	0.39	1.89	0.00	15.00
High Tech	0.12	0.32	0.00	1.00
Observations	95	95	95	95

Table 18. BO transactions year 1

	Mean	SD	Min	Max
Board size	3.38	1.39	0.00	7.00
CEO change	0.11	0.31	0.00	1.00
Chair change	0.23	0.42	0.00	1.00
CEO directorship	0.32	0.47	0.00	1.00
Chair linkages	50.66	44.75	0.00	207.00
Other linkages	92.32	77.49	0.00	339.00
New linkages	20.78	42.15	0.00	228.00
Patents a priori	0.20	0.40	0.00	1.00
Patent stock	2.07	7.64	0.00	54.88
New patents	0.23	0.88	0.00	5.00
High Tech	0.12	0.32	0.00	1.00
Observations	95	95	95	95

Table 19. BO transactions year 2

	Mean	SD	Min	Max
Board size	3.47	1.36	0.00	7.00
CEO change	0.14	0.35	0.00	1.00
Chair change	0.18	0.39	0.00	1.00
CEO directorship	0.33	0.47	0.00	1.00
Chair linkages	55.68	47.06	0.00	205.00
Other linkages	93.17	83.36	0.00	401.00
New linkages	13.82	29.19	0.00	141.00
Patents a priori	0.20	0.40	0.00	1.00
Patent stock	1.85	6.70	0.00	47.65
New patents	0.09	0.46	0.00	4.00
High Tech	0.12	0.32	0.00	1.00
Observations	95	95	95	95

Table 20. BO transactions year 3

	Mean	SD	Min	Max
Board size	3.52	1.52	0.00	7.00
CEO change	0.16	0.37	0.00	1.00
Chair change	0.19	0.39	0.00	1.00
CEO directorship	0.26	0.44	0.00	1.00
Chair linkages	52.26	48.90	0.00	210.00
Other linkages	89.29	80.58	0.00	338.00
New linkages	10.51	23.07	0.00	117.00
Patents a priori	0.20	0.40	0.00	1.00
Patent stock	1.75	6.31	0.00	45.50
New patents	0.18	0.85	0.00	6.00
High Tech	0.12	0.32	0.00	1.00
Observations	95	95	95	95

Appendix 3. Descriptive statistics: venture capital transactions

Table 21. VC transactions year 0

	Mean	SD	Min	Max
Board size	3.48	1.47	0.00	9.50
CEO change	0.15	0.35	0.00	1.00
Chair change	0.26	0.44	0.00	1.00
CEO directorship	0.51	0.50	0.00	1.00
Chair linkages	25.57	32.15	0.00	211.00
Other linkages	58.77	59.81	0.00	341.00
New linkages	29.64	41.53	0.00	222.00
Patents a priori	0.30	0.46	0.00	1.00
Patent stock	1.34	2.95	0.00	17.95
New patents	0.33	1.14	0.00	12.00
High Tech	0.59	0.49	0.00	1.00
Observations	306	306	306	306

Table 22. VC transactions year 1

	Mean	SD	Min	Max
Board size	3.78	1.45	0.00	9.00
CEO change	0.12	0.32	0.00	1.00
Chair change	0.19	0.40	0.00	1.00
CEO directorship	0.47	0.50	0.00	1.00
Chair linkages	31.35	37.83	0.00	231.00
Other linkages	67.58	62.86	0.00	321.00
New linkages	10.98	29.11	0.00	212.00
Patents a priori	0.30	0.46	0.00	1.00
Patent stock	1.47	3.21	0.00	26.26
New patents	0.33	1.15	0.00	11.00
High Tech	0.59	0.49	0.00	1.00
Observations	306	306	306	306

Table 23. VC transactions year 2

	Mean	SD	Min	Max
Board size	3.83	1.36	0.00	8.00
CEO change	0.14	0.34	0.00	1.00
Chair change	0.18	0.38	0.00	1.00
CEO directorship	0.44	0.50	0.00	1.00
Chair linkages	36.07	43.52	0.00	249.00
Other linkages	72.31	66.29	0.00	292.00
New linkages	10.33	28.34	0.00	173.00
Patents a priori	0.30	0.46	0.00	1.00
Patent stock	1.42	3.12	0.00	23.32
New patents	0.17	0.83	0.00	8.00
High Tech	0.59	0.49	0.00	1.00
Observations	306	306	306	306

Table 24. VC transactions year 3

	Mean	SD	Min	Max
Board size	3.86	1.42	0.00	7.00
CEO change	0.09	0.29	0.00	1.00
Chair change	0.16	0.37	0.00	1.00
CEO directorship	0.40	0.49	0.00	1.00
Chair linkages	38.38	47.82	0.00	275.00
Other linkages	75.62	73.65	0.00	348.00
New linkages	7.59	22.42	0.00	174.00
Patents a priori	0.30	0.46	0.00	1.00
Patent stock	1.29	2.83	0.00	19.82
New patents	0.08	0.50	0.00	7.00
High Tech	0.59	0.49	0.00	1.00
Observations	306	306	306	306

Appendix 4. Graphical representation of new linkages and new patents

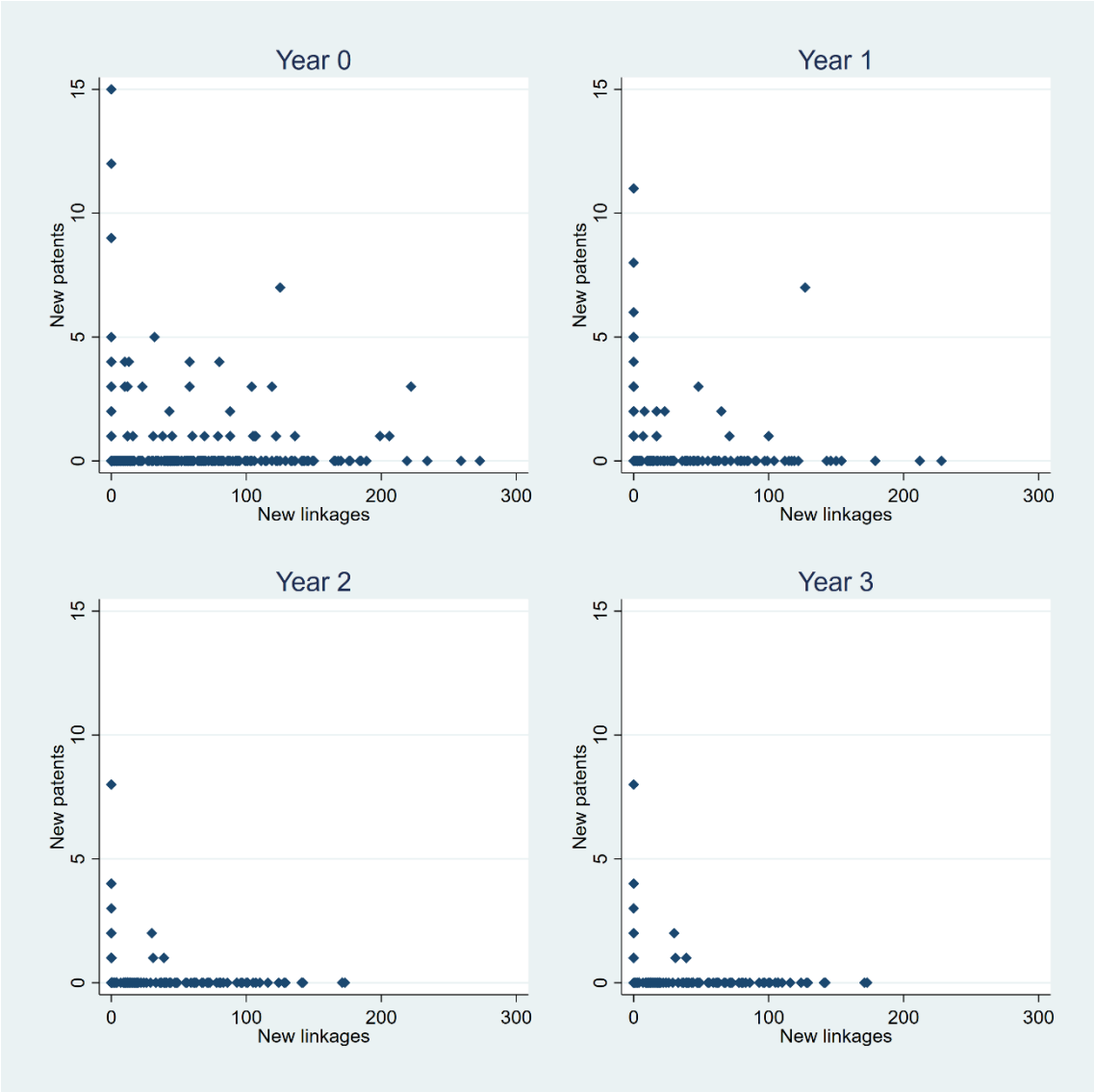

Figure 6. New linkages and new patents t + 1 scatter plot